V. E. S. Institute of Technology

T.E. and B. E.

Instrumentation Engineering
(Semester – V, VII)

Autonomy Syllabus

Effective A. Y. 2023-24

Program Structure for Third Year
Instrumentation Engineering
(With Effect from 2023-2024)
Scheme for Semester- V

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	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	Mini Project–2 A	--	4$	--	2	--	2
Total		15	14	15	07	--	22

* Theory class to be conducted for full class

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

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Dur. (Hrs)			
		Mid Test (MT)	CA*					
ISC501	Electrical Machines and Drives	20	20	60	2		--	100
ISC502	Applications of Microcontroller	20	20	60	2		--	100
ISC503	Control System Design	20	20	60	2		--	100
ISC504	Process Instrumentation System	20	20	60	2		--	100
ISDOC501X	Department Optional Course– 1	20	20	60	2		--	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	Mini Project–2 A	--	--	--	--	25	25	50
Total		**100**	**100**	**300**	**--**	**125**	**125**	**750**

Department Optional Course – 1 (Semester- V)

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

Program Structure for Third Year
Instrumentation Engineering
(With Effect from 2023-2024)
Scheme for Semester- VI

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	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	Mini Project–2 B	--	4$	--	2	--	2
Total		12	12	12	06	--	18

# Out of 4 hours, 2 hours would be taught to entire class and 2 hours practical in batches
$ indicates workload of Learner (Not Faculty), for Mini Project

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Dur. (Hrs)			
		Mid Test (MT)	CA*					
ISC601	Industrial Process Control	20	20	60	2		--	100
ISC602	Digital Signal Processing	20	20	60	2		--	100
ISC603	Industrial Data Communication	20	20	60	2		--	100
ISDOC601X	Department Optional Course - 2	20	20	60	2		--	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	Mini Project–2 B	--	--	--	--	25	25	50
Total		**80**	**80**	**240**	**--**	**100**	**100**	**600**

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	

Program Structure for Third Year Instrumentation Engineering

Scheme for Autonomous Program

(With Effect from 2023-2024)

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ISC501	Electrical Machines and Drives	3	-	-	3	-	3

Course Code	Course Code	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Dur. (Hrs)			
		Mid Test (MT)	CA*					
ISC501	Electrical Machines and Drives	20	20	60	2	-	-	100

Course Code	Course 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: Learner 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	Content	Hrs
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**
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**
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**
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**

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**
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**

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
References:	
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

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:

1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Program Structure for Third Year Instrumentation Engineering

Scheme for Autonomous Program

(With Effect from 2023-2024)

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ISC502	Applications of Microcontroller	3	-	-	3	-	3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Dur. (Hrs)			
		Mid Test (MT)	CA*					
ISC502	Applications of Microcontroller	20	20	60	2	-	-	100

Course Code	Course Name	Credits
ISC502	Applications of Microcontroller	03
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: Learner will be able to:	
1	Understand the definition of embedded system and design trends
2	Understand the architecture of 8051
3	Identify programming and various programming tools of 8051
4	Understand integrated peripherals of 8051
5	Understanding concepts of Interfacing of 8051 with external devices
6	Apply 8051 for various real world applications

Module	Detailed Contents	Hrs.
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**
2	**MCS-51 Microcontroller** Architecture of MCS51 family of microcontroller, and its Variants and comparison. Memory organization and SFRS. Programming model.	**04**
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**
4	**Integrated peripherals of MCS 51** Integrated peripherals such as Timers/Counters, Interrupt, serial port and programming.	**05**
5	**MCS 51 Interfacing** Interfacing with Memories, 7 segment display, LCD, ADC, DAC, relay, opto-isolator, DC motor and Stepper Motor.	**10**
6	**Case Studies** Data acquisition systems, Digital weighing machine, Washing machines, Traffic light controller, home automation and irrigation	**05**

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.
References:	
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.
6	www.atmel.com
7	www.microchip.corn

Internal Assessment:

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Continuous Assessment: -

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Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	6 marks

End Semester Theory Examination:

1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Program Structure for Third Year Instrumentation Engineering

Scheme for Autonomous Program

(With Effect from 2023-2024)

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ISC503	Control System Design	3	-	-	3	-	3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Dur. (Hrs)			
		Mid Test (MT)	CA*					
ISC503	Control System Design	20	20	60	2	-	-	100

Course Code	Course 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	

Course Outcomes: Learner 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

Module	**Content**	**Hrs**
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**
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**
3	**Analysis and Design of Control System in State Space:** Controllability, and observability properties. 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**

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**
5	**Compensator Design using Frequency response:** Systems with time delay, transient response through gain adjustment, Lag, Lead, Lag-Lead compensation.	**08**
6	**PID Controller Design:** PID controller tuning: Ziegler-Nicholas method, Cohen-coon method, Designing PID controller using Root-Locus.	**04**

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.
References:	
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	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

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3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:

1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
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4	Any three questions out of five needs to be solved.

Program Structure for Third Year Instrumentation Engineering

Scheme for Autonomous Program

(With Effect from 2023-2024)

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ISC504	Process Instrumentation System	3	-	-	3	-	3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Dur. (Hrs)			
		Mid Test (MT)	CA*					
ISC504	Process Instrumentation System	20	20	60	2	-	-	100

Course Code	Course Name	Credits
ISC504	Process Instrumentation System	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: Learner 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

Module	Content	Hrs
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**
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**

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**
4	**Control Schemes** Feedback, Feed forward, cascade, Ratio, split range, selective control, adaptive control, inferential control, and selection Guidelines.	**06**
5	**Multivariable Control** Introduction to MIMO systems, Block diagram analysis of multivariable systems, Interaction, relative gain analysis, Decoupler design	**04**
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**

Text Books:	
1	Curtis D. Johnson, "Process Control Instrumentation Technology", PHI /Pearson Education 2002
2	George Stephanopoulos, "Chemical process control", PHI-1999
References:	
1	Bela G. Liptak, "Instrument Engineer"s Hand Book – Process Control", Chilton Company, 3rd Edition, 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

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4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:

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2	Question paper will have a total of five questions
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4	Any three questions out of five needs to be solved.

Program Structure for Third Year Instrumentation Engineering

Scheme for Autonomous Program

(With Effect from 2023-2024)

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ISDOC 5011	Analytical Instrumentation	3	-	-	3	-	3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Dur. (Hrs)			
		Mid Test (MT)	CA*					
ISDOC 5011	Analytical Instrumentation	20	20	60	2	-	-	100

Course Code	Course 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: Learner 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

Module	**Content**	**Hrs**
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 of spectroscopic analytical system – Radiation sources, Wavelength selectors, Detectors, signal processors and readout modules. Scintillation detector	**9**
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**
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**

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**
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**
6	**Industrial Gas Analyzers:** Oxygen Analyzer, Combustion Gas Analyzers (COX, NOX, SOX, hydrocarbons), Gas density analyzer	**5**

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
References:	
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

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:

1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Program Structure for Third Year Instrumentation Engineering

Scheme for Autonomous Program

(With Effect from 2023-2024)

Course Code	Course Name Data	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ISDOC 5012	Data Structure and Algorithm Analysis	03	-	-	03	-	3

Sub Code	Subject Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	End sem Exam			
		Mid Test (MT)	CA*					
ISDOC 5012	Data Structure and Algorithm Analysis	20	20	60	2	-	-	100

Course Code	Course 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: Learner will be able to:	
1	Choose appropriate data structure as applied to specified problem definition and analyze 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

Module	Contents	Hrs.
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 Analyze, 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**

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**
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**
4	**Priority queues:** The priority queues Abstract data Type, Implementing a Priority queues with a List, Heaps, Adaptable priority queues.	**4**
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**
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**

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	Reema Thareja, Data Structures using C, Oxford University press
6	Jean-Paul Tremblay, P. G. Sorenson, Introduction to Data Structure with Applications, Second Edition
References:	
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

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:

1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Program Structure for Third Year Instrumentation Engineering

Scheme for Autonomous Program

(With Effect from 2023-2024)

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ISDOC5013	Mechatronics	3	-	-	3	-	3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Dur. (Hrs)			
		Mid Test (MT)	CA*					
ISDOC5013	Mechatronics	20	20	60	2	-	-	100

Course Code	Course 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: Learner 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

Module	Contents	Hrs.
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**
2	**Modeling and Simulation of physical systems:** Simulation and block diagrams, Analogies and impedance diagrams, mechanical translational 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**
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, magneto strictive actuators, memory metal actuators, Programmable Logic Controller	**07**
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**
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**

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**

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	Stamatios V. Kartalopoulos, Understanding Neural Networks and fuzzy Logic‖, PHI,3rd reprint, 2013
References:	
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

Internal Assessment:

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Continuous Assessment: -

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Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
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3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
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8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:

1	Question paper will be of 60 marks
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Program Structure for Third Year Instrumentation Engineering

Scheme for Autonomous Program

(With Effect from 2023-2024)

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ISDOC5014	Advanced sensors	3	-	-	3	-	3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Dur. (Hrs)			
		Mid Test (MT)	CA*					
ISDOC5014	Advanced sensors	20	20	60	2	-	-	100

Course Code:	Course Title	Credit
ISDOC5014	Advanced sensors	3
Prerequisite: Fundamentals of transducers		
Course Objectives:		
1	To learn the principles of sensors	
2	To provide the knowledge about the sensor fabrication	
3	To explore the students to the concepts of smart sensors	

4	To provide knowledge of micro sensors and its fabrication	
5	To learn the various application fields of smart sensors.	
6	To learn advanced sensing technology	
Course Outcomes:		
1	Explain the various principles employed in sensors	
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	

Module		**Content**	**Hrs**
1		**Review of Fundamental of Sensors:**	**7**
	1.1	Principle of physical and chemical transduction, sensor classification.	
	1.2	Characterization of mechanical, electrical, optical, thermal, magnetic, chemical and biological sensors, their calibration and determination of characteristics	
2		**Sensor Fabrication**	**6**
	2.1	Design considerations and selection criterion as per standards, Sensor fabrication techniques.	
	2.2	Fabrication process details and latest trends in sensor fabrication, Thick film sensing and system design	
3		**Smart Sensors**	**7**
	3.1	Smart sensor basics, signal conditioning and A/D conversion for sensors, Standards for SMART sensing	

	3.2	Examples of available ICs (DHT, Smart analog IC 500, ADXL345) and their applications	
4		**Micro Sensors**	**6**
	4.1	Introduction, Intrinsic characteristics of MEMS, common fabrication techniques	
	4.2	Application of MEMS in sensing systems including pressure sensors, accelerometers, gyroscopes and strain gauges.	
5		**Advanced Sensor Applications**	**7**
	5.1	Temperature & Humidity measurement using DHT Sensor in environment monitoring, Acceleration measurement using ADXL345 for automotive industry.	
	5.2	MEMS Temperature sensors for automotive applications, MEMS chemical sensors for survey meters, MEMS pressure sensors for medical applications	
6		**Advanced Sensing Technology**	**6**
	6.1	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)	
	6.2	Sensors, instruments and measurement techniques for agricultural measurements such as soil moisture, wind speed, leaf wetness duration, sensors for food processing like smell or odour, taste	
		Total	**39**

Textbooks:	
1	Jacob Fraden, "Handbook of Modern Sensors", 5th Edition, Springer .
2	Chang Liu, "Foundations of MEMS", Pearson Education Inc.,2012.
3	Tai Ran Hsu, "MEMS & Micro systems Design and Manufacture", Tata Mc Graw Hill, New Delhi, 2002.
4	Stephen D Senturia, Microsystem Design, Springer Publication,2000
5	Randy Frank, "Understanding Smart Sensors", 2nd edition, Artech House, 2000.
Reference Books:	
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

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -
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4.	Creating Proof of concept	10 marks
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8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:

1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Program Structure for Third Year Instrumentation Engineering

Scheme for Autonomous Program

(With Effect from 2023-2024)

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ISL501	Electrical Machines and Drives Lab		2		1		1

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA*					
ISL501	Electrical Machines and Drives Lab	--	--	--	--	25	25	50

Lab 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
Lab Outcomes:	
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

Sr. No.	**Name of the Experiment**	**CO Mapping**
1	Speed control methods of DC motor	CO1
2	Starting of 3-phase IM by DOL/Autotransformer/rotor resistance method	CO2
3	Study of Single-phase Induction Motor	CO3
4	Plot V-I characteristics of SCR	CO4
5	Triggering Methods of SCR	CO4
6	Plot V-I characteristics of Diac	CO4
7	Plot V-I characteristics of Triac	CO4
8	Plot V-I characteristics of IGBT	CO4
9	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

Term Work:

Term work should consist of 10 experiments

1. Journal must include at least 2 assignments.
2. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work
3. **Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)**

Continuous assessment exam

Based on the subject and related lab of ISC501

Program Structure for Third Year Instrumentation Engineering

Scheme for Autonomous Program

(With Effect from 2023-2024)

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ISL502	Applications of Microcontroller Lab		2		1		1

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA*					
ISL502	Applications of Microcontroller Lab	--	--	--	--	25	25	50

Lab 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
Lab Outcomes:	
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

Sr. No.	**Name of the Experiment**	**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

Term Work:

Term work should consist of 10 experiments

1. Journal must include at least 2 assignments.
2. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work
3. **Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)**

Continuous assessment exam

Based on the subject and related lab of ISC502

Program Structure for Third Year Instrumentation Engineering

Scheme for Autonomous Program

(With Effect from 2023-2024)

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ISL503	Process Instrumentation Systems and Control System Design Lab		2		1		1

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA*					
ISL503	Process Instrumentation Systems and Control System Design Lab	20	20	60	2	25	25	50

Lab 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
Lab Outcomes:	
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 control
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

Sr. No.	**Name of the Experiment**	**CO Mapping**
1	Study Features & operation of ON-OFF Control action & its application	CO1
2	Study of flow rate control using P, PI, PD and PID controller modes	CO1
3	Study of Ratio control system	CO2
4	Study of Multivariable control system	CO3
5	Study of discrete state process control system	CO3

6	Obtain a state-space model in different canonical forms of a given transfer function	CO4
7	Investigate controllability and observability of system, then accordingly design controller and observer	CO5
8	Design of Lead Compensator using Root-locus technique	CO6
9	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

Term Work:

Term work should consist of 10 experiments

1. Journal must include at least 2 assignments.
2. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work
3. **Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)**

Continuous assessment exam

Based on the subject and related lab of ISC503, ISC504

Program Structure for Third Year Instrumentation Engineering

Scheme for Autonomous Program

(With Effect from 2023-2024)

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ISL504	Professional Communication & Ethics-II		2*+2		2		2

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA*					
ISL504	Professional Communication & Ethics-II	--	--	--	--	25	25	50

Lab 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
Lab Outcomes:	
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	**Content**	**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)	06

	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 References) • Language and Formatting • Referencing in IEEE Format 2 EMPLOYMENT SKILLS	
2	**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 Resumes (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, Behavioral, Problem Solving & Case-based) • Modes of Interviews: Face-to-face (One-to one and Panel) Telephonic, Virtual	06

3	**BUSINESS MEETINGS** **3.1. Conducting Business Meetings** • Types of Meetings • Roles and Responsibilities of Chairperson, Secretary and Members • Meeting Etiquette **3.2. Documentation** • Notice • Agenda • Minutes	O2
4	**TECHNICAL/ BUSINESS PRESENTATIONS** **4.1 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 **4.2 Group Presentations** • Sharing Responsibility in a Team • Building the contents and visuals together • Transition Phases	02
5	**INTERPERSONAL SKILLS** **5.1. 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 Behavior, Market Trends, etc.)	08
6	**CORPORATE ETHICS** **6.1Intellectual Property Rights** □ Copyrights □ Trademarks □ Patents □ Industrial Designs	02

	□ Geographical Indications □ Integrated Circuits □ Trade Secrets (Undisclosed Information) **6.2 Case Studies** □ Cases related to Business/ Corporate Ethics	

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

Internal oral:

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

Group Discussion: 10 marks

Project Presentation: 10 Marks

Term Work:

Term work should consist of assignments.

The final certification and acceptance of term work ensures satisfactory performance.

Total 25 Marks (Assignments and presentation: 20 marks, Attendance: 05 marks)

Program Structure for Second Year Automation and Robotics

Scheme for Autonomous Program

(With Effect from 2023-2024)

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ISM501	Mini Project-2A		4[$]	--	2	--	2

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA*					
ISM501	Mini Project-2A	--	--	--	--	25	25	50

Prerequisite:	
Lab Objectives:	
1	To acquaint with the process of identifying the needs and converting it into the problem.
2	To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems
3	To inculcate the process of self-learning and research
Lab Outcomes: On successful completion of the course 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	Analyze the impact of solutions in societal and environmental context for sustainable development
5.	Excel in written and oral communication.
6.	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.
- Student shall 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/software model using various components of their domain and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format.
- 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 bead opted 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 logbook 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 finalization of problem
    - Second shall be on finalization of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype/software model, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype/software model 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/software model and testing

- Two reviews will be conducted for continuous assessment,
  - First shall be for finalization 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/software model as per stated requirements
10. Effective use of skillsets
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 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 Department.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal/External Examiners preferably from industry or research organizations having experience of more than five years approved by Head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

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/software model as per stated

requirements

5. Effective use of skillsets
6. Effective use of standard engineering norms
7. Contribution of an individual’s as member or leader
8. Clarity in written and oral communication

Program Structure for Final Year B.E Instrumentation Engineering

(With Effect from 2023-2024)

Scheme for Semester -VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract. Tut.	Theory	Pract.	Tut.	Total
ISC701	Instrumentation Project Documentation & Execution	3	--	3	--	--	3
ISC702	Process Automation	3	--	3	--	--	3
ISDOC701X	Department Optional Course– 3	3	--	3	--	--	3
IOC701X	Institute Optional Course–1	3	--	3	--	--	3
ISL701	Instrumentation Project Documentation & Execution - Lab	--	2	--	1	--	1
ISL702	Process Automation -Lab	--	2	--	1	--	1
ISL703X	Department Optional Course-3 -Lab	--	2	--	1	--	1
ISP701	Major Project-I	--	6#	--	3	--	3
Total		**12**	**12**	**12**	**6**	--	**18**

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA*					
ISC701	Instrumentation Project Documentation & Execution	20	20	60	2	--	--	100
ISC702	Process Automation	20	20	60	2	--	--	100
ISDOC701X	Department Optional Course– 3	20	20	60	2	--	--	100
IOC701X	Institute Optional Course–1	20	20	60	2	--	--	100
ISL701	Instrumentation Project Documentation & Execution - Lab	--	--	--	--	25	25	50
ISL702	Process Automation - Lab					25	25	50
ISL703X	Department Optional Course -3 – Lab	--	--	--	--	25	25	50
ISP701	Major Project-I	--	--	--	--	50	50	100
Total		**80**	**80**	**240**	**--**	**125**	**125**	**650**

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

Program Structure for Final Year B.E Instrumentation Engineering

(With Effect from 2023-2024)

Scheme for Semester -VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract. Tut.	Theory	Pract.	Tut	Total
ISC801	Instrument and System Design	3	--	3	--	--	3
ISDOC801X	Department Optional Course– 4	3	--	3	--	--	3
ISDOC802X	Department Optional Course– 5	3	--	3	--	--	3
IOC802X	Institute Optional Course–2	3	--	3	--	--	3
ISL801	Instrument and System Design – Lab	-	2	--	1	--	1
ISL802X	Department Optional Course -4 -Lab	-	2	--	1	--	1
ISP801	Major Project-II	-	12#	--	6	--	6
Total		**12**	**16**	**12**	**8**	**--**	**20**

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA*					
ISC801	Instrument and System Design	20	20	60	2	--	--	100
ISDOC801X	Department Optional Course– 4	20	20	60	2	--	--	100
ISDOC802X	Department Optional Course– 5	20	20	60	2	--	--	100
IOC802X	Institute Optional Course–2	20	20	60	2	--	--	100
ISL801	Instrument and System Design – Lab	--	--	--	--	25	25	50
ISL802X	Department Optional Course -4 -Lab	--	--	--	--	25	25	50
ISP801	Major Project-II	--	--	--	--	100	50	150
Total		**80**	80	240	10	150	100	**650**

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

Students group and a load of faculty per week.

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

Department Optional Course – 3 (Semester- VII)

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

Institute Optional Course – 1 (Semester- VII)

IOC7011	Product Lifecycle Management	IOC7016	Cyber Security and Laws
IOC7012	Reliability Engineering	IOC7017	Disaster Management and Mitigation Measures
IOC7013	Management Information System	IOC7018	Energy Audit and Management
IOC7014	Design of Experiments	IOC7019	Development Engineering
IOC7015	Operation Research		

Department Optional Course – 4 (Semester- VIII)

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

Department Optional Course – 5 (Semester-VIII)

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

Institute Optional Course – 2 (Semester- VIII)

IOC8021	Project Management	IOC8026	Research Methodology
IOC8022	Finance Management	IOC8027	IPR and Patenting
IOC8023	Entrepreneurship Development and Management	IOC8028	Digital Business Management
IOC8024	Human Resource Management	IOC8029	Environmental Management
IOC8025	Professional Ethics and Corporate Social Responsibility		

Program Structure for Final Year B.E Instrumentation Engineering

(With Effect from 2023-2024)

Scheme for Semester -VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Total
ISC701	Instrumentation Project Documentation and Execution	3	-	-	3	-	3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA*					
ISC701	Instrumentation Project Documentation and Execution	20	20	60	2	--	--	100

Subject Code	Subject Name	Credits
ISC701	Instrumentation Project Documentation and Execution	3
Prerequisite:		
Course Objectives:		
1	To provide knowledge of Instrumentation Project & Detailed Engineering techniques in the EPC Consultancy.	
2	To make the students capable of executing Project Deliverables and Engineering activities of Project Documentation	

Course Outcomes:	
1	Interpret types of projects and execute it by knowing the relationship between customer, designer and constructor.
2	Apply standards in instrumentation projects and prepare basic engineering documents.
3	Design engineering documents such as loop diagram, hook-up, JB schedule.
4	Develop and test system integration.
5	Schedule and evaluate activities like procurement, commissioning, and installation.
6	Support and evaluate documentation software packages used in industry

Module	**Contents**	**Hrs.**
1	**The Project and Project Team:** Introduction, Types of projects, structure, Project scope, Project flow and deliverables, Need and techniques used for Project Planning and Scheduling **The Project Team:** Customer, designer and constructor; Responsibility matrix.	**5**
2	**Project Documentation Standards**: Introduction to ISA (ISA 5.1, 5.2, 5.4, ISA 20 etc), NEMA, ANSI standards. **Project Engineering Documents:** Preliminary Engineering Documents: PFD, P&ID (ISA S-5.1), Cause and effect diagram. Front End Engineering and Design (FEED) documents: Instrument index sheet, I/O schedule, Instrument specification sheets (ISA S-20) for pressure, temperature, flow and level instruments.	**10**
3	**Detailed Engineering Design:** Instrument Loop wiring diagrams (ISA S-5.4), (ISA S-5.2), Instrument Hook up, BOM, Instrument Location Plan **Cable Engineering:** Class of conductors, Types, Specification, Selection, Cable schemes, Cable trays. Earthing and Grounding for General and power Signals. Power Distribution diagram, Earthing Diagram, Cable and Junction box schedule	**7**
4	**Construction activities:** Site conditions and planning, Installation activities/ procedures and documents required. Types of operating Stations, Control system specifications, Control system graphics (ISA S5.5), databases, I/O allocation and configuration. **System Integration:** HMI specification Development, System Architecture Design: Network single line diagram generation.	**7**

5	**Procurement activities**: Pre-Qualification Evaluation of Vendor, Vendor registration, Tendering and bidding process and required documents, Bid evaluation, Purchase orders. **Commissioning and Testing Activities:** Panel testing Procedure and its documentation. Factory Acceptance Test (FAT), Customer Acceptance Test (CAT), Site inspection and testing (SAT), Calibration records, Test and inspection reports. Cold Commissioning and hot commissioning, punch list.	**6**
6	**Overview of project documentation tools:** Introduction of various tools for project engineering documentation and project planning /scheduling.	**4**

Textbooks:	
1	Andrew & Williams, *"Applied instrumentation in process industries",* Gulf Publishing.
2	Peter Watermeyer, "Hand book for Process Plant Project Engineers", Professional Engineering Publishing, 2002.
3	John Bacon, "Management systems", (ISA)
4	B.G. Liptak, "Hand Book-Process control Instrument Engineers"
5	Michael D. Whitt,"Successful Instrumentation & Control Systems Design", ISA
6	Pradeep Pai, "Project Management", Pearson Education.
7	B.C. Punmia and K.K. Khandelwal, "Project Planning and Control with PERT and CPM", Laxmi Publications Private Limited.
Reference Books:	
1	Harold Kerzner, Van Nostrand, "Project Management A System Approach to Planning, Scheduling and Controlling", Reinhold Publishing, 2001.
2	ISA Manual, "Instrument Installation and Project Management",2000.
3	ANSI-ISA, "Instrumentation Symbols and Identification", 1992.

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.

Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Program Structure for Final Year B.E Instrumentation Engineering

(With Effect from 2023-2024)

Scheme for Semester -VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ISC702	Process Automation	3	- -	3			3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA*					
ISC702	Process Automation	20	20	60	2	--	--	100

Subject Code	Subject Name	Credits
ISC702	Process Automation	3

Prerequisite: Knowledge of Digital Electronics, Process Instrumentation and Control

Course Objectives:

1	To give the students fundamentals of automation and various automation systems used in industry such as PLC, SCADA, and DCS.
2	To impart the knowledge about the architecture, working of PLC, SCADA and DCS
3	To make the students capable to apply knowledge to identify hardware and software requirements of PLC, SCADA and DCS
4	To give the students a comprehension of the aspects related to Safety Instrumented system (SIS).

Course Outcomes:	
1	Define automation, it's need, importance and applications in industry.
2	Identify components of PLC and develop PLC ladder and design PLC based application by proper selection and sizing criteria.
3	Describe SCADA architecture, communication in SCADA and develop any application based on SCADA along with GUI using SCADA software.
4	Explain evolution and architecture of DCS, hierarchical control in DCS, programming DCS through Function Block Diagram (FBD) method.
5	Describe database and alarm management system
6	Identify the components of SIS, risk reduction methods, evaluation of SIL (Safety Integrity Levels)

Module	Content	Hrs
1	**Automation Fundamentals** Automation, Need for automation and its importance, Types of automation, Process and factory automation.Automation applications, Industry 4.0 automation systems architecture. Automation hierarchy – large control system hierarchy, data quantity & quality and hierarchical control.	**4**
2	**Programmable Logic Controller** **Hardware** Evolution of PLC, PLC Architecture,Types & Specifications. Safety PLC I/O modules, local and remote I/Oexpansion, special purpose modules, wiring diagrams of different I/Omodules, communication modules, Memory & addressing- memory organization,I/O addressing, hardware to software interface. **Software** introduction to PLCProgramming, programming devices, IEC standard PLC programminglanguages, LD programming- basic LD instructions, PLC Timers andCounters: Types and examples, data transfer & program control instructions, advanced PLC instructions, PID Control using PLC. **Case study:** PLC selection and configuration for any one process applications**.**	**10**
3	**Supervisory Control and Data Acquisition (SCADA)** SCADA introduction, brief history of SCADA, elements of SCADA. Features of SCADA, Protocol structure, Specifications of SCADA SCADA as a real time system, Communications in SCADA- types & methods used, components. SCADA Development for any one typical application Programming for GUI development using SCADA software.	**7**

4	**Distributed Control System** (**DCS**) Introduction to DCS. Evolution of DCS, DCS flow sheet symbols, architecture of DCS. Specifications of DCS. Introduction of Hierarchical control of memory: Task listing, Higher and Lower computer level task. Supervisory computer tasks DCS configuration. Supervisory computer functions, Control techniques, Supervisory Control Algorithm. DCS & Supervisory computer displays, advanced control Strategies, computer interface with DCS. DCS. System integration with PLCs computer: HMI, Man machine interface sequencing, Supervisory control, and integration with PLC, personal computers and direct I/O, serial linkages, network linkages, link between networks. Introduction to DCS Programming, Function Block Diagram method for DCS programming.	**10**
5	**Database and Alarm Management MES, ERP** Database management, Philosophies of Alarm Management, Alarm reporting, types of alarms generated and acceptance of alarms. MES, Integration with enterprise system.	**4**
6	**Safety Instrumented System (SIS)** Need for safety instrumentation- risk and risk reduction methods, hazard analysis. Process control systems and SIS. Safety Integrity Levels (SIL) and availability. Introduction to the international functional safety standard IEC61508	**4**

Textbooks:	
1	Samuel M. Herb, “Understanding Distributed Processor Systems for Control”, ISA Publication.
2	Thomas Hughes, “Programmable Logic Controller”, ISA Publication.
3	Stuart A. Boyer, “SCADA supervisory control and data acquisition”, ISA Publication.
4	Gruhn and Cheddie, “Safety Shutdown Systems” – ISA, 1998,
Reference Books:	
1	Poppovik Bhatkar, “Distributed Computer Control for Industrial Automation”, Dekkar Publication
2	S.K. Singh, “Computer Aided Process Control”, Prentice Hall of India.
3	Krishna Kant, “Computer Based Process Control”, Prentice Hall of India
4	N.E. Battikha, “The Management of Control System: Justification and Technical Auditing”, ISA.
5	Gary Dunning, “Introduction to Programmable Logic controller”, Thomas Learning, edition, 2001.
6	John. W. Webb, Ronald A Reis, “Programmable Logic Controllers – Principles and Applications”, 3rd edition, Prentice Hall Inc., New Jersey, 1995.
7	Bela G. Liptak “Instrument engineer’s handbook- Process control” Chilton book company- 3rd edition. D.J. Smith & K.G.L. Simpson, “Functional Safety: A Straightforward Guide to IEC61508 and Related Standards”, -Butterworth-Heinemann Publications.
8	D.J. Smith & K.G.L. Simpson, “Functional Safety: A Straightforward Guide to IEC61508 and Related Standards”, -Butterworth-Heinemann Publications.

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.

Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	6 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Program Structure for Final Year B.E Instrumentation Engineering

(With Effect from 2023-2024)

Scheme for Semester -VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ISDOC 7011	Biomedical Instrumentation	3	--	3	--		3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA*					
ISDOC7011	Biomedical Instrumentation	20	20	60	2	--	--	100

Course Code:	Course Title	Credit
ISDOC7011	Biomedical Instrumentation	3
Prerequisite: Bio-Sensors and Signal Processing, Human physiology and anatomy		
Course Objectives:		
1	To make students identify the various bio-signals from human body.	
2	To learn about the working of different physiological systems in the body.	
3	To provide skills to measure various physiological parameters, from these systems.	
4	To make students understand the application of the various biomedical instruments in diagnosis.	

5	To learn about the different medical imaging methods.
6	To make students understand the working of therapeutic instruments in biomedical field.
Course Outcomes:	
1	To identify various Bio-potential with their specifications and perform their measurements.
2	To discuss various Physiological systems and to identify their parameters and related measurements.
3	To explain the principle and working of various cardiovascular parameters and their measurement techniques with applications.
4	To distinguish between the various medical imaging techniques based on the principles and concepts involved in them.
5	To relate between the different life support instruments and to describe their applications.
6	To describe the significance of electrical safety in biomedical measurement.

Module		**Content**	**Hours**
1		**Bio-Potentials and their Measurement:**	**4**
	1.1	Structure of Cell, Origin of Bio-potential, electrical activity of cell and its characteristics and specifications.	
	1.2	Measurement of RMP and AP. Electrode-Electrolyte interface and types of bio-potential electrodes.	
2		**Physiological Systems and Related Measurement**	**10**
	2.1	Respiratory system- Physiology of respiration and measurements of respiration related parameters, Spirometer.	
	2.2	Nervous system- Nerve cell, neuronal communication, nerve-muscle physiology, Generation of EEG and study of its characteristics. Normal and abnormal EEG, evoked potential and epilepsy, 10-20 electrode placement system and EEG amplifier.	
	2.3	Muscular system- Generation of EMG signal, specification and measurement, EMG amplifier system.	
	2.4	Cardiovascular system- Structure of Heart, Electrical and Mechanical activity of Heart, ECG measurements and Cardiac arrhythmias, Heart sound measurement. First aid to be given for heart attack patients, Design	

		of ECG amplifier circuit.	
3		**Cardiovascular Measurement**	**6**
	3.1	Blood Volume measurement using Plethysmograph (True and Impedance)	
	3.2	Blood Pressure measurement - Direct and Indirect types	
	3.3	Blood Flow measurements - Electromagnetic and Ultrasonic types	
	3.4	Cardiac Output measurements - Ficks method, Dye-dilution and Thermo-dilution type	
4		**Medical Imaging techniques**	**8**
	4.1	X-Ray tube, X ray machine, Digital X Ray and its application	
	4.2	CT Machine – Block Diagram, scanning system and application	
	4.3	Ultrasound Imaging- Modes of scanning and their application.	
5		**Life support Instruments**	**9**
	5.1	Pacemaker- Types of Pacemakers, mode of pacing and its application	
	5.2	Defibrillator- AC and DC Defibrillators and their application	
	5.3	Heart Lung machine and its application during surgery.	
	5.4	Hemodialysis system and the precautions to be taken during dialysis	
	5.5	Ventilator system and its important parameters for monitoring	
6		**Electrical Safety in Biomedical field**	**2**
	6.1	Physiological effects of electrical current	
	6.2	Shock Hazards from electrical equipment and methods of accident prevention	
		Total	**39**
Textbooks:			

1	Leslie Cromwell, Biomedical Instrumentation and Measurements, 2nd Edition, Pearson Education, 1980.
2	R. S. Khandpur, Biomedical Instrumentation, TMH, 2004.
3	John G. Webster, Medical Instrumentation, John Wiley and Sons, 4th edition, 2010.
Reference Books:	
1	Joseph J. Carr and John M. Brown, -Introduction to Biomedical Equipment Technology, PHI/Pearson Education, 4th edition, 2001.
2	Richard Aston, - Principles of Biomedical Instrumentation and Instruments‖, PH, 1991.
3	John E Hall, Gyton's- Medical Physiology, 12th edition, 2011.

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	7 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Program Structure for Final Year B.E Instrumentation Engineering

(With Effect from 2023-2024)

Scheme for Semester -VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ISDOC7012	Machine Learning	3	-	-	3	-	-

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Dur. (Hrs)			
		Mid Test (MT)	CA*					
ISDOC7012	Machine Learning	20	20	60	2	-	-	100

Course Code:	Course Title	Credit
ISDOC7012	Machine Learning	3

Prerequisite:

Course Objectives:

1	To familiarize the student with basic concepts of Machine learning algorithms
2	To provide understanding of the concepts of regression and classification ML algorithms.
3	To introduce the students to the basic concepts and application of artificial neural networks

Course Outcomes

1	Apply the basic concepts of various machine learning algorithms
2	Apply the basic concepts of various machine learning algorithms
3	Analyze the various supervised learning algorithms.
4	Design machine learning algorithms based on artificial neural network.
5	Explain the concept and working of support vector machine
6	Apply machine learning algorithms for real time applications

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

Textbooks:	
1	Mehryar Mohri, Afshin Rostamizadeh and Ameet Talwalkar, *"Foundations of Machine Learning (FOML)",* MIT Press, 2012.
2	David Barber, *"Bayesian Reasoning and Machine Learning",* Cambridge University Press, 2007.
3	Tom Mitchell, *"Machine Learning",* McGraw Hill, 1988
4	S. Shridhar, M. Vijayalakshmi, "*Machine learning*", Oxford University Press, 2021.
Reference Books:	
1	Ian Good fellow, Yoshua Bengio and Aaron Courville, *"Deep Learning (DL)",* MIT Pess, 2016. Shai Shalev-Shwartz and Shai Ben-David, *"Understanding Machine Learning: From Theory to Algorithms (UML)",* Cambridge University Press, 2014

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -
Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	8 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Program Structure for Final Year B.E Instrumentation Engineering

(With Effect from 2023-2024)

Scheme for Semester -VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ISDOC7013	Advanced Control System	3	--	3	--		3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA*					
ISDOC7013	Advanced Control System	20	20	60	2	--	--	100

Course Code:	Course Title	Credit
ISDOC7013	Advanced Control System	3

Prerequisite: Knowledge of linear control theory.

Course Objectives:

1	To familiarize the student with nonlinear phenomena.
2	To provide the students an understanding of stability and behavior of nonlinear systems near equilibrium points in phase plane.
3	To analyze stability of nonlinear systems using describing function technique in complex-plane.
4	To introduce the model predictive control to the students.

Course Outcomes	
1	Distinguish between linear and nonlinear systems.
2	Compute or draw the state trajectory in phase-plane to analyze the behavior of nonlinear systems.
3	Linearize the nonlinear system and identify the nature of singular points.
4	Construct the Lyapunov function to determine the stability of equilibrium.
5	Determine the stability of the system in frequency domain via describing functions.
6	Design IMC-PID controller to system with uncertainties and disturbances.

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

Textbooks:	
1	I. J. Nagrath and M. Gopal, Control System Engineering, 3rd Edition, New Age International (P) Ltd., Publishers - 2000.
2	Hassan Khalil, Nonlinear Systems, 3rd edition, paperback edition, 2014.
3	B. WayneBequette, Process Control: Modeling, Design, and Simulation, Prentice Hall PTR, 2002.
4	K. Ogata, Modern Control Engineering, Prentice Hall of India, 4th edition, 2002.
Reference Books:	
1	Pierre R. Belanger, “Control Engineering”, Saunders college Publishing.
2	Alberto Isidori, Nonlinear Control Systems, CSE book series, Springer-Verlag London 1995.
3	Dr. K.P. Mohandas, “Modern Control Engineering”, revised edition, Sanguine Publishers, Bangalore, 2006.
4	Gene F. Franklin, J David Powell, Abbas Emami-Naeini, “Feedback Control of Dynamic Systems”, 5th edition Pearson Educations.
5	Shankar Sastry, Marc Bodson, “Adaptive Control”, Prentice Hall of India (P) Ltd., 1993.
6	John Doyle, Bruce Francis, Allen Tannenbaum, “Feedback Control Theory”
7	Pierre R. Belanger, “Control Engineering”, Saunders college Publishing
8	Norman Nise, “Control System Engineering”, 4th edition Wiley International Edition.

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Program Structure for Final Year B.E Instrumentation Engineering

(With Effect from 2023-2024)

Scheme for Semester -VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ISDOC7014	Advanced Microcontroller	3	- -	3	- -		3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA*					
ISDOC7014	Advanced Microcontroller	20	20	60	2	--	--	100

Course Code:	Course Title	Credit
ISDOC7014	Advanced Microcontroller	3

Prerequisite: Knowledge of High-level language programming.

Course Objectives:

1	To introduce the outline architecture of ARM microcontroller including basics of pipelines, registers, exception modes, etc.
2	Develop program ARM Cortex M3 using the various instructions for different applications and understand the basic hardware components.
3	Understand and design real time operating systems which are backbone of embedded industry
4	To introduce the setup and operate the Raspberry Pi.

Course Outcomes

1	Describe ARM microcontroller Architecture and Operation.
2	Discuss the overview of Cortex-M3 processor.
3	Develop application using Cortex-M3 processor.
4	Explain the memory protection units and the other features of Cortex-M3 Processor.
5	Describe the principle of working of RTOS and related tasks.
6	Build efficient embedded system using Raspberry Pi.

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

Textbooks:	
1	The Definitive Guide to the ARM Cortex-M3, Joseph Yiu, Second Edition, Elsevier Inc. 2010.
2	Embedded/Real Time Systems Concepts, Design and Programming Black Book, Prasad, KVK.
3	David Seal "ARM Architecture Reference Manual", 2001 Addison
4	Andrew N Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide – Designing and Optimizing System Software", 2006, Elsevier.
Reference Books:	
1	Steve Furber, "ARM System-on-Chip Architecture", 2nd Edition, Pearson Education.
2	Cortex-M series-ARM Reference Manual.
3	Cortex-M3 Technical Reference Manual (TRM)
4	Arnold. S. Berger, "Embedded Systems Design - An introduction to Processes, Tools and Techniques", Easwer Press.
5	Raj Kamal, "Microcontroller - Architecture Programming Interfacing and System Design" 1st Edition, Pearson Education.
6	Derek Molloy, "Exploring Raspberry Pi, Interfacing to the Real World with Embedded Linux", 2016.
7	Simon Monk, "Programming the Raspberry Pi, Getting Started with Python", McGraw Hill, 2006.

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

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc.	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Program Structure for Final Year Instrumentation Engineering

Scheme for Autonomous Program

(With Effect from 2023-2024)

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
IOC7011	Product Life Cycle Management	3	--	3	--		3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA*					
IOC7011	Product Life Cycle Management	20	20	60	2	--	--	100

Course Code:	Course Title	Credit
ILO7011	Product Life Cycle Management	3
Prerequisite:		
Course Objectives:		
1	To familiarize the Learner with the need, benefits, and components of PLM	
2	To acquaint Learner with Product Data Management & PLM strategies	
3	To give insights into new product development program and guidelines for designing and developing a product	

4	To familiarize the Learner with Virtual Product Development, Design for environments, Life cycle assessment.
Course Outcomes:	
1	Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2	Illustrate various approaches and techniques for designing and developing products.
3	Apply product engineering guidelines / thumb rules in designing products.
4	Acquire knowledge in applying virtual product development tools and design for the environment.

Module		Content	Hrs
1		**Introduction to Product Lifecycle Management (PLM)**	8
	1.1	Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, spread of PLM, Focus and Application	
	1.2	PLM Strategies: Industrial strategies, Strategy elements, Developing PLM Vision and PLM Strategy, Change management for PLM	
2		**Product Design**	10
	2.1	Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model,	
	2.2	Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management,	
	2.3	The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	
3		**Product Data Management (PDM)**	5
	3.1	Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system	

	3.2	Financial justification of PDM, barriers to PDM implementation	
4		**From sustainable Development to design for environment**	6
	4.1	Sustainable Development, Key factors in sustainable Development, Design for Environment	
	4.2	The Environment driving PLM- External Drivers: scale, Complexity, cycle times, globalization, regulations, Internal Drivers- Productivity innovation, collaboration, quality. Boardroom Driver-IT Value Map: income, revenue, costs. Comparing lean manufacturing, ERP, CRM and PLM	
5		**Life Cycle Assessment and Life Cycle Cost Analysis**	6
	5.1	Premises, Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment.	
	5.2	Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	
6		**Virtual Product Development Tool**	4
	6.1	Introduction VPD, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies.	
		Total	**39**

Reference Books:

1	John Stark, ―Product Lifecycle Management: Paradigm for 21st Century Product Realization, Springer-Verlag, 2004. ISBN: 1852338105
2	Fabio Giudice, Guido La Rosa, Antonino Risitano, ―Product Design for the environment- A life cycle approach, Taylor & Francis 2006, ISBN: 0849327229
3	Saaksvuori Antti, Immonen Anselmie, ―Product Life Cycle Management, Springer, Dreamtech, ISBN: 3540257314
4	Michael Grieve, ―Product Lifecycle Management: Driving the next generation of lean thinking‖, Tata McGraw Hill, 2006, ISBN: 0070636265

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment:

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	Rubrics	Marks
1	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8	Multiple Choice Questions (Quiz)	5 marks
9	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 marks
10	Project based Learning and evaluation / Extra assignment / Question paper solution	10 marks
11	Multiple Choice Questions (Quiz)	5 marks
12	Literature review of papers/journals	5 marks
13	Library related work	5 marks

*For sr.no.1, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.

Indirect Assessment	
1	Mock Viva/Practical
2	Skill Enhancement Lecture
3	Extra Assignments/lab/lecture
End Semester Theory Examination:	
1	Question paper will be of 60 marks and the duration will be 2 hours.
2	Question paper will have a total of five questions

3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Program Structure for Final Year Instrumentation Engineering

Scheme for Autonomous Program

(With Effect from 2023-2024)

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
IOC7012	Reliability Engineering (Abbreviated as RE)	3	--	3	--		3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA*					
IOC7012	Reliability Engineering (Abbreviated as RE)	20	20	60	2	--	--	100

Course Code:	Course Title	Credit
IOC7012	Reliability Engineering (Abbreviated as RE)	3
Prerequisite:		
Course Objectives:		
1	To familiarize the students with various aspects of probability theory	
2	To acquaint the students with reliability and its concepts	

3	To introduce the students to methods of estimating the system reliability of simple and complex systems
4	To understand the various aspects of Maintainability, Availability and FMEA procedure
Course Outcome:	
1	Understand and apply the concept of Probability to engineering problems
2	Apply various reliability concepts to calculate different reliability parameters
3	Estimate the system reliability of simple and complex systems
4	Carry out a Failure Mode Effect and Criticality Analysis

Module	Contents	Hours
1	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Bayes Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance.	**8**
2	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time to Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, linearly increasing, Time	**8**
3	**System Reliability** System Configurations: Series, parallel, mixed configuration, k out of n	**5**
4	**Reliability Improvement** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	**8**
5	**Maintainability and Availability** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement.	**5**

6	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	**5**
	Total	**39**

Reference Books:	
1	L.S. Srinath, ―Reliability Engineering‖, Affiliated East-Wast Press (P) Ltd., 1985.
2	Charles E. Ebeling, ―Reliability and Maintainability Engineering‖, Tata McGraw Hill. .
3	B.S. Dhillion, C. Singh, ―Engineering Reliability‖, John Wiley & Sons, 1980.
4	P.D.T. Conor, ―Practical Reliability Engg.‖, John Wiley & Sons, 1985.
5	K.C. Kapur, L.R. Lamberson, ―Reliability in Engineering Design‖, John Wiley & Sons. Murray R. Spiegel, ―Probability and Statistics‖, Tata McGraw-Hill Publishing Co. Ltd

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Program Structure for Final Year Instrumentation Engineering

Scheme for Autonomous Program

(With Effect from 2023-2024)

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
IOC7013	Management Information System	3	--	3	--		3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA*					
ILO7013	Management Information System	20	20	60	2	--	--	100

Course Code:	Course Title	Credit
ILO7013	Management Information System	03
Prerequisite:		
Course Objectives:		
1	To discuss the roles played by information technology in today's business.	
2	To understand the Intelligent Techniques for Data Analytics.	

Course Code:	Course Title	Credit
3	To determine ethical and privacy issues in management systems.	
4	To understand the requirements for various Business Operations	
5	To define various technologies on which information systems are built	
6	To determine the types of systems used for enterprise-wide knowledge management and the way they provide value for businesses.	
Course Outcomes:		
1	The impact of information systems on an organization's growth.	
2	The principal tools and technologies for accessing information from databases to improve business performance and decision making.	
3	The ethical frameworks and security concerns in information systems.	
4	The various business models used for social computing.	
5	IT infrastructure and its components and its current trends	
6	Various enterprise-wide knowledge management systems and its functionalities.	

Module		Content	Hrs
1		**Introduction to Information Systems (IS):**	**4**
		Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS	
2		**Database and Business Intelligence:**	**8**
		Database Approach, Big Data, Data warehouse and Data Marts, **Managing data** **resources:** **establishing an information policy, ensuring data quality** Business intelligence (BI): Decision Making Process, BI for Data analytics and Presenting Results	
3		**Ethical and Social Issues in Information Systems:**	
		Ethical issues and Privacy, Information Security. Threat to IS, and Security Controls	**6**

4		**Social Computing (SC):**	**7**
		SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	
5		**Emerging Technologies:**	**7**
		The Emerging Mobile Digital Platform: Consumerization of IT and BYOD (Bring Your Own Device), Grid Computing, Virtualization, Cloud Computing, Green Computing, High-Performance and Power-Saving Processors, Autonomic Computing Contemporary Software Platform Trends: Web Services and Service-Oriented Architecture, Software Outsourcing and Cloud Services Management Issues: Dealing with Platform and Infrastructure Change Management and Governance	
6		**Information System within Organization:**	**7**
		Knowledge management System, Knowledge management value chain, Decision Support System, Transaction Processing Systems, ERP and ERP support of Business Process.	
		Total	**39**

Textbooks:	
1	Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2	K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 13th Ed. © Pearson Education Limited 2014
Reference Books:	
1	MIS: Management Perspective, D.P. Goyal, Vikas Publishing House Pvt. Ltd, 4th Edition.
2	D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008.

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment:

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	Rubrics	Marks
1	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8	Multiple Choice Questions (Quiz)	5 marks
9	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 marks
10	Project based Learning and evaluation / Extra assignment / Question paper solution	10 marks
11	Multiple Choice Questions (Quiz)	5 marks
12	Literature review of papers/journals	5 marks
13	Library related work	5 marks

*For sr.no.1, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.

Indirect Assessment	
1	Mock Viva/Practical
2	Skill Enhancement Lecture
3	Extra Assignments/lab/lecture

End Semester Theory Examination:	
1	Question paper will be of 60 marks and the duration will be 2 hours.
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Program Structure for Final Year Instrumentation Engineering

Scheme for Autonomous Program

(With Effect from 2023-2024)

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
IOC7014	Design of Experiments (Abbreviated as DoE)	3	--	3	--		3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA*					
IOC7014	Design of Experiments (abbreviated as DoE)	20	20	60	2	--	--	100

Course Code:	Course Title	Credit
IOC7014	**Design of Experiments (abbreviated as DoE)**	**03**

Prerequisite:	
Course Objectives:	
1	To understand the issues and principles of Design of Experiments (DOE).
2	To list the guidelines for designing experiments.
3	To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization
Course Outcomes:	
1	Plan data collection, to turn data into information and to make decisions that lead to appropriate action.
2	Apply the methods taught to real life situations.
3	Plan, analyze, and interpret the results of experiments

Module	Contents	Hours
1	**Introduction:** Strategy of Experimentation, Typical Applications of Experimental Design, Guidelines for Designing Experiments, Response Surface Methodology.	**6**
2	**Fitting Regression Models:** Linear Regression Models, Estimation of the Parameters in Linear Regression Models, Hypothesis Testing in Multiple Regression, Confidence Intervals in Multiple Regression, Prediction of new response observation, Regression model diagnostics, Testing for lack of fit.	**8**
3	**Two-Level Factorial Designs:** The 2^2Design, The 2^3 Design, The General 2^k Design, A Single Replicate of the 2^kDesign, The Addition of Center Points to the 2^kDesign, Blocking in the 2^kFactorial Design, Split- Plot Designs.	**7**
4	**Two-Level Fractional Factorial Designs:** The One-Half Fraction of the 2^k Design, The One-Quarter Fraction of the 2^k Design, The General 2^{k-p} Fractional Factorial Design, Resolution III Designs, Resolution IV and V Designs, Fractional Factorial Split-Plot Designs.	**7**
5	**Conducting Tests:** Testing Logistics, Statistical aspects of conducting tests, Characteristics of good and bad data sets, Example experiments, Attribute Vs Variable data sets.	**7**
6	**Taguchi Approach:** Crossed Array Designs and Signal-to-Noise Ratios, Analysis Methods, Robust design examples.	**4**

Reference Books:	
1	Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition, John Wiley & Sons, New York, 2001
2	D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3	George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4	W J Dimond, Practical Experiment Designs for Engineers and Scientists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5	Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss
6	Philip J Ross, ―Taguchi Technique for Quality Engineering, McGraw Hill.
7	Madhav S Phadake, ―Quality Engineering using Robust Design, Prentice Hall.

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Program Structure for Final Year Instrumentation Engineering

Scheme for Autonomous Program

(With Effect from 2023-2024)

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
IOC7015	Operation Research (abbreviated as OR)	3	--	3	--		3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA*					
IOC7015	Operation Research (abbreviated as OR)	20	20	60	2	--	--	100

Course Code:	Course Title	Credit
IOC7015	**Operation Research (abbreviated as (OR)**	03

Prerequisite:	
Course Objectives:	
1	Formulate a real-world problem as a mathematical programming model.
2	Understand the mathematical tools that are needed to solve optimization problems.
3	Use mathematical software to solve the proposed models.
Course Outcomes:	
1	Understand the theoretical workings of the simplex method for linear programming and perform iterations of it by hand.
2	Understand the relationship between a linear program and its dual, including strong duality and complementary slackness.
3	Perform sensitivity analysis to determine the direction and magnitude of change of a model ‘s optimal solution as the data change.
4	Solve specialized linear programming problems like the transportation and assignment problems.
5	Solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
6	Understand the applications of, basic methods for, and challenges in integer programming
7	Model a dynamic system as a queuing model and compute important performance measures

Module	Contents	Hrs.
1	**Introduction to Operations Research***:* Introduction, Historical Background, Scope of Operations Research, Features of Operations Research, Phases of Operations Research, Types of Operations Research Models, Operations Research Methodology, Operations Research Techniques and Tools, Structure of the Mathematical Model, Limitations of Operations Research	2

2	**Linear Programming***:* Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, *Simplex Method* Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, ***Duality***, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis	6
3	**Transportation Problem***:* Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel 's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem***:* Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem	6
4	**Integer Programming Problem***:* Introduction, Types of Integer Programming Problems, Gomory 's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	5
5	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	4
6	**Simulation***:* Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation *Monte-Carlo Method:* Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	4
7	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability	4
8	**Games Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	4
9	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	4

Reference Books:	
1	Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2	Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
3	Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4	Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
5	Operations Research, Kanti Swarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.

Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Program Structure for Second Year Automation and Robotics

Scheme for Autonomous Program

(With Effect from 2023-2024)

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ILO7016	Cyber Security and Laws	3	--	3	--	--	3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA *					
ILO7016	Cyber Security and Laws	20	20	60	2	--	--	100

Course Code:	Course Title	Credit
ILO7016	Cyber Security and Laws	03

Prerequisite:	
Course Objectives:	
1	To understand and identify different types cybercrime and cyber law
2	To recognized Indian IT Act 2008 and its latest amendments
3	To learn various types of security standards compliances
Course Outcomes:	
1	Understand the concept of cybercrime and its effect on outside world
2	Interpret and apply IT law in various legal issues

3	Distinguish different aspects of cyber law
4	Apply Information Security Standards compliance during software design and development

Module		Content	Hrs
1		**Introduction to Cybercrime**	**4**
	1.1	Cybercrime definition, history and threats to security goals, Classifications of cybercrime, how criminal plan the attacks	
	1.2	The Need for an Indian Cyber Law, Introduction to Indian ITA 2000	
2		**Cyber frauds and Security issues**	**4**
	2.1	Social Engg, Cyber stalking, Online Drug Trafficking , Botnets, Attack vector, Credit Card Frauds in Mobile and Wireless Computing Era	
	2.2	Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, work from home cybersecurity Tips and Risks	
	2.3	Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	
		Self-Learning Topics: Types of Cyber Frauds and security issues	
3		**Tools and Methods Used in Cybercrime**	**10**
	3.1	Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography	
	3.2	DoS and DDoS Attacks, SQL Injection, Buffer Overflow,	
	3.3	Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	
4		**The Concept of Cyberspace**	**7**

	4.1	E-Commerce, The Contract Aspects in Cyber Law, The Security Aspect of Cyber Law, The Intellectual Property Aspect in Cyber Law	
	4.2	The Evidence Aspect in Cyber Law, The Criminal Aspect in Cyber Law, Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking	
5		**Indian IT Act**	**8**
	5.1	Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	
		Self-Learning Topics: Case Studies	
6		**Information Security Standard compliances**	**6**
	6.1	SOX, HIPAA, ISO	
		Self-Learning Topics: FISMA, NERC, PCI, GLBA	
		Total	**39**

Textbooks:	
1	Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2	Cyber Security and Lawas, Madhumati Chatterjee, Sangita Chaudhary, Gaurav Sharma, Staredu solutions
3	Cyber Law & Cyber Crimes by Advocate Prashant Mali; Snow White Publications, Mumbai
Reference Books:	
1	The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
2	The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
3	Nina Godbole, *Information Systems Security*, Wiley India, New Delhi

4	Kennetch J. Knapp, *Cyber Security* & *Global Information Assurance* Information Science Publishing.
5	William Stallings, *Cryptography and Network Security*, Pearson Publication

Useful Links:	
1	The Information Technology ACT, 2008- TIFR: https://www.tifrh.res.in
2	A Compliance Primer for IT professional: https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer- professionals-33538

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	6 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Program Structure for Final Year Instrumentation Engineering

Scheme for Autonomous Program

(With Effect from 2023-2024)

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
IOC7017	Disaster Management and Mitigation Measures (Abbreviated as DMMM)	3	--	3	--		3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA *					
IOC7017	Disaster Management and Mitigation Measures (abbreviated as DMMM)	20	20	60	2	--	--	100

Course Code:	Course Title	Credit
IOC7017	**Disaster Management and Mitigation Measures (Abbreviated as DMMM)**	03

Prerequisite:	
Course Objectives:	
1	To understand the various types of disaster occurring around the world
2	To identify extent and damaging capacity of a disaster
3	To study and understand the means of losses and methods to overcome /Minimize it.
4	To understand role of individual and various organization during and after disaster
5	To know warning systems, their implementation and based on this to initiate training to a laymen
6	To understand application of GIS in the field of disaster management
7	To understand the emergency government response structures before, during and after disaster
Course Outcomes:	
1	Understand natural as well as manmade disaster and their extent and possible effects on the economy.
2	Planning of national importance structures based upon the previous history.
3	Understand government policies, acts and various organizational structure associated with an emergency.
4	Know the simple do ‘s and don ‘ts in such extreme events and act accordingly

Module	Contents	Hrs
1	Introduction: Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	**3**
2	Natural Disaster and Manmade disasters: Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion. Manmade Disasters:	**7**
3	Disaster Management, Policy and Administration: Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. Policy and administration: Importance and principles of disaster management policies, command and co- ordination of in Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters. disaster management, rescue operations- how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	**7**
4	Institutional Framework for Disaster Management in India: Importance of public awareness, Preparation and execution of emergency management programme. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. Use of Internet and software for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	**7**
5	Financing Relief Measures: Ways to raise finance for relief expenditure, Role of government agencies and NGOs in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. International relief aid agencies and their role in extreme events.	**9**
6	Preventive and Mitigation Measures: Pre-disaster, during disaster and post- disaster measures in some events in general, Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication. Non-Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. Do 's and don 'ts in case of disasters and effective implementation of relief aids.	**6**

Reference Books:	
1	Disaster Management by Harsh K.Gupta, Universities Press Publications.
2	Disaster Management: An Appraisal of Institutional Mechanisms in India by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.

3	Introduction to International Disaster Management by Damon Copolla, Butterworth Heinemann Elseveir Publications.
4	Disaster Management Handbook by Jack Pinkowski, CRC Press Taylor and Francis group.
5	Disaster management & rehabilitation by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6	Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7	Concepts and Techniques of GIS –C.P. Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Program Structure for Final Year Instrumentation Engineering

Scheme for Autonomous Program

(With Effect from 2023-2024)

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
IOC7018	Energy Audit and Management (Abbreviated as EAM)	3	--	3	--		3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA *					
IOC7018	Energy Audit and Management (Abbreviated as EAM)	20	20	60	2	--	--	100

Course Code:	Course Title	Credit
IOC7018	**Energy Audit and Management (Abbreviated as EAM)**	03

Prerequisite:	
Course Objectives:	
1	To understand the importance of energy security for sustainable development and the fundamentals of energy conservation.
2	To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
3	To relate the data collected during performance evaluation of systems for identification of energy saving opportunities
Course Outcomes:	
1	To identify and describe present state of energy security and its importance.
2	To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3	To describe t h e e n e r g y performance evaluation of some common electrical installations and identify the energy saving opportunities.
4	To describe t h e energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5	To analyze the data collected during performance evaluation and recommend energy saving measures

Module	Contents	Hrs
1	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	4
2	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information- analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	8

3	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipment's and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	10
4	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities	10
5	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	4
6	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non- Conventional and Renewable Energy Sources	3

Reference Books:	
1	Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2	Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3	Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4	Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5	Energy Management Principles, C.B.Smith, Pergamon Press
6	Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7	Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8	www.energymanagertraining.com www.bee-india.nic.in

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.

Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Program Structure for Final Year Instrumentation Engineering

Scheme for Autonomous Program

(With Effect from 2023-2024)

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
IOC7019	Development Engineering (abbreviated as DE)	3	--	3	--		3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA *					
IOC7019	Development Engineering (abbreviated as DE)	20	20	60	2	--	--	100

Course Code:	Course Title	Credit
IOC7018	Development Engineering (abbreviated as DE)	03

Prerequisite:

Course Objectives:

1	To understand the characteristics of rural Society and the Scope, Nature and Constraints of rural
2	To study Implications of 73rd CAA on Planning, Development and Governance of Rural Areas
3	An exploration of human values, which go into making a good human being, a good professional, a good society and a _good life in the context of work life and the personal life of modern Indian professionals
4	To understand the Nature and Type of Human Values relevant to Planning Institutions

Course Outcomes:	
1	Apply knowledge for Rural Development
2	Apply knowledge for Management Issues. .
3	Apply knowledge for Initiatives and Strategies.
4	Develop acumen for higher education and research.
5	Master the art of working in group of different nature.
6	Develop confidence to take up rural project activities independently

Module	Contents	Hrs
1	Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development. Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	**08**
2	Post-Independence rural Development Balwant Rai Mehta Committee - three tier system of rural local. Government; Need and scope for people 's participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj participation and rural development.	**05**
3	Rural Development Initiatives in Five Year Plans Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub- plan for the weaker section; Micro-eco zones; Database for local planning; Need for decentralized planning; Sustainable rural development.	**06**
4	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments.	**05**

5	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education. Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom.	**10**
6	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	**05**

Reference Books:	
1	ITPI, Village Planning and Rural Development, ITPI, New Delhi
2	Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3	GoI, Constitution (73rd GoI, New Delhi Amendment) Act, GoI, New Delhi
4	Planning Commission, Five Year Plans, Planning Commission
5	Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6	Planning Guide to Beginners
7	Weaver, R.C., The Urban Complex, Doubleday.
8	Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington.
9	How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150.
10	Watson, V. , Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory and Practice, Vol. 4, No.4, pp.395 – 407

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
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7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Course Code:	Course Title	Credits
ISL701	Instrumentation Project Documentation and Execution Lab	1

Prerequisite: Signal Conditioning and Circuit Design Lab.

Lab Objectives:

1	To provide knowledge of types and execution of I&C type project
2	This Course aims to explain Project deliverables and engineering activities of project documentation.
3	To get acquainted with commercial software used for documentation.

Lab Outcomes:

1	Apply standards used in instrumentation projects for preparation of deliverables**.**
2	Interpret, design and construct documents such as PFD, P&ID, Index sheet.
3	Apply ISA specification data sheet / loop standard, to prepare Instrument specification sheet and construct loop wiring diagram.
4	Interpret, design and construct Hook-up diagrams, and develop skill to prepare different project schedules.
5	Select and apply procurement, installation procedure and pre-commissioning and commissioning activities with Inspection.
6	Select and support documentation software packages used in industry

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

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

Students should prepare it on A3/A1 size drawing paper
Any other experiments/assignments based on syllabus which will help students to understand the topic/concept.

Oral Examination:

Oral examination will be based on entire syllabus

Term Work:

1	Term work should consist of 08 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)

Lab Code	Lab Name	Credit
ISL702	Process Automation - Lab	1

Prerequisite:

Lab Objectives:

1	To give the students fundamentals of automation and various automation systems used in industry such as PLC, DCS, and SCADA.
2	To impart the knowledge about the architecture, working of PLC, SCADA and DCS.
3	To make the students capable to apply knowledge to identify hardware and software requirements of PLC, SCADA and DCS
4	To give the students a comprehension of the aspects related to Safety Instrumented system (SIS)

Lab Outcomes:

1	Define automation, its need, importance and applications in industry.
2	Design PLC based application by proper selection and sizing criteria, developing GUI and ladder program.
3	Develop any application based on SCADA along with GUI using SCADA software.
4	Develop DCS program using Function Block Diagram (FBD) method.
5	Describe database and alarm management system.
6	Define automation, its need, importance and applications in industry.

Syllabus: Same as that of Subject ISC702 Process Automation.

List of Laboratory Experiments/Assignments:

Sr. No.	Detailed Content	CO Mapping
1.	Demonstration of PLC	CO2
2.	Processing of sensor signals by the PLC to drive various end effectors such as pneumatic/electric/hydraulic.	CO2
3.	PLC programs for process control applications (minimum 4 nos.)	CO2
4.	GUI development for any application using SCADA software.	CO3
5.	DCS programming using Function block diagram method	CO4
6.	Assignment/Exercise based on Automation Fundamentals	CO1
7.	Assignment/Exercise based on DCS	CO3
8.	Assignment/Exercise based on SCADA	CO4
9.	Assignment based on Database and Alarm management	CO5
10.	Assignment based on Safety Instrumented System	CO6
	Any other experiments/assignments based on syllabus which will help students to understand the topic/concept. Industrial visit is advised to understand the Process Automation subject.	

Oral Examination:

Oral examination will be based on the entire syllabus.

Term Work:

1	Term work should consist of 08 experiments.
2	Journal must include at least 2 assignments.

3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)

Lab Code	Lab Name	Credit
ISC7031	**Biomedical Instrumentation Lab**	**1**

Prerequisite: Signal Conditioning and Circuit Design Lab.	
Lab Objectives:	
1	To make students perform experiments based on the principle and working of various Biomedical Instruments used for Bio-potential measurements.
2	To develop skills in the design of various biomedical instruments used in diagnosis and life-support.
3	To develop knowledge on application of various medical imaging methods.
Lab Outcomes:	
1	Students will be able to measure and identify various Bio-potentials with their specifications.
2	Students will be able to observe and plot various physiological parameters with their specifications.
3	Students will be able to measure the various cardiovascular parameters by Designing the related circuitry.
4	Students will be able to distinguish between the various medical imaging techniques by comparing, principle and concept involved in each of the technique.
5	Students will be able to realize the circuitry of different life support instruments, like pacemaker, defibrillator.
6	Students will be able to describe the significance of electrical safety in biomedical measurement.

Suggested Experiments: Students are required to complete at least 08 experiments.	
Sr. No.	**Name of the Experiment**
1	Study of electrodes for various biomedical applications.
2	Demonstration and working of instruments like EMG and ECG.
3	Measure Blood pressure by indirect method.
4	Design and implement an asynchronous pacemaker circuit.
5	Study of Defibrillator system and its voltage waveforms.
6	Design and implement ECG signal conditioning circuit.
7	Design and implement EMG Quantification circuit.
8	Study of Hemodialysis or Heart/Lung machine-based models.
9	Implement ECG simulation on PC / Microcontroller.
10	Study of working of pulse oximeter / Heart rate meter.
11	Study on Medical Imaging Techniques
12	Study on Electrical Safety
Useful Links:	
1	www.vlab.co.in
Term Work:	
1	Term work should consist of 08 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.

4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)

Lab Code	Lab Name	Credit
ISL7032	Machine Learning Lab	1

Prerequisite:

Lab Objectives:

1	To familiarize the student with basic concepts of Machine learning algorithms
2	To provide understanding of the concepts of regression and classification ML algorithms.
3	To introduce the students to the basic concepts and application of artificial neural networks

Lab Outcomes:

1	Develop programs based on supervised learning.
2	Implement programs based on unsupervised learning.
3	Execute programs on data classification.
4	Develop programs based on artificial neural networks.
5	Execute programs based on support vector machines.
6	Develop applications using machine learning.

Syllabus: Same as that of Subject ISDOC7012 Machine Learning.

List of the Laboratory Experiments:

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

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

Practical and Oral Examination:	
Practical and Oral examinations will be based on the entire syllabus.	
Term Work:	
1	Term work should consist of 08 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)

Lab Code	Lab Name	Credit
ISL7033	**Advanced Control System Lab**	**1**

Prerequisite: Fundamentals of Control systems lab

Lab Objectives:

1	Students should be able to examine stability of limit cycle
2	The students should be able to examine stability of nonlinear system using DF techniques and Lyapunov's functions
3	The students should be able to design the IMC structure.
4	The students should able to examine the stability using sliding mode control
5	Students can be able to optimize the any particular system

Lab Outcomes:

1	Construct the phase-plane trajectories using Delta Method.
2	. Classify stability of limit cycle as per obtained response of the system
3	Linearize the nonlinear system, identify the singular point and its nature.
4	Derive DF for common nonlinearities and investigate stability of system with limit cycle.
5	Investigate the stability of nonlinear system using Lyapunov's function
6	Design the IMC based PID controller.

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

List of the Laboratory Experiments:

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

14.	Design of IMC controller for delay and non-minimum phase systems.

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

Practical and Oral Examination:	
Practical and Oral examination will be based on entire syllabus of **ISDOC7013**	
Term Work:	
1	Term work should consist of 08 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)

Lab Code	Lab Name	Credit
ISL7034	**Advanced Microcontroller Lab**	**1**

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

Syllabus: Same as that of Subject ISDOC7014 Advanced Microcontroller.

List of the Laboratory Experiments:

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

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

Practical and Oral Examination:	
Practical and Oral examination will be based on entire syllabus of **ISDOC7014**	
Term Work:	
1	Term work should consist of 08 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)

Lab Code	Lab Name	Credit
ISP701	**Major Project – I**	**1**

Prerequisite:	
Lab 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.
Lab Outcomes: On successful completion of course learner/student will be able to:	
1	Identify problems based on societal /research needs.
2	Apply Knowledge and skill to solve societal problems in a group.
3	Develop interpersonal skills to work as member of a group or leader.
4	Draw the proper inferences from available results through theoretical/ experimental/simulations.
5	Analyze the impact of solutions in societal and environmental context for sustainable development.
6	Use standard norms of engineering practices.
7	Excel in written and oral communication.
8	Demonstrate capabilities of self-learning in a group, which leads to lifelong learning.
9	Demonstrate project management principles during project work.

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

Guidelines for Major Project

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

Guidelines for Assessment of Major Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments. The progress of major project to be evaluated on continuous basis, minimum two reviews in the semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book: 15
    - Marks awarded by review committee: 15
    - Quality of Project report: 20

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

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

Assessment criteria of Major Project-I

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

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

Guidelines for Assessment of Major Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the Department.
- Major Project shall be assessed through a presentation and demonstration of working model/software model by the student project group to a panel of Internal and External Examiners preferably from

industry or research organizations having experience of more than five years approved by head of Institution.

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

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

1. Quality of problem and Clarity

2. Innovativeness in solutions

3. Cost effectiveness and Societal impact

4. Full functioning of working model/software 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