AC_____

Item No. _____

UNIVERSITY OF MUMBAI

Bachelor of Engineering
In
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

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year2019–2020)

AC_____
Item No. _____

UNIVERSITY OF MUMBAI

Sr. No.	Heading	Particulars
1	Title of the Course	T.Y of B.E in Instrumentation Engineering
2	Eligibility for Admission	**After Passing Second Year Engineering as per the Ordinance 0.6242**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6242**
5	No. of Years / Semesters	**8 semesters**
6	Level	~~P.G.~~ / **U.G.**/ ~~Diploma / Certificate~~ (Strike out which is not applicable)
7	Pattern	~~Yearly~~ / **Semester** (Strike out which is not applicable)
8	Status	~~**New**~~ / Revised **REV- 2019 'C' Scheme**
9	To be implemented from Academic Year	**With effect from Academic Year: 2021-2022**

Date:

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr. Anuradha Majumdar
Dean
Faculty of Science and Technology
University of Mumbai

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. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 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.

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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.

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Dr. Anuradha Muzumdar
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Faculty of Science and Technology
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PREAMBLE

Technical education in our country is progressing rapidly in manifolds. To maintain the quality of education a systematic approach is necessary,which can beobtained by building a strong technical base with the quality. Accreditation provides quality assurance in higher education and recognition to the institution or program, meeting certain specified standards. The main-focus of an accreditation process is to measure the program outcomes, essentially the range of skills and knowledge that a student will have at the time of graduation from the program. Faculty of Science & Technology of the University of Mumbai has taken a lead in incorporating a philosophy of outcome-based education in the process of curriculum development. The earlier syllabus was more focused on providing information and knowledge across various domains, which led to loading of students heavily, in terms of direct contact hours.

I, as a Chairman, Board of Studies in Instrumentation Engineering of University of Mumbai, happy to state here that,the revised curriculum focused on not only providing knowledge content but also on skill-based activities like attitudes, self-learning, and project-based activities.More than 30 senior faculty members from the different affiliated institutes of University of Mumbai were actively participated in this process. They are either Heads of Departments or their senior representatives from the Department of Instrumentation Engineering. The salient features of revised syllabus of Instrumentation Engineering, REV 2019 'C' Scheme are:

1. The overall credits and approach of the curriculum proposed in the present revision are in line with AICTE model curriculum.
2. Course objectives and course outcomes are framed as per NBA guidelines (Bloom's Taxonomy) and are clearly defined for each course.
3. Detailed guidelines are presentedto understand the depth and the approach to course to be taught, which will enhance learner's learning process.
4. The credit and grading system enables a learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching.
5. Minimizes the burden of contact hours, total credits of the entire program will be approximately 172. Learners are now getting sufficient time for self-learning either through online courses or additional projects for enhancing their knowledge and skillsets.
6. It also focuses on continuous evaluation which will enhance the quality of education.
7. Credit assignment for courses is based on 15 weeks teaching-learning process, however, the content of courses is to be taught in 12-13 weeks and the remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond the syllabus, etc.
8. The revised curriculum emphasizes on skill-based laboratories and project-based learning by introducing mini projects in the second and third year of programs, which will facilitate self-learning of students.

Dr. Alice Cheeran - Chairperson (BoS in Instrumentation Engineering)
Dr. Mukesh D. Patil - Member
Dr. M. J. Lengare - Member

Dr. Sharad P. Jadhav - Member
Dr. Dipak Gawali– Member

Program Structure for Second Year Instrumentation Engineering
(With Effect from 2021-2022)
Scheme for Semester- V

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
ISC501	Electrical Machines and Drives	3	--	3	--	3
ISC502	Applications of Microcontroller	3	--	3	--	3
ISC503	Control System Design	3	--	3	--	3
ISC504	Process Instrumentation System	3	--	3	--	3
ISDOC501X	DepartmentOptionalCourse-1	3	--	3	--	3
ISL501	Electrical Machines and Drives Lab	--	2	--	1	1
ISL502	Applications of Microcontroller Lab	--	2	--	1	1
ISL503	Process Instrumentation and Control System Design Lab	--	2	--	1	1
ISL504	Professional Communication and Ethics-II	--	2*+2	--	2	2
ISM501	MiniProject–2 A	--	4$	--	2	2
Total		**15**	**14**	**15**	**07**	**22**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	PR &OR	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test1	Test2	Avg					
ISC501	Electrical Machines and Drives	20	20	20	80	3	--	--	100
ISC502	Applications of Microcontroller	20	20	20	80	3	--	--	100
ISC503	Control System Design	20	20	20	80	3	--	--	100
ISC504	Process Instrumentation System	20	20	20	80	3	--	--	100
ISDOC501X	Department Optional Course– 1	20	20	20	80	3	--	--	100
ISL501	Electrical Machines and Drives Lab	--	--	--	--	--	25	25	50
ISL502	Applications of Microcontroller Lab	--	--	--	--	--	25	25	50
ISL503	Process Instrumentation and Control System Design Lab	--	--	--	--	--	25	25	50
ISL504	Professional Communication and Ethics-II	--	--	--	--	--	25	25 (Internal)	50
ISM501	MiniProject–2 A	--	--	--	--	--	25	25	50

Total	--	--	**100**	**400**	--	**125**	**125**	**750**

* Theory class to be conducted for full class

$ indicates workload of Learner (Not Faculty), for Mini Project

Program Structure for Second Year Instrumentation Engineering

(With Effect from 2021-2022)

Scheme for Semester -VI

Course Code	CourseName	TeachingScheme (ContactHours)		CreditsAssigned		
		Theory	Pract. Tut.	Theor	Pract.	Total
ISC601	Industrial Process Control	3	--	3	--	3
ISC602	Digital Signal Processing	3	--	3		3
ISC603	Industrial Data Communication	3	--	3	--	3
ISDOC601X	Department Optional Course– 2	3	--	3	--	3
ISL601	Industrial Process Control Lab	--	2	--	1	1
ISL602	Digital Signal Processing Lab	--	2	--	1	1
ISL603	Python Programming Lab	--	4#	--	2	2
ISM601	MiniProject–2 B	--	4$	--	2	2
Total		**12**	**12**	**12**	**06**	**18**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	PR & OR	Total
		Internal Assessment			End Sem Exam	Exam. Duration (inHrs)			
		Test1	Test	Avg					
ISC601	Industrial Process Control	20	20	20	80	3	--	--	100
ISC602	Digital Signal Processing	20	20	20	80	3	--	--	100
ISC603	Industrial Data Communication	20	20	20	80	3	--	--	100
ISDOC601X	Department Optional Course– 2	20	20	20	80	3	--	--	100
ISL601	Industrial Process Control Lab	--	--	--	--	--	25	25	50
ISL602	Digital Signal Processing Lab	--	--	--	--	--	25	25	50
ISL603	Python Programming Lab	--	--	--	--	--	25	25	50
ISM601	MiniProject–2 B	--	--	--	--	--	25	25	50
Total				**80**	**320**		**100**	**100**	**600**

$ indicates workload of Learner (Not Faculty), for Mini Project.

out of 4 hours, 2 hours theory shall be taught to entire class and 2 hours practical in batches

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)

ISDOC6011	Instrumentation for Agriculture	**No Lab work**
ISDOC6012	Optimization Techniques	
ISDOC6013	Database Management Systems	
ISDOC6014	Biosensors and Signal Processing	

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISC501	Electrical Machines and Drives	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.					
ISC501	Electrical Machines and Drives	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISC501	Electrical Machines and Drives	3
Course Objectives	1. To learn the basic concept and characteristics of Electrical motors. 2. To equip the students with the knowledge of semiconductor devices & their applications.	
Course Outcomes	Students will be able to: 1. Explain working of DC motors and study their characteristics. 2. Describe the working principle of 3-phase I.M. 3. Discuss the constructional features of single-phase I.M. 4. Compare basic characteristics and ratings of power electronic devices. 5. Use controlled rectifiers, Inverters & choppers with different loads. 6. Illustrate working of AC & DC drives.	

Module	Contents	Hours	CO Mapping
Prerequisite: Knowledge of Faraday's laws, Lenz's law. Semiconductor devices such as diodes and transistors and their characteristics.			
1.	**DC Machines** Types of DC motors, EMF equation generating & motoring action. Characteristics of DC motors. Speed control methods of DC motors (Numerical Based on Speed control and torque calculation). A selection criterion of DC motors for various applications.	07	CO1
2.	**3-Phase Induction Motors** Construction & working principle of 3-phase IM. Slip, rotor frequency torque slip characteristic, power stages in IM, Numericals based on torque calculation.	06	CO2
3.	**Fractional Horse Power (HP) Motors** Construction & working principle of 1-phase I. M. split phase IM. Shaded pole IM Basic, concepts of Stepper Motor, Servomotor, BLDC Motor.	04	CO3
4.	**Semiconductor Devices** Introduction, characteristic, ratings & applications of power diode, power BJT, power MOSFET & IGBT Construction & characteristic, ratings of SCR, TRIAC. Triggering methods of Thyristors using DIAC, UJT & PUT only, Commutation methods of Thyristors.	06	CO4
5.	**Applications of Power Semiconductor Devices** Controlled Rectifier: Principle of operation of 1-phase controlled converters, 1-phase half bridge& full bridge converter performance with R-L load. Basic operation of 3- phase converter. AC power control with TRIAC-DIAC Inverter: Principle of operation of basic inverter, bridge inverter, PWM inverter DC-to-DC Converter: Basic operation of chopper, study of different types of chopper circuit like step up & step down chopper.	10	CO5
6.	**Drives** DC motor drives: 1-phase & 3-phase converter drives for continuous & discontinuous operation, chopper fed drive. AC motor drives and control: Control strategies of IM like stator voltage control & frequency control. Variable frequency VSI drives. Variable frequency CSI drives.	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. Nagrath I.J., Kothari D.P., Electrical Machines, second edition, Tata McGraw Hill, New Delhi.
2. B. L. Theraja, Fundamentals of Electrical & Electronics, S.Chand, Technical.
3. V.K. Mehta, Rohit Mehta, Principles of Electrical Engg. & Electronics, S.Chand
4. P.S. Bhimbra, Power Electronics, Khanna publishers, 2004
5. M. H. Rashid, Handbook of Power Electronics, 2nd Edition, PHI, 2005.
6. M.D. Singh, Khanchandani, Power Electronics, Tata Mcgraw-Hill Education.

Reference Books:

1. Say M. G.,The performance & Design of Alternating Current Machines, 3rd edition, Oxford University
2. P.C. Sen, Power Electronics, Tata McGraw Hill, 2005
3. Mohan Undeland Robbins, Power Electronics- Converters application & Design, Wiley Eastern,1996
4. Dubey, Dorald, Thyristorised Power Controller, Wiley Eastern Ltd.1993
5. S.K. Bhattacharya, Industrial Electronics & Control, TATA McGraw Hill, 2007
6. B.K.Bose, Modern power Electronics & AC Drives Pearson Education Inc.2002.

Subject Code	Subject Name	Teaching Scheme	Credits Assigned					
ISC502	**Applications of Microcontroller**	Theory	PR	Tut.	Theory	PR	Tut.	Total
		3	-	-	3	-	-	3

Subject Code	Subject Name	Examination scheme							
		Theory Marks (100)				Term work	PR and OR	Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Avg.					
ISC502	**Applications of Microcontroller**	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISC502	**Applications of Microcontroller**	**3**
Course objectives	1. To give overview of embedded systems and make aware of design challenges and technology. 2. To impart knowledge of fundamentals of MCS-51 microcontroller family and working of the system. 3. To make the students understand various programming tools and development of software using assembly and higher level language. 4. To give knowledge of integrated hardware of MCS-51 5. To give knowledge of interfacing of MCS-51 with different peripheral devices such as LCD, keyboard, Memory, ADC, DAC etc. 6. To make the students capable to develop application using learned concepts of hardware, software and interfacing.	
Course Outcomes	The students will be able to: 1. Identify the technology in the area of embedded systems. 2. Explain the comparative study of various microcontrollers and microprocessors. 3. Outline the knowledge of operation of integrated hardware components. 4. Explain programming tools and design software programs in assembly or‟ C language. 5. Solve and construct interfacing of peripheral components with MCS51 and Arduino. 6. Investigate, recommend and design the sophisticated application based on MCS-51 such as Traffic light control, Digital weighing machine etc.	

Details of Syllabus:

Prerequisite: Knowledge of Digital Electronics, Programming skills.

Module	Content	Hrs	CO Mapping
1	**Introduction to Embedded systems** Overview of embedded system and examples, Design trends in Embedded systems. RISC and CISC processors. Introduction to Embedded platforms like MCS51, Arduino, Raspberry PI, ARM and PIC development boards	05	CO1
2	**MCS-51 Microcontroller** Architecture of MCS51 family of microcontroller, and its Variants and comparison. Memory organization and SFRS. Programming model.	04	CO2
3	**MCS 51 Programming and tools** Simulator, in-circuit debugger, in-circuit emulator, programmers, integrated development environment (IDE), cross compilers. Merits & demerits of above tools. Assembly language programming process. Programming tools. Instruction set, addressing modes. Programming practice using assembly & C compiler.	10	CO3
4	**Integrated peripherals of MCS 51** Integrated peripherals such as Timers/Counters, Interrupt, serial port and programming.	05	CO4
5	**MCS 51 Interfacing** Interfacing with Memories, 7 segment display, LCD, ADC, DAC, relay, opto-isolator, DC motor and Stepper Motor. **Arduino Interfacing**	10	CO5
6	**Case Studies** Data acquisition systems, Digital weighing machine, Washing machines, Traffic light controller, Home automation and irrigation	05	CO6

Internal Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules)

End Semester Theory Examination:

1. Question paper will comprise of 6questions, each carrying 20 Marks.
2. Total 4 questions need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus where in 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. Mazidi M.A.,The8051 Microcontroller & Embedded systems, Pearson Education Second edition.2006
2. Kenneth Ayala,The8051 Microcontroller, Thomson Delmar Learning, Third Edition.2005
3. Steve Heath, Embedded Systems Design, Newness publication, Second edition, ISBN 0 7506 5546

Reference Books:

1. David Simon, Embedded Software Primer, Pearson Education, ISBN 81-7808-045-
2. Tony Givargis, Embedded System Design: A Unified Hardware/Software Introduction, Wiley Student Edition. ISBN No.812650837X
3. P.S. Manoharan, P. S. Kannan, Microcontroller based system design, SciTech Publications (India) Pvt. Ltd. ISBN No. 8183715982
4. 8051 / MC151 / MCS251Datasheets
5. Microcontrollers-Architecture, Programming, Interfacing and System Design, Pearson Education India; Second edition(2011),ISBN-10: 8131759903.

Websites:

1. www.atmel.com
2. www.microchip.corn
3. www.nxp.com.

Subject Code	Subject Name	Teaching Scheme	Credits Assigned					
ISC503	**Control System Design**	Theory	PR	Tut.	Theory	PR	Tut.	Total
		3	-	-	3	-	-	3

Subject Code	Subject Name	Examination scheme							
		Theory Marks (100)				Term work	PR and OR	Oral	Total
		Internal Assessment (20)			End Sem Exam				
		Test1	Test2	Avg.					
ISC503	**Control System Design**	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISC503	**Control System Design**	**3**
Course objectives	1. To develop the skills to represent the system in state space form. 2. To impart knowledge required to design state feedback controller and state estimator. 3. To develop the skills to design the compensator in time and frequency domain and to design the PID compensator.	
Course Outcomes	The students will be able to: 1. Obtain state-space model of electrical circuits, translational/rotational mechanical systems and electromechanical systems etc with emphasis on linear time-invariant systems 2. Obtain solution of state equations by using Laplace transform methods, Cayley Hamilton method etc. 3. Examine system for its stability, controllability and observability and design controller and observer with given transient specifications. 4. Design Lead, Lag and Lead –lag compensator using time domain method. 5. Design Lead, Lag and Lead –lag compensator using frequency domain method. 6. Study the PID controller tuning by Ziegler Nicholas and Cohen-coon methods	

Details of Syllabus:

Prerequisite: Knowledge of Matrix algebra, Root-locus, Bode-plot and Nyquist stability criterion.

Module	Content	Hrs	CO Mapping
1	**State Space Representation of Continuous Time Systems:** Terminology of state space representation, advantages of state space representation over classical representation, physical variable form, phase variable forms: controllable canonical form (companion I), observable canonical form (companion II), diagonal/Jordon canonical form (parallel realization), cascade realization, conversion of state model to transfer function. Similarity transformation for diagonalization of a plant matrix, Vander Monde matrix.	08	CO1
2	**Solution of State Equation:** State Transition Matrix and its properties, computation of state transition matrix using Laplace transformation method, state solution to the homogeneous & non homogeneous differential equations	04	CO2
3	**Analysis and Design of Control System in State Space:** Controllability, and observabilityproperties. Necessary and sufficiency conditions for complete state controllability and observability. State feedback structure, Pole placement design using state feedback. State observers – Full state observer.(Numerical examples on full-state observer are avoided)	07	CO3
4	**Introduction to Compensator:** Derivative and integral error compensation, Analysis of the basic approaches to compensation, cascade compensation, feedback compensation **Compensator Design using Root-locus:** Improving steady-state error and transient response by feedback compensation, cascade compensation, Lag, Lead, Lag-Lead compensation	08	CO4
5	**Compensator Design using Frequency response:** Systems with time delay, transient response through gain adjustment, Lag, Lead, Lag-Lead compensation.	08	CO5
6	**PID Controller Design:** PID controller tuning: Ziegler-Nichols method, Cohen-coon method, Designing PID controller using Root-Locus.	04	CO6

Internal Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules)

End Semester Theory Examination:

1.Question paper will comprise of 6questions, each carrying 20 Marks.
2.Total4questions need to be solved.
3.Question No. 1 will be compulsory and based on entire syllabus where in 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. K. Ogata, Modern Control Engineering, Prentice Hall of India, 4th edition, 2002

2. M. Gopal, Control Systems Principles and Design, TMH, New Delhi, 2nd edition,2002

Reference Books:

1. Norman S. Nise, Control Systems Engineering, John Wiley and Sons, Inc. 2000.

2. Francis Raven, Automatic Control Engineering, 5thedition McGraw-Hill

International Edition,

3. G. C. Goodwin, S. F. Graebe, M.E. Salgado, Control System Design, Pearson education

4. B. C. Kuo “Automatic control systems”, Prentice Hall of India.

5. M. Gopal, Control Systems Principles and Design, TMH, New Delhi, 2n edition, 2002.

6. Stefani, Shahian, Savant, Hostetter, Design of Feedback Control Systems, Oxford University Press, 4thEdition, 2007.

7. Richard C. Dorf, Robert H. Bishop, Modern Control Systems, Addition-Wesley,1999.

8. I.J.Nagrath and M. Gopal, Control System Engineering, 3rdEdition, New Age International (P) Ltd., Publishers - 2000.

9. B.C. Kuo, Farid Gdna Golnaraghi, Automatic Control Systems, PHI, 7th edition, 2003.

10. M. N. Bandopadhay, Control Engineering - Theory &Practice, PHI, 2003.

Subject Code	Subject Name	Teaching Scheme	Credits Assigned					
		Theory	PR.	Tut.	Theory	PR	Tut.	Total
ISC504	**Process Instrumentation System**	3	-	-	3	-	-	3

Subject Code	Subject Name	Examination scheme							
		Theory Marks (100)				Term work	PR and OR	Oral	Total
		Internal Assessment			End Sem Exam				
		Test 1	Test2	Avg.					
ISC504	**Process Instrumentation System**	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISC503	**Control System Design**	**3**
Course Objectives	1. To make the students to familiar with different Process Dynamics & process control actions. 2. Students are expected to learn classification & working of Controllers & Tuning Methods. 3. Students are expected to understand various control schemes. 4. To familiarize concept of Multivariable Control & Discrete state process control requirement.	
Course Outcomes	The students will be able to: 1. Understand & Learn Process Control Terminologies, Process Dynamics & their mathematical model. 2. Understand different types of control actions & their selection. 3. Learn Features & Classify controllers like electronic, pneumatic and Hydraulic & their Tuning Techniques. 4. Learn various process control schemes & their applications and selection. 5. Understand Multivariable Control systems & their Interaction 6. Develop relay logic for various processes & symbols.	

Details of Syllabus:

Prerequisite: Measurement of physical parameters, sensors/transducers and basic control system.

Module	Content	Hrs	CO Mapping
1	**Introduction to Process Control** Process Control Terminology, Development of Typical Process Control loops like Pressure, Temperature, flow & Level. Process characteristics, control system parameters, Dynamic elements in a control loop, Dead time processes and smith predictor compensator. Inverse response behavior of processes and compensator. Dynamic behavior of first and second order systems. Interacting and non-interacting systems. Development of Mathematical Model for first & second order system with Example.	08	CO1
2	**Process Control Actions** Types-Discontinuous, continuous (P, I, D) and composite control actions (PI, PD, and PID), Effects of control actions, selection criteria.	04	CO2
3	**Process Controllers and Tuning** Need for controller, General features, specifications, classification& working of Pneumatic, Hydraulic and Electronic controllers. Need for controller Tuning. Tuning Methods-Process reaction curve method, Ziegler-Nichols method, Cohen coon correction for quarter amplitude, Frequency response method, Relay based tuning. Concept of Auto Tuning. Introduction to Model based Controller.	10	CO3
4	**Control Schemes** Feedback, Feed forward, cascade, Ratio, split range, selective control, adaptive control, inferential control, and selection Guidelines.	06	CO4
5	**Multivariable Control** Introduction to MIMO systems, Block diagram analysis of multivariable systems, Interaction, relative gain analysis, Decoupler design	04	CO5
6	**Discrete-State process control** Need for Discrete state process control systems, process specification and event sequence description, Relay Logic symbols, Development of Relay ladder Logic diagram and case study examples.	07	CO6

Internal Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules)

End Semester Theory Examination:

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

Books Recommended:

Text Books:

1. Curtis D. Johnson, "Process Control Instrumentation Technology", PHI /Pearson Education 2002.

2. George Stephanopoulos, "Chemical process control", PHI-1999.

Reference Books:

1. Bela G. Liptak, "Instrument Engineer"s Hand Book – Process Control", Chilton Company, 3rdEdition, 1995.

2. M.Chidambaram, "Computer Control of Processes", Narosa, 2002.

3.Deshpande P.B and Ash R.H, "Elements of Process Control Applications", ISA Press, New York, 1995.

4.D. Patranabis, "Principles of Process Control", Second edition, TMH.

5.F.G. Shinsky, "Process Control System", TMH.

6.N.E. Battikha, "Condensed Handbook of Measurement and Control",3rd Edition., ISA Publication.

7.Donald P. Eckman, "Automatic Process Control", Wiley Eastern Ltd.

8.Franklyn W. Kirk, Nicholas R. Rimboi, "Instrumentation", First edition,1996, D.

Subject Code	Subject Name	Teaching	Credits Assigned					
ISDOC 5011	**Analytical Instrumentation**	Theory	PR	Tut.	Theory	PR	Tut.	Total
		3	-	-	3	-	-	3

Subject Code	Subject Name	Examination scheme							
		Theory Marks (100)				Term work	PR and OR	Oral	Total
		Internal Assessment (20)			End Sem Exam				
		Test1	Test2	Avg.					
ISDOC 5011	**Analytical Instrumentation**	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISDOC5011	**Analytical Instrumentation**	**3**
Course objectives	1. Introduce the basic concept of qualitative and quantitative analysis of a given sample. 2. Study various spectroscopic techniques and its instrumentation. 3. Study the concept of separation science and its applications. 4. Study the concept of radiochemical analysis along with industrial analyzers.	
Course Outcomes	The students will be able to: 1. Define and explain various fundamentals of spectroscopy, qualitative and quantitative analysis. 2. Discuss the terms, principle, instrumentation, operation and applications of Molecular spectroscopic techniques. 3. Differentiate between principle, instrumentation and operation of Atomic absorption and emission Spectroscopy. 4. Explain the various Separation techniques and its instrumentation. 5. Describe the principle and working of various Radiation detectors. 6. Discuss the principle and working of various Gas analyzers.	

Details of Syllabus:

Prerequisite: Knowledge of sensors and analog electronic circuits.

Module	Content	Hrs	CO Mapping
1	**Introduction:** Introduction to analytical Instrumentation. **Fundamentals of Spectroscopy:** Nature of Electromagnetic Radiation, Electromagnetic spectrum, Beer Lambert's Law statement and derivation. Deviations from Beer's law. Numerical on EMR and laws of photometry. Interaction of radiation with matter. Instrumentation ofspectroscopic analytical system – Radiation sources,Wavelength selectors, Detectors, signal processors and readoutmodules. Scintillation detector	**9**	CO1
2	**Molecular Spectroscopy:** Molecular Energy levels, correlation of energy levels with transitions. **Electronic transitions and Vibrational transitions –** Introduction to UV-VIS molecular spectroscopy – basics of single beam, double beam spectrophotometer and filter photometer, its instrumentation and applications. Basic principle,components and instrumentation of Fluorimeters, Phosphorimeters and Raman spectrometers.	**9**	CO2
3	**Molecular Spectroscopy – Nuclear/Rotational transitions** – Nuclear Magnetic Resonance (NMR) spectroscopy, basic principle and numerical problems based on NMR principle, instrumentation and constructional details of NMR Spectrometer. **Electron Spin Resonance (ESR) Spectroscopy** – Basic principle and construction of ESR spectrometer.	**4**	CO3
4	**Atomic Spectroscopy:** Atomic Energy levels, Atomic absorption spectrometers- components, working and absorption spectra. Atomic Emission spectrometers – components, working and emission spectra, comparison between AAS and AES.	**3**	CO4
5	**Separation Science:** **Chromatography:** Fundamentals of chromatographic Separations, Classification, Gas chromatographic system with components, factors affecting separation, applications. Analysis of Gas Chromatogram. HPLC – Its principle and instrumentation. **Mass Spectrometers:** Basic principle, components and types of mass spectrometers, sample handling techniques for liquids and solids, resolution and numerical problems based on resolution.	**9**	CO5
6	**Industrial Gas Analyzers:** Oxygen Analyzer, Combustion Gas Analyzers (COX, NOX, SOX, hydrocarbons), Gas density analyzer	**5**	CO6

Internal Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules)

End Semester Theory Examination:

1. Question paper will comprise of 6questions, each carrying 20 Marks.
2. Total 4 questions need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus where in 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. Willard, Merritt, Dean, Settle, Instrumental Methods of Analysis, CBS Publishers & Distributors, New Delhi, 7th Edition.

2. Khandpur R. S., Handbook of Analytical Instruments, Tata McGraw–Hill Publications, 3rd Edition.

Reference Books:

1. Skoog, Holler, Niemen, Thomson Principles of Instrumental Analysis, Books-Cole Publications, 5th Edition.

2. Ewing Galen W., Instrumental Methods of Chemical Analysis, McGraw-Hill Book Company, 5th Edition.

3. Braun Robert D., Introduction to Instrumental Analysis, McGraw-Hill Book Company.

4. Sherman R.E., Analytical Instrumentation, ISA Publication.

5. B. R. Bairi, Balvinder Singh, N.C.Rathod, P.V.Narurkar, Handbook nuclear medical Instruments, McGraw-Hill Book Company.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISDOC 5012	Data Structure and Algorithm Analysis	03	-	-	03	-	-	03

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 5012	Data Structure and Algorithm Analysis	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISDOC5012	Data Structure and Algorithm Analysis	3
Course Objectives	1. To improve the logical ability 2. To teach efficient storage mechanisms of data for an easy access. 3. To design and implementation of various basic and advanced data structures and algorithm analysis. 4. To introduce various techniques for representation and analysis of the data in the real world. 5. To develop application using data structures and algorithm and analysis. 6. To teach the concept of protection and management of data.	
Course Outcomes	Student will be able to: 1. Choose appropriate data structure as applied to specified problem definition and analyse the algorithm. 2. Handle operations like searching, insertion, deletion, traversing mechanism etc. on various data structures and algorithm analysis. 3. Apply concepts learned in various domains like DBMS, compiler construction etc. 4. Use linear and non-linear data structures like stacks, queues, linked list etc. 5. Assess different sorting algorithms and select depending on application. 6. Apply graph algorithms to solve real-world challenges	

Details of Syllabus:

Module	Contents	Hrs.	CO mapping
1	**Introduction:** Introduction, Mathematics Review, Exponents, Logarithms, Series, Modular Arithmetic, The P Word, A Brief Introduction to Recursion, Recursion and Induction. Algorithm Analysis: Mathematical Background, Model, What to Analyse, Running Time Calculations, General Rules, Solutions for the Maximum Subsequence Sum Problem, Logarithms in the Running Time, Euclid's Algorithm, Exponentiation, Checking Your Analysis, A Grain of Salt.	6	CO1
2	**Stacks, Queues and List:** Stacks, Queues, Linked Lists, Double-ended Queues. Abstract Data Type (ADT), The List ADT, Simple Array Implementation of Lists, Linked Lists, Programming Details, Common Errors, Doubly Linked Lists, Circularly Linked Lists, Examples, Cursor Implementation of Linked Lists, The Stack ADT, Implementation of Stacks, Applications, The Queue ADT, Array Implementation of Queues, Applications of Queues.	9	CO2
3	**Trees and Search Trees:** Tree, Implementation of Trees, Tree Traversals with an Application, Binary Trees, Expression Trees, the Search Tree ADT-Binary Search Trees, AVL Trees, Single Rotation, Double Rotation, Red-Black Trees, External searching in B-Trees, Tree Traversals, B-Trees	9	CO3
4	**Priority queues:** The priority queues Abstract data Type, Implementing a Priority queues with a List, Heaps, Adaptable priority queues.	4	CO4
5	**Sorting Sets, and Selection:** Insertion Sort, Shellsort, Heapsort, Quicksort, Bucket Sort, Merge Sort and radix Sort, and A Lower Bound on comparison-based Sorting and radix Sort, the complexity of some sorting algorithms, comparison of Sorting Algorithms, The Set ADT and union / file Structures	4	CO5

6	**Graphs:** The graph Abstract Data Type, Data Structures for Graphs, Graph Traversals, Directed Graphs, Weighted Graphs, Shortest Paths, and Minimum spanning Trees. Applications of DFS and BSF, Shortest-Path Algorithms, Dijkstra's Algorithm, Graphs with Negative Edge Costs, Acyclic Graphs, Network Flow Problems, Minimum Spanning Tree	7	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. Mark Allien Weiss, Data Structure and Algorithm Analysis in C, Pearson.
2. Micheal Goodrict, Roberto Tamassia, Data Structure and Algorithm in C++, Wiley India
3. Richard F. Gilberg&Behrouz A. Forouzan, Data Structures A Pseudo code Approach with C, second edition, CENGAGE Learning.
4. Rajesh K. Shukla, Data Structures Using C & C++, Wiley- India
5. ReemaThareja, Data Structures using C, Oxford University press.
6. Jean-Paul Tremblay, P. G. Sorenson, Introduction to Data Structure with Applications, Second Edition

Reference Books:

1. Ellis Horowitz, Sarataj Sahni, S.Rajsekaran," Fundamentals of computer algorithm", University Press .
2. Mark Allen Weiss, "Data Structure & algorithm Analysis in C++", 3rd Edition, Pearson Education
3. Data Structures Using C, ISRD Group, Second Edition, Tata McGraw-Hill
4. Balagurusamy, Data Structure Using C,
5. Prof. P.S. Deshpande, Prof. O.G. Kakde, C & Data Structures, , Dreamtech press.
6. Data Structures, Adapted by: GAV PAI, Schaum's Outlines.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISDOC5013	Mechatronics	3	-	-	3	-	-	3

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.					
ISDOC5013	Mechatronics	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISDOC5013	Mechatronics	3
Course Objectives	1. To present architecture of the mechatronics system design 2. To study on broad spectrum the characteristics of the mechanical and electrical actuators and their selection for mechatronic systems. 3. Development of process plan and templates for design of mechatronic systems.	
Course Outcomes	The students will be able to: 1. Examine key elements and design process of mechatronics system. 2. Apply the concept of system modeling to physical systems. 3. Identify the suitable sensor and actuator for a mechatronic system. 4. Examine feedback and intelligent controllers. 5. Illustrate mechatronics system validation. 6. Integrate the components in mechatronics system.	

Details of Syllabus:

Prerequisite: Knowledge of sensors and mechanical and electronic components.

Module	Contents	Hrs.	CO mapping
1	**Introduction to mechatronics systems:** Definition and evolution levels of mechatronics, integrated design issues in mechatronics, key elements of mechatronics, mechatronics design process- modeling and simulation, prototyping, deployment /life cycle, advanced approaches in mechatronics.	05	CO1
2	**Modeling and Simulation of physical systems:** Simulation and block diagrams, Analogies and impedance diagrams, mechanicaltranslational and rotational systems-sliding block with friction, elevator cable system, mass-damper system, automobile suspension system, mechanical lever system, geared elevator system, electromechanical coupling- DC motor,	07	CO2
3	**Electrical actuation:** A.C and DC motors, stepper motors, mechanical switches and solid state switches. **Mechanical Actuation:** types of motion, kinematic chain, cams, gears, ratchets and pawl, belt and chain drives, bearings, mechanical aspects of motor selection, piezoelectric actuators, magnetostrictive actuators, memory metal actuators, Programmable Logic Controller	07	CO3
4	**Intelligent control:** Automatic control methods, Artificial Neural Network (ANN) – Modeling, basic model of neuron, characteristics of ANN, perceptron, learning algorithms, Fuzzy logic – propositional logic, membership function, fuzzy logic and fuzzy rule generation, defuzzification, time dependent and temporal fuzzy logic.	08	CO4
5	**Components based modular design and system validation:** Components based modular design view, system validation, validation methodology- integrated and design dependence, distributed local level, validation schemes, fusion technique	06	CO5
6	**Integration:** Advanced actuators, consumer mechatronic products, hydraulic fingers, surgical equipment, industrial robot, autonomous guided vehicle, drilling machine, 3D Plotter, Motion Control Systems-Printing machines, coil winding machines, machine tools, and robotics, IC, and PCB manufacturing.	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. 4 to 5 marks will be asked.
5. Remaining questions will be mixed in nature.
6. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Text Books:

1. Devdas Shetty and Richard Kolk, Mechatronics System Design‖, Thomson Learning, 2nd reprint, 2001.
2. W. Bolton, Mechatronics - Electronic Control Systems in Mechanical and Electrical Engineering, Pearson Education Ltd, 4th edition, 2010.
3. StamatiosV. Kartalopoulos,Understanding Neural Networks and fuzzy Logic‖, PHI,3rd reprint, 2013.

Reference Books:

1. Nitaigour Mahalik, Mechatronics- Principles, Concepts and Applications‖, Tata McGraw Hill.
2. Zhijun Li, Shuzhi Sam Ge, Fundamentals in Modeling and Control of Mobile Manipulators, 2017, CRC Press.
3. Sergey Edward Lyshevski, Mechatronics and Control of Electromechanical Systems, 2017, CRC Press.
4. BodganWilamowski, J. David Irwin, Control and Mechatronics, 2017, CRC Press.
5. Takashi Yamaguchi, Mitsuo Hirata, Justin CheeKhiang Pang, High-Speed Precision Motion Control, 2017, CRC Press.
6. David Allan Bradley, Derek Seward, David Dawson, Stuart Burge, Mechatronics and the Design of Intelligent Machines and Systems, 2000, CRC Press.
7. Clarence W. de Silva, Farbod Khoshnoud, Maoqing Li, Saman K. Halgamuge, Mechatronics: Fundamentals and Applications, 2015, CRC Press.
8. Clarence W. de Silva, Mechatronics: A Foundation Course, 2010, CRC Press.
9. GENERAL CATALOGUE 2011 Motion & Drives, OMRON.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISDOC5014	Advanced Sensors	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.					
ISDOC5014	Advanced Sensors	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISDOC5014	Advanced Sensors	3
Course Objectives	1. To expose the students to the concepts of smart sensors and micro sensors 2. To provide sufficient knowledge about the sensor fabrication. 3. To create awareness about the various application fields of smart sensors.	1.
Course Outcomes	The students will be able to - 1. Explain the various principles employed intransducers. 2. Examine the methods of fabricating a sensor. 3. Apply knowledge in designing smart sensors. 4. Discuss the techniques of fabrication and application of MEMS. 5. Describe the various applications of smart sensors. 6. Discuss advanced sensing technology.	

Details of Syllabus:

Prerequisite: Fundamentals of transducers.

Module	Content	Hrs	CO Mapping
1	**Review of Fundamental of Sensors:** Principle of physical and chemical transduction, sensor classification, characterization of mechanical, electrical, optical, thermal, magnetic, chemical and biological sensors, their calibration and determination of characteristics	07	CO1
2	**Sensor Fabrication**: Design considerations and selection criterion as per standards, Sensor fabrication techniques, process details and latest trends in sensor fabrication. Thick film sensing and system design.	06	CO2
3	**Smart Sensors:** Smart sensor basics, signal conditioning and A/D conversion for sensors, examples of available ICs (DHT, Smart analog IC 500, ADXL345) and their applications.	07	CO3
4	**Micro Sensors:** Introduction, Intrinsic characteristics of MEMS, common fabrication techniques, application of MEMS in sensing systems including pressure sensors, accelerometers, gyroscopes and strain gauges.	06	CO4
5	**Advanced Sensor Applications:** Temperature & Humidity measurement using DHT Sensor in environment monitoring, Acceleration measurement using ADXL345 for automotive industry, MEMS Temperature sensors for automotive applications, MEMS chemical sensors for survey meters, MEMS pressure sensors for medical applications	07	CO5
6	**Advanced Sensing Technology:** Sensors, instruments and measurement techniques for emerging application areas such as environmental measurement like DO (dissolves oxygen),BOD (biological oxygen demand), COD (chemical oxygen demand), TOC (total organic carbon), Cox (carbon dioxides), NOx (nitrogen oxide), for navigation and inertial measurements, for agricultural measurements such as soil moisture, wind speed, leaf wetness duration, sensors for food processing like smell or odour,taste.	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 20Marks.
2. Total 4 questions need to besolved.
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. Chang Liu, Foundations of MEMS, Pearson Education Inc.,2012.
2. Stephen D Senturia, Microsystem Design, Springer Publication,2000.
3. Tai Ran Hsu, MEMS & Micro systems Design and Manufacture, Tata Mc Graw Hill, New Delhi,2002.
4. Jacob Fraden, Handbook of Modern Sensors, 5th Edition, Springer .
5. S. M. Sze, Semiconductor Sensors, Wiley
6. M J Usher, Sensors and Transducers, MacMillan,1985.

References:

1. Nadim Maluf," An Introduction to Micro Electro Mechanical System Design", Artech House, 2000.
2. Mohamed Gad-el-Hak, editor, The MEMS Handbook, CRC press Baco Raton,2001.
3. Julian w. Gardner, Vijay K. Varadan, Osama O.Awadelkarim, Micro Sensors MEMS and Smart Devices, John Wiley & Son LTD,2002.
4. James J.Allen, Micro Electro Mechanical System Design, CRC Press Publisher,2005.
5. Thomas M. Adams and Richard A.Layton, Introduction to MEMS, Fabrication and Application, Springer,2010.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL501	Electrical Machines and Drives 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.					
ISL501	Electrical Machines and Drives Lab	--	--	--	--	25	25		50

Subject Code	Subject Name	Credits
ISL501	Electrical Machines and Drives Lab	1
Course Objectives	1. To learn the basic concept and characteristics of Electrical motors. 2. To equip the students with the knowledge of semiconductor devices&their applications.	
Course Outcomes	Students will be able to: 1. Explain working of DC motors and study their characteristics. 2. Describe the working principle of 3-phase I.M. 3. Discuss the constructional features of single-phase I.M. 4. Compare basic characteristics and ratings of power electronic devices. 5. Use controlled rectifiers, Inverters & choppers with different loads. 6. Illustrate working of AC & DC drives.	

Syllabus: Same as that of Subject ISC501Electrical Machines and Drives.

List of Laboratory Experiments:

Sr. No	Detailed Contents	CO Mapping
01	Speed control methods of DC motor.	CO1
02	Starting of 3-phase IM by DOL/Autotransformer/rotor resistance method.	CO2
03	Load Test on DC Motor/ Induction Motor.	CO1/CO2
04	Plot V-I characteristics of SCR.	CO4
05	Triggering Methods of SCR.	CO4
06	Plot V-I characteristics of Diac.	CO4
07	Plot V-I characteristics of Triac.	CO4
08	Plot V-I characteristics of IGBT.	CO4
09	Triac based AC power control circuit.	CO5
10	Half wave & full wave controlled rectifier.	CO5
11	SCR Based Inverter	CO5
12	MOSFET/IGBT Based Inverter	CO5
13	Step UP-Step Down Chopper.	CO5
14	DC motor speed control drive	CO5
15	AC drive for I.M.	CO6

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

Practical Oral Examination:

Oral examination will be based on entire syllabus.

Term Work:

Term work shall consist of minimum eight experiments and any two using software.

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	PR	Tut.	Theory	PR/ OR	Tut.	Total
ISL502	Applications of Microcontroller Lab	-	2	-	-	1	-	1

Subject Code	Subject Name	Examination scheme							
		Theory Marks(100)				Term work	PR and Oral	Oral	Total
		Internal Assessment(20)			End Sem Exam				
		Test 1	Test2	Avg.					
ISL502	Applications of Microcontroller Lab					25	25	-	50

Subject Code	Subject Name	Credits
ISL502	Applications of Microcontroller Lab Practice	1
Course objectives	1. To explain the assembly and,, c‟ programming concepts. 2. To explain addressing modes and instruction set of MCS-51 and develop programs using instructions. 3. To give knowledge of integrated hardware of MCS-51 4. To study different SFRs associated with integrated peripherals and to give knowledge of interfacing of MCS-51 and Arduino with different peripheral devices such as LCD, keyboard, Memory, ADC, DAC etc. **5.** To develop simple application board using MCS-51 and Arduino. **6.** To make the students capable to develop application using learned concepts of hardware, software and interfacing	
Course Outcomes	The students will be able to: 1. Design and develop programs using instructions learned from instructions in assembly or,, c‟ language. 2. Explain Integrated timers and Counters implantation. 3. Outline the knowledge of operation of integrated hardware components. 4. Designs of programs in assembly or,, C‟ language. 5. Solve and construct interfacing of peripheral components with MCS 51 and Arduino. 6. Investigate, recommend and design the sophisticated application based on MCS-51 such as Traffic light control, Digital weighing machine etc.	

Syllabus: Same as that of SubjectISC502Applications of Microcontroller.

List of Laboratory Experiments/Assignments:

Sr. No.	Detailed Content	CO Mapping
1	To develop a program to perform16 bit Arithmetic and Logical operations	CO1
2	To develop a program to perform Code conversion	CO1
3	To develop a program for generating square wave on port pin with and without timer.	CO2
4	To develop a program for interfacing 7 segments/ LCD displays with MCS-51	CO4
5	To develop a program for Serial Communication with PC.	CO3
6	To develop a program for interfacing DAC and its application.	CO5
7	To develop a program for Speed control of DC Motor	CO6
8	To develop a program for Stepper motor control	CO6
9	To develop a program for implementing traffic light controller.	CO6
10	To develop a program for interfacing Switch, LED, LDR with Arduino	CO5
11	To develop a program for interfacing7 segments/ LCD displays with Arduino	CO5
12	To develop a program for interfacing LM35, DHT11, accelerometer with Arduino	CO5
13	To develop a program for interfacing of DC Motor/ Stepper motor with Arduino	CO5

Any additional experiments/assignments based on syllabus whichwillhelp students to understand topic/concept.

Practical/Oral Examination:

Practical/Oral examinationwill be based on entire syllabus.

Term Work:

Term work shall consist of minimum 10 experiments and twoassignments. The distribution of marks for term work shall be as follows:

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

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
ISL503	Process Instrumentation Systems and Control System Design 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.					
ISL503	Process Instrumentation Systems and Control System Design Lab	--	--	--	--	25	25		50

Subject Code	Subject Name	Credits
ISL503	Process Instrumentation and Control System - Lab	1
Course Objectives	1. To make students familiar with different dynamics and process control actions. 2. To understand various control schemes. 3. To understand concept of Multivariable Control & Discrete state process control Requirement. 4. To develop the skills needed to represent the system in state space form. 5. To impart knowledge required to design state feedback controller and state estimator. 6. To design the compensator in time and frequency domain.	
Course Outcomes	Students will be able to – 1. To relate the working of different types of control actions, controllers and their tuning methods. 2. To analyze various control schemes and their application. 3. To evaluate interaction of multivariable control systems & to develop ladder logic for discrete state process contro 4. Obtain state model of a system from transfer function and study similarity transformation. 5. Verify the controllability and observability of the given system and design the controller and observer for the given system with transient specifications. 6. Design lead, lag, and lag-lead compensator using root-locus and bode-plot techniques with given transient specifications.	

Syllabus: Same as that of Subject ISC503 Control System Design and ISC504 Process Instrumentation System

List of Laboratory Experiments:

Sr. No	Detailed Contents	CO Mapping
01	Study Features & operation of ON-OFF Control action & its Application.	CO1
02	Study of flow rate control using P, PI, PD and PID controller modes.	CO1
03	Study of Ratio control system.	CO2
04	Study of Multivariable control system.	CO3
05	Study of discrete state process control system.	CO3
06	Obtain a state-space model in different canonical forms of a given transfer function.	CO5
07	Investigate controllability and observability of system , then accordingly design controller and observer.	CO5
08	Design of Lead Compensator using Root-locus technique.	CO6
09	Design of Lag Compensator using Root-locus technique	CO6
10	Design of Lag-Lead Compensator using Root-locus technique	CO6
11	Design of Lead Compensator using Bode-plot technique.	CO6
12	Design of Lag Compensator using Bode-plot technique	CO6
13	Design of Lag-Lead Compensator using Bode-plot technique	CO6

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

Practical Oral Examination:

Oral examination will be based on entire syllabus.

Term Work:

Term work shall consist of minimum eight experiments and any two using software.

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	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL504	Professional Communication & Ethics-II	--	2*+ 2 Hours (Batch-wise)	--	--	2	--	02

***Theory class to be conducted for full class.**

Course Code	Course Name	Examination Scheme									
		Theory									
		Internal Assessment			End sem	Duration (hrs)	Term work	Pract	Oral	Internal Oral	Total
		Test 1	Test 2	Avg.							
ISL504	Professional Communication & Ethics-II (abbreviated PCE-II)	--	--	--	--	--	25	--	--	25	50

Course Code	Course Name	Credits
ISL504	Professional Communication & Ethics-II	02
Course Rationale	This curriculum is designed to build up a professional and ethical approach, effective oral and written communication with enhanced soft skills. Through practical sessions, it augments student's interactive competence and confidence to respond appropriately and creatively to the implied challenges of the global Industrial and Corporate requirements. It further inculcates the social responsibility of engineers as technical citizens.	
Course Objectives	1. To discern and develop an effective style of writing important technical/business documents. 2. To investigate possible resources and plan a successful job campaign. 3. To understand the dynamics of professional communication in the form of group discussions, meetings, etc. required for career enhancement. 4. To develop creative and impactful presentation skills. 5. To analyze personal traits, interests, values, aptitudes and skills. 6. To understand the importance of integrity and develop a personal code of ethics.	

Course Outcomes	**Learner will be able to…** 1. plan and prepare effective business/ technical documents which will in turn provide solid foundation for their future managerial roles. 2. strategize their personal and professional skills to build a professional image and meet the demands of the industry. 3. emerge successful in group discussions, meetings and result-oriented agreeable solutions in group communication situations. 4. deliver persuasive and professional presentations. 5. develop creative thinking and interpersonal skills required for effective professional communication. 6. apply codes of ethical conduct, personal integrity and norms of organizational behaviour.

Module	Contents	Hours
1	**ADVANCED TECHNICAL WRITING :PROJECT/PROBLEM BASED LEARNING (PBL)** **1.1 Purpose and Classification of Reports:** **Classification on the basis of:** • Subject Matter (Technology, Accounting, Finance, Marketing, etc.) • Time Interval (Periodic, One-time, Special) • Function (Informational, Analytical, etc.) • Physical Factors (Memorandum, Letter, Short & Long) **1.2. Parts of a Long Formal Report:** **1.** Prefatory Parts (Front Matter) **2.** Report Proper (Main Body) **3.** Appended Parts (Back Matter) **1.3. Language and Style of Reports** 1. Tense, Person & Voice of Reports 2. Numbering Style of Chapters, Sections, Figures, Tables and Equations 3. Referencing Styles in APA & MLA Format **4.** Proofreading through Plagiarism Checkers **1.4. Definition, Purpose & Types of Proposals** • Solicited (in conformance with RFP) & Unsolicited Proposals • Types (Short and Long proposals) **1.5. Parts of a Proposal** 1. Elements 2. Scope and Limitations 3. Conclusion **1.6. Technical Paper Writing** • Parts of a Technical Paper (Abstract, Introduction, Research Methods, Findings and Analysis, Discussion, Limitations, Future Scope and	**06**

	References) • Language and Formatting • Referencing in IEEE Format	
2	**EMPLOYMENT SKILLS** **2.1. Cover Letter & Resume** • Parts and Content of a Cover Letter • Difference between Bio-data, Resume & CV • Essential Parts of a Resume • Types of Resume (Chronological, Functional & Combination) **2.2 Statement of Purpose** Importance of SOP Tips for Writing an Effective SOP **2.3 Verbal Aptitude Test** • Modelled on CAT, GRE, GMAT exams **2.4. Group Discussions** • Purpose of a GD • Parameters of Evaluating a GD • Types of GDs (Normal, Case-based & Role Plays) • GD Etiquettes **2.5. Personal Interviews** • Planning and Preparation • Types of Questions • Types of Interviews (Structured, Stress, Behavioural, Problem Solving & Case-based) • Modes of Interviews: Face-to-face (One-to one and Panel) Telephonic, Virtual	**06**
3	**BUSINESS MEETINGS** **1.1. Conducting Business Meetings** • Types of Meetings • Roles and Responsibilities of Chairperson, Secretary and Members • Meeting Etiquette **3.2. Documentation** • Notice • Agenda • Minutes	**02**
4	**TECHNICAL/ BUSINESS PRESENTATIONS** **1.1 Effective Presentation Strategies** • Defining Purpose • Analyzing Audience, Location and Event • Gathering, Selecting &Arranging Material • Structuring a Presentation • Making Effective Slides • Types of Presentations Aids • Closing a Presentation • Platform skills	**02**

	1.2 Group Presentations • Sharing Responsibility in a Team • Building the contents and visuals together • Transition Phases	
5	**INTERPERSONAL SKILLS** **1.1. Interpersonal Skills** • Emotional Intelligence • Leadership & Motivation • Conflict Management & Negotiation • Time Management • Assertiveness • Decision Making **5.2 Start-up Skills** • Financial Literacy • Risk Assessment • Data Analysis (e.g. Consumer Behaviour, Market Trends, etc.)	**08**
6	**CORPORATE ETHICS** **6.1Intellectual Property Rights** • Copyrights • Trademarks • Patents • Industrial Designs • Geographical Indications • Integrated Circuits • Trade Secrets (Undisclosed Information) **6.2 Case Studies** • Cases related to Business/ Corporate Ethics	**02**

List of assignments:

(In the form of Short Notes, Questionnaire/ MCQ Test, Role Play, Case Study, Quiz, etc.)

- Cover Letter and Resume
- Short Proposal
- Meeting Documentation
- Writing a Technical Paper/ Analyzing a Published Technical Paper
- Writing a SOP
- IPR
- Interpersonal Skills
- Aptitude test (Verbal Ability)

Note:

1. The Main Body of the project/book report should contain minimum 25 pages (excluding Front and Back matter).
2. The group size for the final report presentation should not be less than 5 students or exceed 7 students.
3. There will be an end–semester presentation based on the book report.

Assessment:

Term Work:

Term work shall consist of minimum 8 experiments.

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

Assignment : 10 Marks
Attendance : 5 Marks
Presentation slides : 5 Marks
Book Report (hard copy) : 5 Marks

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

Internal oral:

Oral Examination will be based on a GD & the Project/Book Report presentation.

Group Discussion : 10 marks
Project Presentation : 10 Marks
Group Dynamics : 5 Marks

Books Recommended:

Textbooks and Reference books:

1. Arms, V. M. (2005). Humanities for the engineering curriculum: With selected chapters from Olsen/Huckin: Technical writing and professional communication, second edition. Boston, MA: McGraw-Hill.
2. Bovée, C. L., &Thill, J. V. (2021). Business communication today. Upper Saddle River, NJ: Pearson.
3. Butterfield, J. (2017). Verbal communication: Soft skills for a digital workplace. Boston, MA: Cengage Learning.
4. Masters, L. A., Wallace, H. R., & Harwood, L. (2011).Personal development for life and work. Mason: South-Western Cengage Learning.
5. Robbins, S. P., Judge, T. A., & Campbell, T. T. (2017). Organizational behaviour. Harlow, England: Pearson.
6. Meenakshi Raman, Sangeeta Sharma (2004) Technical Communication, Principles and Practice. Oxford University Press
7. Archana Ram (2018) Place Mentor, Tests of Aptitude For Placement Readiness. Oxford University Press
8. Sanjay Kumar &PushpLata (2018). Communication Skills a workbook, New Delhi: Oxford University Press.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISM501	Mini Project – 2A	--	4$	--	--	2	--	2

$ 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.					
ISM501	Mini Project – 2A	--	--	--	--	25	--	25	50

Subject Code	Subject Name	Credits
ISM501	Mini Project – 2 A	2
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 life long learning. 9. Demonstrate project management principles during project work.	

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini 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 mini 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 Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each 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 : 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first 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 finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
- In second 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.

Half-year project:

In this case in one semester students' group shall complete project in all aspects including,

- Identification of need/problem
- Proposed final solution
- Procurement of components/systems
- Building prototype and testing

Two reviews will be conducted for continuous assessment,

- First shall be for finalisation of problem and proposed solution
- Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project 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
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

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

Mini 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 individual's as member or leader
8. Clarity in written and oral communication

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Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISC601	Industrial Process Control	3	-	-	3	-	-	3

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.					
ISC601	Industrial Process Control	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISC601	Industrial Process Control	3
Course objectives	1. To impart the knowledge of different industrial unit operations. 2. To make the students capable to design and develop instrumentation and control schemes for industrial processes. 3. To give them overview of various process industries, hazardous areas and their classification.	
Course Outcomes	The students will be able to: 1. Explain working and control of heat exchanger and evaporator 2. Explain working and control boiler and furnace 3. Elaborate working and control of distillation and reactor 4. Explain working and control of dryer and crystallizer 5. Describe the processes of batch and continuous process industries and instrumentation involved in them. 6. Classify hazardous areas in the industry.	

Details of Syllabus:

Prerequisite: Temperature, flow, pressure sensors, fundamentals of process instrumentation and control, control schemes like feedback, feedforward, cascade, split range, selective etc., basics of unit operations.

Module	Content	Hrs	CO Mapping
1	**Heat transfer unit operations-I:** Introduction to unit operations and processes, concept of heat transfers and energy balance, heat transfer coefficient. **Heat exchanger control:** classification as per fluid flow arrangement and construction, feedback, feed-forward, bypass control schemes, fouling in heat exchangers. **Evaporator control:** Evaporator terminologies, Types of Evaporator, control systems for Evaporator – feedback, cascade, feed forward and selective control.	06	CO1
2	**Heat transfer unit operations-II:** **Boiler control:** Types, working and operation of boilers, Terms related- Shrink and swell effect and excess oxygen, boiler efficiency, Boiler controls- Drum level control- Single, two and three elements, and Combustion Control- Type 1, 2, 3 and 4, steam temperature control, boiler pressure control, furnace draft control. **Furnacecontrol:** Start- up heaters, fired re-boilers, process andsafety controls.	09	CO2
3	**Heat and mass transfer unit operations-I:** **Distillation column:** Basic principle, Distillation equipment and its accessories.Batch and continuous distillation, Binary product distillation, multi-product distillation, Vacuum distillation. **Distillation column control strategies**- Top and bottom product composition controls-inferential and direct, Pressure controls, Vapors recompression, Feed controls- Column feed controls,economizer. **Reactor control:** Reactor characteristics, runaway reaction, various schemesof temperature control of reactors.	09	CO3

4	**Heat and mass transfer unit operations-II:** **Dryer control:** Process of drying, types and control strategies of dryer- Tray, , fluidized bed, rotary and spray dryer. **Crystallizers control:** Process of crystallization, Super-saturation methods, types of crystallizer and control strategies- evaporating crystallizer, cooling crystallizers, vacuum crystallizers.	06	CO4
5	**Continuous and Batch Process Industries:** **Refinery Industry:** Process flow diagram, separation, conversion methods, sensors and control schemes. **Iron and steel Industry**: Process flow diagram, Sensors and Control schemes. **Pharmaceutical industries**- Penicillin-G production, sensors and control schemes.	05	CO5
6	**Safety in Instrumentation control systems:** Area and material classification as per IEC and NEC standard, techniques used to reduce explosion hazards, intrinsic safety, and installation of intrinsically safe systems.	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. W. L. McCabe and Julian Smith, Unit operation and chemical engineering‖, Tata McGraw Hill, Sixth edition, 2001.
2. Bela G. Liptak, Instrument engineers handbook-Process control ,Chilton book company, third edition,1995.
3. Bela G. Liptak, Instrumentation in the processing industries, Chilton book company-first edition, 1973.

Reference Books:

1. Douglas M. Considine, Process industrial instruments and controls handbook‖, McGraw Hill-4th edition,1993.
2. George T. Austin, Shreve‘s chemical process industries‖, Mc-GrawHill- fifth edition,1984.
3. George Stephenopoulos, Chemical process control, PHI-1999.
4. David Lindsey, Power Plant control and instrumentation – control of boilers HRSG, Institution of Engineering and Technology,

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISC602	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.					
ISC602	Digital Signal Processing	20	20	20	80			-	100

Subject Code	Subject Name	Credits
ISC602	Digital Signal Processing	3
Course Objectives	1. To introduce the basic concept of discrete time signal processing and acquire knowledge about DSP and its fundamentals. 2. To familiarize with Fourier transform algorithms and convolution of DT sequences. 3. Ability to design IIR digital filter and realization of its structures using different forms. 4. To design FIR filter using different methods.	
Course Outcomes	Students will be able to 1. Understand the basic concepts of discrete-time signals and systems, sampling, aliasing, and DSP. 2. Analyse LTI systems in time-domain and realize it using different structures. 3. Analyse LTI systems in frequency domain. 4. Demonstrate an ability to apply Discrete Fourier Transform, Fast Fourier transform. 5. Design FIR filter by different techniques. 6. Describe how IIR filters are designed and Implemented by different methods.	

Details of Syllabus:
Prerequisite: Knowledge of Fundamentals of Engineering Mathematics, Basic programming skills.

Module	Contents	CO	Hrs.
1.	**Introduction to Signals and Systems:** Discrete-time signals and systems: classification of signals, sampling process/theorem, aliasing effect and reconstruction, classification of systems, input-output description of systems, block-diagram representation of discrete-time systems. Basic elements of Digital Signal Processing (DSP), analog to digital conversion (ADC), comparison between DSP and Analog Signal Processing (ASP) with applications of DSP.	CO1	06
2.	**Analysis of discrete-time systems** Linear convolution, causality and stability of discrete time systems, autocorrelation, cross-correlation, z-transform and its properties, solving difference equations and analysis of discrete-time systems in z-domain, transfer function, pole-zero plot. Implementation of discrete-time systems: Structures for the realization, Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) structures.	CO2	07
3.	**Frequency analysis of discrete-time signals** Frequency response of LTI systems, ideal frequency selective filters, magnitude and phase response, Discrete-time Fourier Series, properties of DFS, The Discrete Time Fourier Transform (DTFT), symmetry properties and theorems of DTFT. Energy density spectrum and power density spectrum.	CO3	06
4.	**Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT)** Discrete Fourier transform (DFT), properties of DFT, symmetry properties, circular convolution, linear filtering methods based on DFT, Frequency analysis of signals using DFT, Efficient computation of DFT, Fast Fourier Transform (FFT) algorithms: radix-2 decimation-in-time (DIT) and decimation-infrequency (DIF)FFT algorithms.	CO4	07
5.	**Design of FIR filters** Introduction to FIR filters, linear phase filters, symmetric and anti-symmetric filters, FIR design by Fourier approximation, window method, frequency sampling method, comparison between FIR and IIR filters.	CO5	06
6.	**Design of digital IIR filters from analog filters** Introduction to analog IIR filters, Butterworth approximation, Chebyshev approximation. Design of digital IIR filter: approximation derivative method, impulse invariance method, bilinear transformation, Frequency transformations in analog and digital domain.	CO6	07

Internal Assessment:

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

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. V. Oppenheim and R. W. Schafer, Discrete Time Signal Processing, Pearson Education, 2000.
2. J. G. Proakis and D. J. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, PHI, 4th Edition, 2007.
3. NagoorKani, "Digital Signal Processing", McGraw Hill Publications, 2017.

Reference Books:

1. B. Porat, A Course in Digital Signal Processing, J. Wiley and Sons, 1996.
2. J. R. Johnson, Introduction to Digital Signal Processing, PHI, 1989.
3. Rabiner, Gold, Theory and Applications of Digital Signal Processing, TMH, 1996.
4. S. K. Mitra, Digital Signal Processing-A Computer Based Approach, MGH, 1997.
5. E. C. Ifeachor and B. W. Jervis, Digital Signal Processing-A practical Approach, Addison-Wesley publication, 2002.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISC603	Industrial Data Communication	3	-	-	3	-	-	3

Subject Code	Subject Name	Examination scheme							
		Theory Marks (100)							
		Internal Assessment (20)			End Sem Exam	Termwork	Pract. and Oral	Oral	Total
		Test 1	Test2	Avg.					
ISC603	Industrial Data Communication	20	20	20	80	-	-	-	100

Subject Code	Subject Name	credits
ISC603	Industrial Data Communication	3
Course objectives	1. To expose students to the basics of communication 2. To create awareness about the the OSI refrence model. 3. To acquaint the students with the different types of networks at various levels such as sensor level, device network and control network. 4. To provide sufficient knowledge about the HART. 5. To impart the fundamentals of foundation field bus.	
Course Outcomes	The students will be able to: 1. Explain the importance of modulation in communication. 2. Examine the importance of OSI,TCP/IP model, various networking components. 3. Compare the different types of networks at various levels of field communication. 4. Use HART for communication 5. Establish Foundation fieldbus communication. 6. Investigate the various wireless devices.	

Details of Syllabus:

Prerequisite: Awareness of transmitters, different process loops, Basics of communication system.

Module	Content	Hrs	CO Mapping
1	**Introduction to Communication System:** Elements of communication system, Noise in communication Systems. Amplitude Modulation: Introduction, Time and frequency domain analysis, Frequency Modulation, Phase Modulation, Effect of noise in FM. Digital Modulation, PAM,PPM,PWM,FSK,QPSK.	08	CO1
2	**Introduction to Networks:** OSI reference model**,** TCP/IP model, Transmission media, UTP-STP cable, co-axial cable, N/W components: Repeaters, bridge, hub, switch, router, gateways. **Open Control N/W: RS232, RS422,EIA485** Modbus Structure, Implementation, GPIB. Proprietary Control N/W:Modbus Plus	06	CO2
3	**Networks at different levels:** Sensor level network: AS-i, CAN, Devicenet, Interbus and LON Device networks: Foundation Fieldbus H1-HART Profibus-PA Control Network: BACnet,control-net, FF-HSE, Profibus-DP, Ethernet, TCP/IP	08	CO3
4	**HART:** Architecture, Physical, Data Link, Application, Communication Technique, Normal and burst mode of communication, Troubleshooting, Benefits of HART	06	CO4
5	**Foundation Fieldbus:** Fieldbus requirement, features, advantages, fieldbus components, types, architecture–physical, data link, application layer, system and network management, wiring, segment functionality checking, installation in safe and hazardous area and troubleshooting, function block application process. **OPC Architecture**	06	CO5
6	**Wireless Technologies:** Satellite systems, Wireless LANs (WLANs), WiFi, VPAN, Zigbee, bluetooth GPRS and – their comparison, limitations and characteristics, Introduction to IOT and IIOT,RFID	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.

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. Deon Reynders, Steve Mackay, Edwin Wright, Practical Industrial Data Communications, 1st edition ELSEVEIR,2005.

2. Lawrence M Thompson, Industrial Data Communication, 2nd edition , 1997.

Reference Books:

1. Daniel T Miklovic, Real Time Control Networks, ISA 1993.

2. Bela G Liptak, Process Software and Digital Networks,3rd edition2002.

3. Andrew S. Tanenbaum, Computer Networks, 4th edition, PHI/Pearson Education, 2002.

4. Behrouz A. Forouzan, Data Communications and Networking, 2nd update edition, Tata McGraw Hill Publishing Company, New Delhi,2000.

5. Douglas E.Corner, Computer Networks and Internets, 2nd edition, Pearson Education Asia,5th Indian reprint, 2001.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISDOC6011	Instrumentation for Agriculture	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.					
ISDOC6011	Instrumentation for Agriculture	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISDOC6011	Instrumentation for Agriculture	3
Course Objectives	To impart background information required for studying application of instrumentation in agriculture.	
Course Outcomes	The student will be able to: 1. Illustrate necessity of instrumentation in agriculture. 2. Demonstrate soil properties and sensors used to measure the same. 3. Develop automation scheme for irrigation. 4. Develop automation scheme for green house. 5. Apply instrumentation to agricultural equipment. 6. Demonstrate instrumentation in continuous and batch process in agriculture-based product.	

Details of Syllabus:

Prerequisite: Fundamental knowledge of sensors & transducers

Module	Contents	Hrs.	CO mapping
1	**Introduction:** Necessity of instrumentation and control for agriculture sensor requirement, remote sensing, biosensors in agriculture, standards for food quality.	3	CO1
2	**Soil Properties:**Engineering properties of soil pH, conductivity, resistivity, temperature, soil moisture and salinity. **Sensors:**Ion concentration measurement, method of soil analysis, Instrumentation for environmental conditioning of seed germination and growth, introduction to sonic anemometers, hygrometers/ soil moisture measurement (resistance-based method, voltage-based method, thermal based method), fine wire thermocouples, open & close path gas analyzers.	7	CO2
3	**Instrumentation in Irrigation:** irrigation methods: overhead, Centre pivot, lateral move, micro irrigation systems &it's performance, comparison of different irrigation systems, irrigation scheduling, irrigation efficiencies, auto drip & sprinkler irrigation systems. Water distribution & management control, irrigation canal management systems, design considerations in irrigation channels, upstream & downstream control concept.	7	CO3
4	**Greenhouse Parameters & Instrumentation:** Basic concept of Greenhouse, merits & demerits, ventilation, cooling & heating, wind speed, temperature & humidity, soil moisture, rain gauge, carbon dioxide enrichment measurement & control, Leaf area length Evapo-transpiration, temperature, wetness & respiration measurement & data logging, electromagnetic radiations photosynthesis.	7	CO4
5	**Applications in Agricultural Equipment:** Automation in earth moving equipment& farm equipment, implementation of hydraulic, pneumatic & electronics control circuits in harvesters cotton pickers, tractor etc. classification of pumps: pump characteristics, pump selection & installation.	7	CO5
6	**Instrumentation in Continuous & Batch process:** Flow diagram, sensors & instrumentation set up of: Sugar plant, Fermenter (batch process), Dairy industry, Juice extraction and Oil extraction.	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 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. D. Patranabis, Principles of Industrial instrumentation,TMH (2010), ISBN-13: 9780070699717
2. Michael. A.M, Irrigation: Theory and Practice, Vikas Publishing House Pvt Ltd, Second edition (2008), ISBN-13: 978-8125918677
3. Curtis D. Johnson, Process control and instrumentation technology, 8th Edition, 2015,Person, ISBN: 9789332549456, 9332549451
4. Akalank Kumar Jain, Vidhi Jain Food Safety and Standards Act, Rules & Regulations, Akalank Publications; 13th Edition (2015), ISBN-13: 9788176393584
5. Rosana G. Moreira, Automatic Control for Food Processing Systems (Food Engineering Series), Springer; 2001 edition (28 February 2001), ISBN-13: 9780834217812
6. Wills B.A., Mineral Processing Technology, 4th Ed.,Pergamon Press.

Reference Books:

1. Bela G. Liptak, Instrument Engineers' Handbook, Process Control and Optimization, CRC Press; 4 edition (29 September 2005), ISBN-13: 978-0849310812.
2. Robert H. Brown, CRC Handbook of Engineering in Agriculture, Volume II: Volume 1 (C R C SERIES IN AGRICULTURE), CRC Press; 1 edition (30 June 1988), ISBN13: 978-0849338625.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISDOC6012	Optimization Techniques	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.					
ISDOC6012	Optimization Techniques	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISDOC6012	Optimization Techniques	3
Course Objectives	1. Student should understand the process of optimization, formulation of practical engineering problem into optimization problem and applying necessary and sufficient conditions of optimality to check the feasibility of the problem. 2. Students should study the concepts of linear as well as nonlinear programming methods. 3. Based on the nature of problem i.e. linear, nonlinear, one dimensional, multidimensional, students can use appropriate method to solve it. 4. Students will understand how to apply numerical unconstrained methods to solve constrained optimization problem.	
Course Outcomes	Students would be able 1. Translate descriptive statements of the design engineering problems in to a mathematical statement of optimization. 2. Write optimality conditions for unconstrained and constrained problems and use Lagrange multiplier and KKT necessary conditions for solving problems. 3. Translating linear programming problem (LPP) in to standard form and then use simplex or two phase simplex method. 4. Use alternate form of two-phase simplex method called Big-M method also write dual problem for the given LP Problem for solving it. 5. Explain gradient-based search and direct search methods for design optimization problems. 6. Use the numerical methods for unconstrained optimization.	

Details of Syllabus:

Prerequisite: Knowledge of derivative, partial differentiation, Matrix Algebra, Taylor series.

Module	Contents	Hrs	CO Mapping
1	**Introduction to Optimization:** Definition and meaning of optimization, need of optimization, optimization problem formulation – statement of an optimization problem, terminology- design vector, objective function, objective function surface, design constraints, constraint surface, Iteration, convergence, classification of optimization problem, conventional versus -optimum design process, -optimal control problem, problem formulation process, engineering applications of optimization.	06	CO1
2	**Classical Optimization Techniques:** Fundamental concepts- local and global minima, local and global maxima, quadratic form, necessary and sufficient condition of single and multivariable optimization with no constraints, multivariable optimization with equality and inequality constraints (Kuhn-Tucker condition), Lagrange Theorem	05	CO2
3	**Linear Programming – Simplex Method** Definition of linear programming problem (LPP), standard form of LPP, terminology, basic concepts, Simplex Algorithm and flowchart, simplex method, two-phase simplex method	08	CO3
4	**Linear Programming – Revised Simplex Method** Duality in linear programming – standard primal LP problem, dual LP problem, Treatment of equality constraints, determination of the primal solution from the dual solution, dual variables as Lagrange multipliers, KKT conditions for the LP problem,	09	CO4
5	**Numerical Methods for Unconstrained Optimum Design – Direct Method** General algorithm for unconstrained minimization methods, rate of convergence, unimodal and multimodal function, reduction of a single variable, one dimensional minimization methods- Equal Interval method, Golden section search method.	06	CO5
6	**Numerical Methods for Unconstrained Optimum Design – Indirect Method** Gradient of a function, Steepest Descent, Conjugate gradient (Fletcher-Reeves), Step size determination – polynomial interpolation, properties of gradient vector	05	CO6

Internal Assessment:

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

Theory Examination:

1. Question paper will comprise of 6questions, 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 5marks 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. Jasbir S. Arora, Introduction to Optimum Design, 3rd Edition, Academic Press – 2012.

2. Ashok D. Belegundu, Optimization concepts and applications in Engineering, Pearson Education, 2002.

Reference Books:

1. S. S. Rao, Optimization, 3rd Enlarged Edition, New Age International (P) Ltd., Publishers, New Delhi, 2010.

2. T. E. Edger and D. M. Himmeblaue, Optimization of Chemical Processes, McGraw Hill International Editions, 1989.

3. William L. Luyben, Process Modeling, Simulation, and Control For Chemical Engineers, McGraw-Hill Publishing Company,1990.

4. Kalyanmoy Deb, “Optimization for Engineering Design”, Prentice Hall of India (P) Ltd., New Delhi, 1998.

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISDOC 6013	Database Management 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.					
ISDOC 6013	Database Management System	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISDOC 6013	Database Management System	3
Course Objectives	1. Learn and practice data modeling using the entity-relationship and developing database designs. 2. Understand the use of Structured Query Language (SQL) and learn SQL syntax. 3. Apply normalization techniques to normalize the database 4. Understand the needs of database processing and learn techniques for controlling the consequences of concurrent data access.	
Course Outcomes	The student will be able to: 1. To describe data models and schemas in DBMS. 2. Explain the features of database management systems and Relational database. 3. Use SQL- the standard language of relational databases. 4. Identify the functional dependencies and Design a database. 5. Describe the concept of Transactions Management and Concurrency. 6. Explain the concept of Query Processing and Optimization.	

Details of Syllabus:

Module	Contents	Hrs.	CO mapping
1	**Introduction Database Concepts:** Introduction, Characteristics of databases, File system V/s Database system, Users of Database system, Concerns when using an enterprise database, Data Independence, DBMS system architecture, Database Administrator **Entity–Relationship Data Model:** Introduction, Benefits of Data Modeling, Types of Models, Phases of Database Modeling, The Entity-Relationship (ER) Model, Generalization, Specialization and Aggregation, Extended Entity Relationship (EER) Model.	6	CO1
2	**Relational Model and Algebra:** Introduction, Mapping the ER and EER Model to the Relational Model, Data Manipulation, Data Integrity, Advantages of the Relational Model, Relational Algebra, Relational Algebra Queries, Relational Calculus.	6	CO2
3	**Structured Query Language (SQL):** Overview of SQL, Data Definition Commands, Set operations, aggregate function, null values, Data Manipulation commands, Data Control commands, Views in SQL, Nested and complex queries.	6	CO3
4	**Integrity and Security in Database:** Domain Constraints, Referential integrity, Assertions, Trigger, Security, and authorization in SQL **Relational–Database Design:** Design guidelines for relational scheme, Function dependencies, Normal Forms- 1NF, 2 NF, 3NF, BCNF and 4NF	8	CO4
5	**Transactions Management and Concurrency:** Transaction concept, Transaction states, ACID properties, Implementation of atomicity and durability, Concurrent Executions, Serializability, Recoverability, Implementation of isolation, Concurrency Control: Lock-based, Timestamp-based, Validation-based protocols, Deadlock handling, Recovery System: Failure Classification, Storage structure, Recovery & atomicity, Log based recovery, Shadow paging.	8	CO5
6	**Query Processing and Optimization:** Overview, Issues in Query Optimization, Steps in Query Processing, System Catalog or Metadata, Query Parsing, Query Optimization, Access Paths, Query Code Generation, Query Execution, Algorithms for Computing Selection and Projection, Algorithms for Computing a Join, Computing Aggregation Functions, Cost Based Query Optimization.	5	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. G. K. Gupta, Database Management Systems, McGraw – Hill.
2. Korth, Slberchatz,Sudarshan, Database System Concepts, 6th Edition, McGraw – Hill
3. Elmasri and Navathe, Fundamentals of Database Systems, 5thEdition, PEARSON Education.
4. Peter Rob and Carlos Coronel, Database Systems Design, Implementation and Management, Thomson Learning, 5th Edition.

Reference Books:

1. Dr. P.S. Deshpande, SQL and PL/SQL for Oracle 10g, Black Book, Dreamtech Press
2. Mark L. Gillenson, Paulraj Ponniah, Introduction to Database Management,Wiley
3. Sharaman Shah, Oracle for Professional, SPD.
4. Raghu Ramkrishnan and Johannes Gehrke, Database Management Systems,TMH
5. DebabrataSahoo, Database Management Systems, Tata McGraw Hill, Schaum‟s Outline

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISDLO6023	Bio-Sensors and 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.					
ISDLO6023	Bio-Sensors and Signal Processing	20	20	20	80	-	-	-	100

Subject Code	Subject Name	Credits
ISDLO6023	Bio- Sensors and Signal Processing	3
Course Objectives	1. To provide basic knowledge of various bio-sensors and their uses in biomedical applications. 2. To provide understanding of principle and operation of different types of bio-sensors like potentiometric, optical and amperiometric sensors. 3. To introduce the students to basic signal processing methods used in bio-signal measurement and analysis	
Course Outcomes	Students would be able 1. To describe the basic concept behind bioelectric phenomena. 2. To classify the different types of bio-sensors and describe their characteristics. 3. To explain different biosensors and transducers used for physical measurands. 4. To explain the various types of chemical biosensors and transducers and their significance in chemical measurands. 5. To explain about the various basic signal processing techniques used in bio-signal acquisition and analysis. 6. To apply the appropriate biosensor for different applications.	

Details of Syllabus:

Prerequisite: Knowledge about the basic working principle of various transducers.

Module	Contents	Hrs	CO Mapping
1	**Bioelectricity and Bio-electric Phenomena** Sensors/receptors in the human body, basic organization of nervous system, neural mechanism and circuit processing. Propagation of action potential, Electrode theory, electrode-tissue interface (metal-electrolyte interface), electrode-skin interface, electrode impedance.	05	CO1
2	**Introduction to biological sensors** Sensor architecture and Classification of biosensors: Medically significant measurands, functional specifications of medical sensors; Biosensor characteristics: linearity, repeatability, hysteresis, drift; Bio-sensor models in the time & frequency domains.	05	CO2
3	**Physical Biosensors and Transducers** Biosensors for physical measurands: strain, force, pressure, acceleration, flow, volume, temperature and bio-potentials. Various types of transducers; principles and applications- Resistive, Capacitive, Inductive, Photoelectric, piezoelectric, mechanical and molecular electronics based transducers in biosensors. Principle of fiber optic cable, fiber optic sensors, Photo acoustic sensors in biomedical field.	09	CO3
4	**Chemical Biosensors and Transducers** Bio-sensorsfor measurement of chemicals: Potentiometric sensors, ion selective electrodes, Amperometric sensors, Clark Electrode biosensors, Catalytic biosensors, Immuno-sensors. Chemiluminiscene- based biosensors, Liquid and solid ion exchange membrane electrode, Enzyme electrode.	09	CO4
5	**Bio-signal Acquisition and Processing** Measuring ultra- small signals, noise.Electrical signals produced by cells, Various types of signal processing techniques used for bio-signals.	05	CO5
6	**Applications of Biosensors** Biosensors in clinical chemistry, medicine and healthcare, biosensors for veterinary, agriculture and food, Low cost-biosensor for industrial processes for on line monitoring; biosensors for environmental monitoring.	06	CO6

Internal Assessment:

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

Theory Examination:

1. Question paper will comprise of 6questions, each carrying 20 Marks.
2. Total 4questions 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. Richard S.C, Cobbold, Transducers for Biomedical Measurements: Principles and Applications, John Wiley& Sons, 1992.
2. A.P.F. Turner, I. Karube & G. S. Wilson, Biosensors: Fundamentals &Applications, Oxford University Press, Oxford, 1987.
3. Rangan C.S., Sarma G.R., and Mani V.S.V., Instrumentation devices and system, Tata McGraw Hill Publishing Company limited, New Delhi, 2006.
4. John G.Webster, Medical Instrumentation: Application and Design, John Willey and sons, 1999.
5. Jacob Kline, Handbook of Bio Medical Engineering, Academic press Inc., Sandiego, 1988.

Reference Books:

1. Richard Aston: Principles of Biomedical Instrumentation and Measurement, Merril Publishing Co., Columbus, 1990.
2. Ernest O. Doeblin, Measurement Systems, Application and Design, Tata McGraw-Hill, 1985.
3. R. S. Khandpur, Handbookof Biomedical Instrumentation, Tata McGraw Hill.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISL601	Industrial Process Control Lab	-	2	-	-	1	-	1

Sub Code	Subject Name	Examination scheme							
		Internal Assessment			End Sem Exam	Term work	Pract. and Oral	Oral	Total
		Test 1	Test 2	Avg.					
ISL601	Industrial Process Control Lab	-	-	-	-	25	-	25	50

Subject Code	Subject Name	credits
ISL601	Industrial Process Control-Lab Practice	1
Course objectives	1. To impart the knowledge of different industrial unit operations. 2. To make them capable to design and develop instrumentation and control scheme for industrial processes. 3. To give them exposure to work in process industry. 4. To explain students about hazardous area and safety design system.	
Course Outcomes	The students will be able to 1. Explain working and control of heat transfer unit operations- heat exchanger and evaporator 2. Explain working and control of heat transfer unit operations- boiler and furnace 3. Explain working and control of heat and mass transfer unit operations- distillation and reactor 4. Explain working and control of heat and mass transfer unit operations- dryer and crystallizer 5. Describe the processes of batch and continuous process industries and instrumentation involved in them. 6. Classify hazardous areas in the industry.	

Syllabus: Same as that of Subject ISC601 Industrial Process Control.

List of Laboratory Experiments/Assignments:

Sr. No.	Detailed Content	CO Mapping
1	Demonstrate the operation and control scheme of Heat exchanger	**CO1**
2	Learn working of various Unit Operations (Boilers/furnace / Distillation column etc.) using online learning resources.	**CO2/CO3**
3	Demonstrate the reactor control system.	**CO3**
4	Demonstrate the operation & control scheme of dyer/crystallizer.	**CO4**
5	Prepare a report on any one industry.	**CO5**
6	Develop some charts on hazardous area classification.	**CO6**
7	Assignment/Exercise on heat transfer unit operations- heat exchanger,evaporator	**CO1**
8	Assignment/Exercise on heat transfer unit operations-boiler, furnace	**CO2**
9	Assignment/Exercise on heat and mass transfer unit operations-Distillation, reactor	**CO3**
10	Assignment/Exercise on heat and mass transfer unit operations-Crystallization, dryer	**CO4**
11	Assignment/Exercise on continuous or batch process industries	**CO5**
12	Assignment/Exercise on hazardous area classification	**CO6**

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

- Industry visit is advised to understand the unit operations, industrial processes and their control.

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 (Journal/program) : 10 marks
Assignment : 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
ISL602	Digital Signal Processing Lab	-	2	-	-	1	-	1

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.					
ISL602	Digital Signal Processing Lab	-	-	-		25	25	-	50

Subject Code	Subject Name	Credits
ISL602	Digital Signal Processing Lab	1
Course Objectives	1. Study simulation software platform for digital signal processing and Plot different type of signals. 2. To understand the concept of linear, circular convolution, correlation and simulate it by computer software. 3. To understand Fourier transform and its algorithms such as FFT and IFFT and simulate it. 4. To design and implement filters both FIR and IIR using computer simulation.	
Course Outcomes	Students will be able to 1. Verify sampling theorem using simulation software. 2. Demonstrate convolution and correlation concepts using simulation software. 3. Analyse frequency response of LTI systems using DTFT. Perform Discrete Fourier Transform of signals. 4. Design and implement FIR and IIR filters using computer simulation software platform. 5. Design and implement IIR filters using computer simulation software platform. 6. Design and implement IIR filters using computer simulation software platform.	

Syllabus: Same as that of Subject ISC602 Digital Signal Processing

List of Experiments:

Sr. No.	Contents	CO
1.	Write a Program to generate the basic signals and verify sampling theorem.	CO1
2.	Write a Program to implement the basic operations on the given signals	CO1
3.	Write a Program to implement Linear Convolution of the two given sequences.	CO2
4.	Write a Program to obtain the auto-correlation and Cross-correlations of the given sequences.	CO2
5.	Write a Program to obtain the transfer function and plot is pole-zero plot	CO3
6.	Write a Program to find the DTFT of the given sequence and plot its magnitude and phase plot	CO3
7.	Write a Program to find the DFT of the given sequences. Plot its magnitude and phase plot. Also find its IDFT to obtain the original sequence.	CO4
8.	Write a Program to obtain the circular convolution of the two given sequences.	CO4
9.	Write a Program to obtain the linear convolution using circular convolution of two given sequences.	CO4
10.	Write a Program to obtain the DFT of the given sequences using DIT-FFT algorithm and plot its magnitude and phase spectrum.	CO4
11.	Write a Program to design low-pass and high-pass FIR filters using window functions.	CO5
12.	Write a Program to design a digital IIR low-pass filter using Butterworth/Chebyshev approximations.	CO6

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

Oral Examination:

Oral examination will be based on entire syllabus.

Term Work:

Term work shall consist of minimum Eight experiments.
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Laboratory work (programs /journal) : 10 Marks
Attendance : 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
ISL603	Python Programming Lab	--	4#		--	2	-	2

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.					
ISL603	Python Programming Lab	--	--	--	--	25	25	-	50

out of 4 hours, 2 hours theory shall be taught to entire class and 2 hours practical in batches

Subject Code	Subject Name	Credits
ISL603	**Python Programming Lab**	2
Course Objectives	To know the basics of algorithmic problem solving 1. To read and write simple Python programs. 2. To develop Python programs with conditionals and loops. 3. To define Python functions and call them. 4. To use Python data structures - lists, tuples, dictionaries.	
Course Outcomes	Upon completion of the course, students will be able to 1. Read, write, execute by hand simple Python programs. 2. Represent compound data using Python lists, tuples, dictionaries. 3. To develop Python programs with conditionals and loops. 4. To learn simple Python programs for solving linear algebra operations. 5. Structure simple Python programs for visualizing the data. 6. To develop Python programs to solve different numerical methods.	

List of the Laboratory Experiments:

Module	Contents	CO mapping
1.	Write a program to demonstrate different number data types in Python.	CO1
2.	Write a program to perform different Arithmetic Operations on numbers in Python	CO2
3.	Write a program to create, concatenate and print a string and accessing sub-string from a given string.	CO2
4.	Write a program to create, append, and remove lists in python.	CO2
5.	Write a program to demonstrate working with tuples in python	CO2
6.	Write a program to demonstrate working with dictionaries in python.	CO3
7.	Write a python program to find largest of three numbers.	CO3
8.	Write a Python program to convert temperatures to and from Celsius,	CO4

	Fahrenheit.	
9.	Write a Python script that prints prime numbers less than 20.	CO5
10.	Write a python program to find factorial of a number using Recursion.	CO5
11.	Write a program that accepts the lengths of three sides of a triangle as inputs. The program output should indicate whether or not the triangle is a right triangle (Recall from the Pythagorean Theorem that in a right triangle, the square of one side equals the sum of the squares of the other two sides).	CO5
12.	Write a script named copyfile.py. This script should prompt the user for the names of two text files. The contents of the first file should be input and written to the second file.	CO4
13.	Write a program that inputs a text file. The program should print all of the unique words in the file in alphabetical order.	CO4
14.	Write a program to generate different sinusoidal signal and plot it using Matplotlib.	CO5
15.	Using scipy's quad function, write a program that solves the following integral numerically:$I = \int_0^1 \cos(2\pi x)\, dx$.	CO6
16.	Write a function with name plotquad which takes the same arguments as the quad command (i.e. f, a and b) and which • (i) creates a plot of the integrand f(x) and • (ii) computes the integral numerically using the quad function. The return values should be as for the quad function.	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: Term work shall consist of minimum 10 programs from the list of suggested programs and one Mini-project of your choice or from the list given above.

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

Laboratory work (Performing Experiments): 20 Marks
Laboratory work (programs/ journal) : 10 Marks
Mini Project : 15 Marks
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
ISM601	Mini Project – 2B	--	4$	--	--	2	--	2

$ 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.					
ISM601	Mini Project – 2B	--	--	--	--	25	--	25	50

Subject Code	Subject Name	Credits
ISM601	Mini Project – 2B	1.5
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. Analyse 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 Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini 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 mini 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 Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each 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 : 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first 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 finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
- In second 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.

Half-year project:

In this case in one semester students' group shall complete project in all aspects including,

- Identification of need/problem
- Proposed final solution
- Procurement of components/systems
- Building prototype and testing

Two reviews will be conducted for continuous assessment,

- First shall be for finalisation of problem and proposed solution
- Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project 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
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

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

Mini 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 individual's as member or leader
8. Clarity in written and oral communication

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