COEP Technological University Pune
(A Unitary Public University of Govt. of Maharashtra)

School of Engineering and Technology

Curriculum Structure & Detailed Syllabus

S. Y. B. Tech.

Instrumentation and Control Engineering

(Effective from: A.Y. 2026-27)

Program Educational Objectives (PEOs)

After the completion of the program,

I. Student will be employable in the diversified sectors of the industry, government organizations, public sector and research organizations.

II. Student will pursue higher education in engineering or other fields of their interests, at institutes of repute and high ranking.

1. Student will demonstrate effective communication, lifelong learning ability, integrity, teamwork, leadership qualities, concern to environment and commitment to safety, health, legal and cultural issues in the fields they choose to pursue.

Program Outcomes (POs):

Engineering Graduate will be able to:

PO1: Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problem.

PO2: Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural science, and engineering sciences.

PO3: Design/Development Solution: Design solution for complex engineering problems and design system component or process that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, social and environmental conditions.

PO4: Conduct Investigation of Complex Problem: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of the information to provide valid conclusion.

PO5: Method, Tool Usage: Create, select and apply appropriately technique, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with understanding the limitation.

PO6: The Engineer and Society: Apply reasoning informed by the contextual knowledge to access societal health, safety, legal and cultural and consequent responsibility relevant to the professional engineering practice.

PO7: Environment and Sustainability: Understand the impact of the professional engineering solution in societal and environmental context, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principle and commitment to professional ethics and responsibilities and norms of the engineering practices.

PO9: Individual and Team Work: Function effectively as an individual, and as the member or leader in diverse team and multidisciplinary setting.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, and being able to comprehend and write effective reports and design documentation and effective presentation and give and receive clear instructions.

PO11: Project management and Finance: Demonstrate knowledge & understanding of the engineering and management principles and apply these to one's work, as the member and the leader in a team to manage projects and in multidisciplinary environment.

PO12: Lifelong Learning: Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in broadest context of technological change.

S.Y. B. Tech.
Instrumentation and Control Engineering

List of Abbreviations

Abbreviation	Title	No of Courses	Credits	% of Credits
BS	Basic Science Course	05	14	35
ESC	Engineering Science Course	05	15	37.5
PCC	Programme Core Course (PCC)	01	03	7.5
PEC	Programme Elective Course (PEC)	--	--	--
OE/SE	Open/School Elective (OE/SE) other than particular program	--	--	--
MDM	Multidisciplinary Minor (MDM)	--	--	--
VSEC	Vocational and Skill Enhancement Course (VSEC)	01	02	5
HSMC	Humanities Social Science and Management	01	02	5
IKS	Indian Knowledge System (IKS)	01	02	5
VEC	Value Education Course (VEC)	--	--	--
RM	Research Methodology (RM)	--	--	--
--	Internship	--	--	--
--	Project	--	--	--
CEA	Community Engagement Activity (CEA)/Field Project	--	--	--
CCA	Co-curricular & Extracurricular Activities (CCA)	02	02	5
	Total	**16**	**40**	**100**

S.Y. B. Tech.
Instrumentation and Control Engineering

Semester -III

Sr. No	**Course Type**	**Course Code**	**Course Name**	**L**	**T**	**P**	**S**	**Cr**	**Evaluation Scheme**				
									Theory			**Laboratory**	
									MSE	**TA**	**ESE**	**ISE**	**ESE**
1	PCC-08	*HS-24003*	Sensors and Transducers	3	0	2	1	4	30	20	50	50	50
2	PCC-09	*IE-24003*	Analog Electronics	3	0	2	1	4	30	20	50	50	50
3	OE-03	*OEC-24001*	Electrical Machines and Drives	2	0	0	1	2	30	20	50	--	--
4	ES	IE-24008	Numerical Methods	0	1	2	0	2				50	50
5	HSMC	*HS-24003*	Indian language	2	0	0	0	2	CIE: 100	--	--	--	--
6	HSMC	*HS-24002*	Design Thinking	1	-	-	1	1	--	--	--	CIE: 100	
7	HSMC	*HS-24001*	Entrepreneurship	2	0	0	1	2	30	20	50	--	--
8	VEC	*AS-24001*	Environmental Studies	1	0	0	2	1	CIE: 100	--	--		
9	CEA	*AS-24004*	Community Engagement Activity (CEA)/Field Project	-	-	-	-	2	--	--	--	CIE: 100	
10			*Mathworks certificate course on "Matlab Onramp"	0	0	0	2	0	--	--	--	--	
Total				**14**	**01**	**06**	**09**	**20**					

Semester -IV

Sr. No	Course Type	Course Code	Course Name	L	T	P	S	Cr	Evaluation Scheme				
									Theory			Laboratory	
									MSE	TA	ESE	ISE	ESE
1	PCC-08	*IE-24006*	Microcontrollers and Applications	3	0	2	1	4	30	20	50	50	50
2	PCC-09	*IE-24004*	Automatic Control System	3	0	2	1	4	30	20	50	50	50
3	PCC-10	*IE-24005*	Digital Electronics	3	0	2	1	4	30	20	50	50	50
4	PEC-01	*IE-24001*	Signals & Systems	2	1	0	1	3	30	20	50	--	--
5	OE-03	*OEC-24010 P*	Principles of Electronic Communication	2	0	0	1	2	30	20	50	--	--
6	VSEC-01	*AS-24003 C*	Constitution of India	1	0	0	2	1	CIE: 100	--	--		
7	MDM-02		Multidisciplinary Minor - II	2	0	2	1	3	30	20	50	50	50
Total				**17**	**00**	**12**	**06**	**24**					

Exit option to qualify for Certification:

- Calibration and Testing (3 Credits)
- Programmable Logic Controller (3 Credits)

S.Y. B. Tech.
Instrumentation and Control Engineering

Semester -III

(Lateral Entry (Diploma)

Sr. No	**Course Type**	**Course Code**	**Course Name**	**L**	**T**	**P**	**S**	**Cr**	**Evaluation Scheme**				
									Theory			**Laboratory**	
									MSE	**TA**	**ESE**	**ISE**	**ESE**
1	PCC-08	*HS-24003*	Sensors and Transducers	3	0	2	1	4	30	20	50	50	50
2	PCC-09	*IE-24003*	Analog Electronics	3	0	2	1	4	30	20	50	50	50
3	OE-03	*OEC-24001*	Electrical Machines and Drives	2	0	0	1	2	30	20	50	--	--
4	ES	IE-24008	Numerical Methods	0	1	2	0	2				50	50
5	HSMC	*HS-24003*	Indian language	2	0	0	0	2	CIE: 100	--	--	--	--
6	HSMC	*HS-24002*	Design Thinking	1	-	-	1	1	--	--	--	CIE: 100	
7	HSMC	*HS-24001*	Entrepreneurship	2	0	0	1	2	30	20	50	--	--
8	VEC	*AS-24001*	Environmental Studies	1	0	0	2	1	CIE: 100	--	--		
9	CEA	*AS-24004*	Community Engagement Activity (CEA)/Field Project	-	-	-	-	2	--	--	--	CIE: 100	
10			Mathematics	3	0	0	1	3	30	20	50	--	--
10			*Mathworks certificate course on “Matlab Onramp”	0	0	0	2	0	--	--	--	--	
Total				**16**	**01**	**06**	**09**	**23**					

Semester -IV

(Lateral Entry (Diploma)

Sr. No	Course Type	Course Code	Course Name	L	T	P	S	Cr	Evaluation Scheme				
									Theory			Laboratory	
									MSE	TA	ESE	ISE	ESE
1	PCC-08	*IE-24006*	Microcontrollers and Applications	3	0	2	1	4	30	20	50	50	50
2	PCC-09	*IE-24004*	Automatic Control System	3	0	2	1	4	30	20	50	50	50
3	PCC-10	*IE-24005*	Digital Electronics	3	0	2	1	4	30	20	50	50	50
4	PEC-01	*IE-24001*	Signals & Systems	2	1	0	1	3	30	20	50	--	--
5	OE-03	*OEC-24010 P*	Principles of Electronic Communication	2	0	0	1	2	30	20	50	--	--
6	VSEC-01	*AS-24003 C*	Constitution of India	1	0	0	2	1	CIE: 100	--	--		
7	MDM-02		Multidisciplinary Minor - II	2	0	2	1	3	30	20	50	50	50
Total				**17**	**00**	**12**	**06**	**24**					

Semester - III

Sensors and Transducers					
Course Code	*HS-24003*	**Examination Scheme**			
Teaching Scheme	3-0-2-1	**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3	**Laboratory**	CIE: 50	ESE: 50	--

Course Outcomes: Students will be able to:

1. Describe working principles of various transducers/sensors [PEO1][PO1]
2. Interpret the characteristics of the transducers/sensors [PEO2][PO2]
3. List various standards used for selection of transducers/sensors [PEO2][PO3]
4. Select transducers/sensors for specific applications [PEO3] [PO6]

Temperature Measurement: **[8 Hrs]**

Introduction to sensors and its characteristics, selection criteria, standards and calibration, data acquisition, Importance of sensing and its use in data analytics, Temperature scales, classification of temperature sensors, standards, working principle, types, materials, Non electrical sensors (thermometer, thermostat), electrical sensors (RTD thermocouple, thermistor, radiation sensors (pyrometers).

Pressure and Level Measurement: **[7 Hrs]**

Definition, pressure scale, standards, working principle, types, materials, elastic pressure sensors, secondary pressure sensors, differential pressure sensors, capacitive (delta cell), high-pressure sensors, low-pressure sensors, standards, working principle, types, materials, design criteria: float, displacers, bubbler, ultrasonic, microwave, radar, resistance, thermal, solid level detectors.

Flow Measurement: **[7 Hrs]**

Standards, working principle, types, materials, and design criterion: primary or quantity meters (positive displacement flow meter), secondary or rate meter (obstruction type, variable area type), electrical flow sensors (turbine type, electromagnetic type, and ultrasonic type), flow switches.

Environmental sensors: **[7 Hrs]**

pH sensors, Conductivity sensors, Humidity, turbidity, dissolved oxygen (DO) sensor, Biochemical oxygen demand (BOD) sensor, total dissolved oxygen (DO) sensor, Chemical Oxygen Demand (COD) sensor: working principles, types and applications

Miscellaneous sensors: **[7 Hrs]**

flame sensor, smoke sensor, motion sensor, leak detector, density, Viscosity: working principles, types and applications

Advances in sensor technology: **[5 Hrs]**

Smart sensors, MEMS, Nano sensors, semiconductor sensors, biosensors: Introduction and applications

Textbooks:

[1]	D.V.S. Murthi, "Instrumentation and Measurement Principles", PHI, New Delhi, Second ed. 2003.
[2]	D. Patranabis, "Principle of Industrial Instrumentation", Tata McGraw Hill, Second ed., 1999.
[3]	B. C. Nakra and K. K. Choudhari, "Instrumentation Measurements and Analysis" by, Tata McGraw Hill Education, Second ed., 2004.

[4]	R. S, Khandpur, "Handbook of Analytical Instruments", Tata McGraw Hill Education, third edition., 2017.
[5]	R. Frank, "Understanding Smart Sensors", Artech house, second edition, 2000.
Reference Books:	
[1]	B.G. Liptak, "Process Measurement & Analysis", Chilton Book Company, Fourth ed., 2003.
[3]	E.O. Doebelin, "Measurement Systems", McGraw Hill, Fifth ed., 2003.
[4]	Sabrie Soloman, "Sensors Handbook" ,McGraw Hill Publication, First ed., 1998.
[5]	A. K. Sawhney, "Electrical & Electronic Instruments & Measurement", Dhanpat Rai and Sons, Eleventh ed., 2000.
[6]	R. K. Jain, "Engineering Metrology", Khanna Publisher, Delhi, Eighteenth ed.,2002.
[7]	Paul Chapman, "Smart Sensors" ISA series, 1996.
Note:	
[1] [2] [3] [4] [5]	To measure CO1, questions may be of the type- define, identify, state, match, list, name etc. To measure CO2, questions may be of the type- explain, describe, illustrate, evaluate, give examples, compute etc. To measure CO3, questions will be based on applications of core concepts. To measure CO4, questions may be of the type- true/false with justification, theoretical fill in the blanks, theoretical problems, prove implications or corollaries of theorems, etc. To measure CO5, some questions may be based on self-study topics and comprehension of unseen passages.

Sensors and Transducers Laboratory					
Course Code	*HS-24003*	**Examination Scheme**			
Teaching Scheme	0-0-2-0	**Theory**	TA:	MSE:	ESE:
Credits		**Laboratory**	CIE: 50	ESE: 50	--

Course Outcomes: Students will be able to:

1. Identify various elements required for characterization of given transducers/sensors
2. Design and conduct experiments for measurement and characterization for different transducers/sensors.
3. Analyze and interpret sensor data of given transducers/sensors.

List Of Experiments:

1	Identify various characteristics of sensors from given dataset.
2	Characterization and calibration of temperature measurement system. (Thermocouple, RTD and Thermistor).
3	Characterization of pressure and vacuum sensor.
4	Characterization and calibration of level sensors. (Capacitive, resistive, and radar level gauge).
5	Characterization and calibration of flow measurement system. (Orifice, Pitot tube, Venture)
6	Characterization and calibration of flow measurement system. (Turbine, Electromagnetic and Ultrasonic)
7	Study of the detectors. (leak detectors, flame detectors, smoke detectors)
8	Characterization and calibration of density and viscosity sensors.
9	Characterization and calibration of pH
10	Characterization and calibration of conductivity
11	Characterization and calibration of turbidity
12	Maintenance and fault findings of various sensors

Note:

[1]	To measure CO1, questions may be of the type- define, identify, state, match, list, name etc.
[2]	To measure CO2, questions may be of the type- explain, describe, illustrate, evaluate, give examples, compute etc.
[3]	To measure CO3, questions will be based on applications of core concepts.
[4]	To measure CO4, questions may be of the type- true/false with justification, theoretical fill in the blanks, theoretical problems, prove implications or corollaries of theorems, etc.
[5]	To measure CO5, some questions may be based on self-study topics and comprehension of unseen passages.

Analog Electronics					
Course Code	*IE-24003*	**Examination Scheme**			
Teaching Scheme	3-0-2-1	**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3	**Laboratory**	CIE: 50	ESE: 50	--

Course Outcomes: Students will be able to:

1. Analyze transistor circuit using h parameter model.
2. Design and analyze different op-amp circuits for various applications.
3. Describe the characteristics of various power devices and power converters.
4. Select a particular power device and power converter for specific application

Transistor and operational amplifier: **[7 Hrs]**

Transistor biasing, H parameters, two port analysis, Analysis of transistor configurations, Parameters, comparison of parameters; Current Mirrors Circuit, Class A, B and AB amplifiers, Class C amplifier, Power amplifiers, Servo amplifiers, Applications of Amplifiers.

Operational Amplifiers: **[8 Hrs]**

Op-Amp parameters, frequency response, effect of temperature on Op-Amp parameters, differential versus single input amplifiers, instrumentation amplifier, Instrumentation amplifier ICs, Rubric for selection of Instrumentation amplifier ICs, bridge amplifier, differentiator, integrator, comparators, V to I and I to V Converters, Miller circuits, Voltage controlled oscillators, PLL and its applications, Signal conditioning circuits for temperature transmitter, design of Oscillator's - LC and RC

Signal Generators and filters: **[6 Hrs]**

Multi vibrators, triangular wave generator, sawtooth wave generator, square wave generator, sine wave generator, Bootstrap / Sweep generator, Basics of filters, low pass& high pass Butterworth filters, band pass, band reject filters, filter specifications, and applications of filters

Power devices and Applications: **[6 Hrs]**

SCR, Triac, DIAC, UJT, MOSFET, IGBT Characteristics and principal of operation, Switching Characteristics, triggering requirement, protections, Performance specifications and applications.

Regulators: **[6 Hrs]**

Line and load regulation, characteristics of regulators, voltage multipliers, three terminal regulators, fixed and variable voltage regulators, current boosters, protection circuits for regulators, High and low current power supply design, Types of batteries, Criteria's for selection of batteries, Design of battery charging circuits

Power Converters: **[6 Hrs]**

SMPS, working principles, performance parameters, DC-DC converters- different types, working principles, analysis and applications.

Textbooks:

[1] Robert L. Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory" Pearson Education, 10th ed., 2009.

[2]	Ramakant Gayakwad, “Op-Amp and Linear Integrated Circuits”, PHI, 4th ed.,2021.
Reference Books:	
[1]	George Clayton and Steve Winder, “Operational Amplifiers”, Newnes Publishers, 5^{th} ed., 2003.
[2]	M. Rashid, “Power Electronics Circuit, Devices and Applications” Pearson Education, 3^{rd} ed. 2004.
Note:	
[1] [2] [3] [4] [5]	To measure CO1, questions may be of the type- define, identify, state, match, list, name etc. To measure CO2, questions may be of the type- explain, describe, illustrate, evaluate, give examples, compute etc. To measure CO3, questions will be based on applications of core concepts. To measure CO4, questions may be of the type- true/false with justification, theoretical fill in the blanks, theoretical problems, prove implications or corollaries of theorems, etc. To measure CO5, some questions may be based on self-study topics and comprehension of unseen passages.

Analog Electronics Laboratory					
Course Code	*IE-24003*	**Examination Scheme**			
Teaching Scheme	0-0-2-0	**Theory**	TA:	MSE:	ESE:
Credits	3	**Laboratory**	CIE: 50	ESE: 50	--

Course Outcomes: Students will be able to:

1. Design an experimental setup for measurement of transistor and operational amplifier's parameters.
2. Design and implement op-amp circuits for specific applications.
3. Plotting and analyzing characteristics of power devices and its usage for typical applications.

List Of Experiments:

1	Design and Implementation of transistor biasing circuits.
2	Measurement of op-amp parameters).
3	Design and implementation of integrator, differentiator, and comparators.
4	Design and implementation of Instrumentation amplifier
5	Design and implementation of voltage multiplier.
6	Design of Oscillator circuits- LC and RC.
7	Design and implantation of voltage-controlled oscillator and its practical applications
8	Design and implementation of phase locked loop and its applications.
9	Design and implementation of various signal generators.
10	Design of low pass and high pass filter.
11	Study, plot and analyze characteristics of DIAC and SCR.
12	Study, plot and analyze characteristics of BJT, UJT and MOSFET
13	Study of UJT as relaxation oscillator.

Note:

[1]	To measure CO1, questions may be of the type- define, identify, state, match, list, name etc.
[2]	To measure CO2, questions may be of the type- explain, describe, illustrate, evaluate, give examples, compute etc.
[3]	To measure CO3, questions will be based on applications of core concepts.
[4]	To measure CO4, questions may be of the type- true/false with justification, theoretical fill in the blanks, theoretical problems, prove implications or corollaries of theorems, etc.
[5]	To measure CO5, some questions may be based on self-study topics and comprehension of unseen passages.

Numerical Methods					
Course Code	IE-24008	**Examination Scheme**			
Teaching Scheme	3-0-2-1	**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3	**Laboratory**	CIE: 50	ESE: 50	--

Course Outcomes: Students will be able to:

1. Be familiar with the use of numerical methods in modern scientific computing [PEO1][PO1]
2. Be familiar with finite precision computation. [PEO1][PO1]
3. Be familiar with numerical solutions of nonlinear equations in a single variable [PEO1][PO1]
4. Be familiar with numerical integration and differentiation[PEO1][PO4]
5. Ability to determine different methods of numerical interpolation and approximation of functions. [PEO3][PO3

Linear and Non-linear equations:	**[7 Hrs]**

Iterative method for solution of system of linear equations Jacobi and Gauss Seidel method. Solution for transcendental equations, Bisection Method, Secant method, Newton-Raphson method

Interpolation:	**[8 Hrs]**

error terms. Uniqueness of interpolating polynomial. Newton's fundamental interpolation. Forward, backward and central difference interpolations. Interpolation by iteration, Lagrange method

Numerical integration and differentiation:	**[6 Hrs]**

Trapezoidal rule, Simpson's rule, method of undetermined coefficients, Gaussian rule, approximation of first derivative methods based on interpolation

Numerical ordinary differential equations and partial differential equations:	**[6 Hrs]**

Eular's method, Modified Eular's method, Runge-Kutta Method, Finite-difference approximation. Explicit methods

List of Experiments:

1	**Roots of Non-Linear Equations**-To find the roots of non-linear equations using Bisection method.
2	**Roots of Non-Linear Equations** -To find the roots of non-linear equations using Newton-Raphson method.
3	**Interpolation**- Using Linear or Quadratic interpolation, finds intermediate data points from given set of data.
4	**Interpolation**- Using Lagrange interpolation, find intermediate data point form given set of data and compare the result with linear or quadratic interpolation.
5	**Curve Fitting**- For a give data set; find best fit curve using linear regression
6	**Curve Fitting**- For a give data set; find best fit curve using polynomial regression.
7	**Linear Solver**-To solve system of linear equations using Gauss Elimination method

8	**Linear Solver**-To solve system of linear equations using Gauss Jordan method.
9	**Integration**-To integrate numerically using Trapezoidal Rule.
10	**Integration**-To integrate numerically using Simpson's Rule.
11	**Matrix Eigen values**-To find Eigen values of matrix by power method
12	**Differential Equation**-To find numerical solution of ordinary differential equations by Euler's methods
13	**Differential Equation**-To find numerical solution of ordinary differential equations by Runge- Kutta methods.
Textbooks:	
[1]	Steven C. Chapra, Raymond P. Canale, Numerical Methods for Engineers, 7th Edition, sMcGraw-Hill
[2]	Steven C. Chapra, Applied Numerical Methods with Matlab for Engineers and Scientist McGraw-Hill Ramakant Gayakwad, "Op-Amp and Linear Integrated Circuits", PHI, 4th ed.,2021.
Note:	
[1] [2] [3] [4] [5]	To measure CO1, questions may be of the type- define, identify, state, match, list, name etc. To measure CO2, questions may be of the type- explain, describe, illustrate, evaluate, give examples, compute etc. To measure CO3, questions will be based on applications of core concepts. To measure CO4, questions may be of the type- true/false with justification, theoretical fill in the blanks, theoretical problems, prove implications or corollaries of theorems, etc. To measure CO5, some questions may be based on self-study topics and comprehension of unseen passages.

Semester - IV

Microcontrollers and Applications					
Course Code	IE-24006	**Examination Scheme**			
Teaching Scheme	3-0-2-1	**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3	**Laboratory**	CIE: 50	ESE: 50	

Course Outcomes: Students will be able to:

1. Differentiate amongst various architectures of microcontrollers
2. Impart microcontroller programming and design skills.
3. Undertake problem identification formulation and selection of appropriate microcontroller as per the applications
4. Interface and use different peripherals with microcontrollers
5. Compare and analyze different microcontrollers for the real world applications
6. Evaluate and compare the performance of microcontrollers

Introduction to Microcontroller:	**[8 Hrs]**
Numbering system, Microcontrollers Vs Microprocessors, RISC and CISC architecture comparison. Von-Neumann vs. Harvard architecture, comparison between 8-bit, 16-bit, 32-bit microcontroller. Stack and use of stack pointer. Memory structure, Data Memory, Program Memory and execution of programs.	
Programming with microcontroller:	**[8 Hrs]**
Programming: Concept of assembler directives, editor, linker, loader, debugger, simulator, emulator. Instruction set, basic programming using assembly instructions. Introduction to embedded-C, Integrated Development Environment (IDE), cross compiler, ISP, software delay generation.	
8 Bit micro-controller:	**[8 Hrs]**
Introduction to 8 bit microcontroller, Addressing Modes & Instruction Set, architecture and PIN description, Interrupts and Operating Modes, Analog Input-Output and PWM, Digital Input-Output, Memory Mapping (internal as well as external) of microcontroller.	
I/O Interfacing:	**[6 Hrs]**
I/O programming, interfacing with simple switch, LED, Keypad programming. Timers, various modes of operations of timers, counters, PWM programming.	
Communication Protocols:	**[6 Hrs]**
Serial peripheral interface (SPI), SPI based memory interfacing, Universal Serial Communications Interface (USCI) interfacing and programming, Interrupt understanding and interfacing, I2C based RTC interfacing, WDT (Watch dog timer).	
External Peripheral Interfacing:	**[6 Hrs]**
Analog to digital convertor, interfacing with external serial and parallel ADC's, Digital to analog convertor (DAC), Interfacing with DAC, Interfacing with stepper motor and DC motor, Comparative analysis of different 8 bit microcontrollers.	

Textbooks:	
[1]	Mazidi, "8051 microcontroller & embedded system" 3rdEdition ,Pearson
[2]	Mazidi, "PIC microcontroller & embedded system" 3rdEdition ,Pearson
[3]	Kenneth J. Ayala, "8051 Microcontroller: Programming, Architecture and Interfacing", Thomas Delmar Learning, Third ed., 2007.
[4]	Newnes, 1st Edition, 2010 "MSP430 Microcontroller Basics" by John H Davies
Reference Books:	
[1]	Kenneth J. Ayala, "The 8051 Micro-controller – Architecture, Programming & Applications", Penram International & Thomson Asia, Second Edition.
[2]	John B. Peatman, "Design with PIC Micro-controllers", Pearson Education Asia, Low Price Edition
[3]	MSP430 Technical Reference Manual
[4]	Newnes Publication, 2009 *Texas Instruments MSP 430 microcontroller, Guide and Datasheet

[5]	Muhammad A. Mazidi, "AVR Microcontroller and Embedded Systems: Assembly and C", Pearson; 1st edition, 2015

<table>
<tr><th colspan="6">Microcontrollers and Applications Laboratory</th></tr>
<tr><td>Course Code</td><td>IE-24006</td><td colspan="4">Examination Scheme</td></tr>
<tr><td>Teaching Scheme</td><td>3-0-2-1</td><td>Theory</td><td>TA: 20</td><td>MSE: 30</td><td>ESE: 50</td></tr>
<tr><td>Credits</td><td>3</td><td>Laboratory</td><td></td><td></td><td></td></tr>
<tr><td colspan="6">Course Outcomes: At the end of the course, students will demonstrate the ability to:</td></tr>
<tr><td colspan="6">1. Understand and apply the fundamentals of assembly/embedded ‘c’ level programming of microprocessors and microcontroller
2. Analyze problems and apply a combination of hardware and software to address the problem.</td></tr>
<tr><td colspan="6">List of Experiments</td></tr>
</table>

<table>
<tr><th colspan="2">Design build and test the circuits of ---</th></tr>
<tr><td>1</td><td>GPIO toggling.</td></tr>
<tr><td>2</td><td>Seven segment LED interfacing with microcontroller.</td></tr>
<tr><td>3</td><td>Keypad interfacing with microcontroller.</td></tr>
<tr><td>4</td><td>ADC interfacing with microcontroller with the help of waveform generation.</td></tr>
<tr><td>5</td><td>Timers and counters.</td></tr>
<tr><td>6</td><td>UART interfacing.</td></tr>
<tr><td>7</td><td>Interrupts in microcontrollers.</td></tr>
<tr><td>8</td><td>PWM generation using a microcontroller</td></tr>
<tr><td>9</td><td>DC/stepper motor interfacing with a microcontroller.</td></tr>
<tr><td>10</td><td>I2C and SPI based peripheral interfacing.</td></tr>
</table>

Automatic Control System					
Course Code	IE-24004	**Examination Scheme**			
Teaching Scheme	3-0-2-1	**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3	**Laboratory**	CIE: 50	ESE: 50	-

Course Outcomes: At the end of the course, students will demonstrate the ability to:

1. Develop mathematical model of Electrical and Mechanical system using differential equations and transfer function and develop analogy between Electrical and Mechanical systems.
2. Determine time response of systems for a given input and perform analysis of first and second order systems using time domain specifications.
3. Investigate closed loop stability of system in s-plane using Routh Hurwitz stability criteria and root locus.
4. Analyze the systems in frequency domain and investigate stability using Nyquist plot and Bode plot

Basics of Control System: **[10Hrs]**

Basic concepts of control system, classification of control systems, types of control system: feedback, tracking, regulator system, feed forward system, transfer function, concept of pole and zero, modeling of Electrical and Mechanical systems (Only series linear and rotary motion) using differential equations and transfer function , analogy between electrical and mechanical systems, block diagram algebra, signal flow graph, Mason's gain formula

Time domain analysis: **[10 Hrs]**

Concept of transient and steady state response, standard test signals: step, ramp, parabolic and impulse signal, type and order of control system, time response of first and second order systems to unit impulse, unit step input, time domain specifications of second order systems, derivation of time domain specifications for second-order under-damped system for unit step input, steady state error and static error coefficients

Stability analysis and Root Locus: **[10 Hrs]**

Concept of stability: BIBO, nature of system response for various locations of poles in S-plane, Routh's-Hurwithz criterion. Root Locus: Angle and magnitude condition, Basic properties of root locus. Construction of root locus, Stability analysis using root locus

Frequency domain analysis: **[10 Hrs]**

Introduction to Frequency domain specifications, correlation between time and frequency domain specifications, polar Plot, Nyquist plot, stability analysis using Nyquist plot. Introduction to Bode plot, Asymptotic approximation: sketching of Bode plot, stability analysis using Bode plot

Textbooks:

[1]	I.J. Nagrath, M. Gopal, "Control System Engineering", New Age International Publishers, 6th edition, 2017.
[2]	R. Anandanatrajan and P.Ramesh Babu, "Control Systems Engineering", Scitech Publication,3rd edition, 2011
[3]	D. Roy Choudhary, "Modern Control Engineering", PHI Learning Pvt. Ltd., 2005.

Reference Books:

[1]	B. C. Kuo, "Automatic Control System", Wiley India, 8th Edition, 2003
[2]	Van de Vegte, John. *Feedback Control Systems*. 3rd ed. Prentice Hall, 1994.
[3]	Nise N. S. "Control Systems Engineering", John Wiley & Sons, Incorporated, 2011
[4]	Richard C Dorf and Robert H Bishop, "Modern control system", Pearson Education, 12th edition, 2011.
[5]	Ogata, Katsuhiko. *Solving Control Engineering Problems with MATLAB*. Prentice Hall, 1993.

<table>
<tr><td colspan="6">Automatic Control System Laboratory</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Course Code</td><td>IE-
24004</td><td colspan="4">Examination Scheme</td></tr>
<tr><td>Teaching Scheme</td><td>3-0-2-1</td><td>Theory</td><td>TA: 20</td><td>MSE: 30</td><td>ESE: 50</td></tr>
<tr><td>Credits</td><td>3</td><td>Laboratory</td><td>CIE: 50</td><td>ESE: 50</td><td>-</td></tr>
<tr><td colspan="6">Course Outcomes: At the end of the course, students will demonstrate the ability to:</td></tr>
<tr><td colspan="6">1. Analysis and validation of time domain response for 1st & 2nd order system
2. Experimental validation of mathematical model
3. Write a program for validation of different control strategies</td></tr>
<tr><td colspan="6">List of Experiments</td></tr>
<tr><td>1</td><td colspan="5">Transfer function of RC System and its step response.</td></tr>
<tr><td>2</td><td colspan="5">Transfer function of RLC System step response.</td></tr>
<tr><td>3</td><td colspan="5">Study of first and second order system response and find its time constant and verify it, Theoretically.</td></tr>
<tr><td>4</td><td colspan="5">Find steady state error of Type 0, 1, 2 systems</td></tr>
<tr><td>5</td><td colspan="5">Study of under damped, over damped and critically damped response of second order system (RLC ckt) and theoretically verify it</td></tr>
<tr><td>6</td><td colspan="5">Find TF of two RC n/w using Bode plot</td></tr>
<tr><td>7</td><td colspan="5">Introduction to Control System Toolbox in MATLAB.</td></tr>
<tr><td>8</td><td colspan="5">Introduction to Simulink (Basic blocks used in Control system).</td></tr>
<tr><td>9</td><td colspan="5">Calculation of time domain specifications using MATLAB.
Implementation and verifications of Combinational circuits on programmable logic devices.</td></tr>
<tr><td>10</td><td colspan="5">Stability analysis using root locus approach.</td></tr>
<tr><td>11</td><td colspan="5">Stability analysis using frequency response approach (Bode plot approach).</td></tr>
</table>

Digital Electronics					
Course Code	IE-24005	**Examination Scheme**			
Teaching Scheme	3-0-2-1	**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3	**Laboratory**	CIE: 50	ESE: 50	-

Course Outcomes: At the end of the course, students will demonstrate the ability to:

1. Describe various logic families and select a logic family logic gate(s) for a typical application
2. Apply Boolean algebra and other minimization techniques to digital circuits.
3. Design combinational and sequential circuits for a given problem / case studies related to digital circuits.
4. Evaluate appropriate hardware and software tools for combinational and sequential circuit design, implementation and verification.

Logic Families:	**[06 Hrs]**

Digital IC specification terminology, different types of logic families, complementary metal oxide semiconductor logic, logic families interfacing – TTL driving CMOS, CMOS driving TTL, measurement of specification parameters of IC’s, 5400 /7400 series ICs, Tristate Logic, Comparison of Different logic families.

Combinational Circuits:	**[06 Hrs]**

Introduction to Combinational circuits, analysis procedure, design procedure, Boolean algebra, Kmap, Tabular method, binary adder, binary subtractor, decimal adder and their implementation, binary multiplier, magnitude comparator, decoders, encoders, multiplexer, hardware design logic for combinational circuits, Combinational Logic design using MSI Circuits, Hazards in Combinational circuits.

Sequential Circuits:	**[07 Hrs]**

Flip Flops, Conversion of flip flops, ripple counters, synchronous counters, Hardware for counters , Ring, Johnson, Binary, BCD, Up-Down counters and its applications, registers, shift registers and their applications, Hardware design logic for counters, Hazards in sequential Circuits

Analysis of sequential circuits:	**[07 Hrs]**

Synchronous and Asynchronous Sequential Logic: Sequential circuits, latches, analysis of clocked sequential circuit, hardware design logic for sequential circuits, state reduction, State diagram, and state equation, Asynchronous logic, circuits with latches, design procedure, reduction of state and flow tables, race free state assignments, design examples

Programmable Logic Devices I:	**[06 Hrs]**

Introduction to memories, Types of memories, Memory specification, Introduction to PAL, PLA, Configurable Programmable Logic Devices, Various types of CPLD’s.

Programmable Logic Devices II:	**[07 Hrs]**

Introduction to FPGA and its various architectures, PLD Programming concepts, Introduction to PLD Programming languages, Realization of combinational and sequential circuits on PLDs.

Textbooks:

[1]	Ronald J. Toccii, ”Digital Systems: Principles and Applications”, Pearson LPE, Fourthed. 2009
[2]	R. P. Jain, ”Modern Digital Electronics”, McGraw Hill Higher Education, Fourth ed.,2010

Reference Books:

[1]	Mano M.M, “Digital Logic and Computer Design”, Pearson LPE, Fourth, ed., 2009.
[2]	Boyce J. C., “Digital Logic: Operation and Analysis”, Prentice Hall, Second ed., 1982

Digital Electronics Laboratory					
Course Code	IE-24005	**Examination Scheme**			
Teaching Scheme	0-0-2-0	**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	-	**Laboratory**	CIE: 50	ESE: 50	-
Course Outcomes: At the end of the course, students will demonstrate the ability to:					

1. Design experimental setup for measurement of digital IC parameters & its verification.
2. Design, realize and analyze various combinational and sequential circuits
3. Select and use latest hardware and software tools for digital system realization.

List of Experiments

1	Measurement of IC's parameters like rise time, fall time, propagation delays, and current and voltage parameters.
2	Design and implementation of arithmetic circuits.
3	Design and implementation of various code converters and its applications.
4	Design and implementation of multiplexer and demultiplexer and its applications
5	Design and implementation of encoders and decoders and its applications
6	Design and implementation of synchronous and asynchronous counters and its applications.
7	Design and implementation of non-sequential counters.
8	Design and implementation of shift registers and its applications.
9	Implementation and verifications of Combinational circuits on programmable logic devices.
10	Implementation and verifications of sequential circuits on programmable logic devices

Signals and Systems					
Course Code	IE-24001	**Examination Scheme**			
Teaching Scheme	2-1-0-1	**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3	**Laboratory**	-	-	-

Course Outcomes: At the end of the course, students will demonstrate the ability to:

1. Classify signals based on their characteristics and perform basic operations on signals.
2. Interpret system characteristics and analyze LTI systems.
3. Analyze the spectral properties of signals using Fourier analysis.
4. Apply Z- transform to study discrete-time signals and systems.

Introduction to Signals	[05 Hrs]
Definition of Signals, Classification of Signals, elementary signals, basic operations on signals.	
System Classification and Properties	**[06 Hrs]**
Introduction to Systems, Classification of Systems, Properties of Systems, Impulse response characterization and convolution for CT- LTI and DT-LTI systems, LTI systems characterized by Differential and difference equations.	
Fourier analysis of Continuous Time Signals	**[06 Hrs]**
Fourier analysis for Continuous time signals, Continuous time Fourier Transform, its properties, frequency response.	
Fourier Analysis of Discrete Time Signals	**[05 Hrs]**
Discrete time Fourier series and its convergence, discrete time Fourier Transform, its properties, frequency response.	
Z-Transform	**[05 Hrs]**
Representation of Signals Using Discrete-Time Complex Exponentials: Z-Transform, Significance and Properties of Region of Convergence, Properties of Z-Transform, Inverse Z-Transform, relationship of z-transform with Fourier transform, applications of Z-transform to solutions of difference equations, Properties of Z transform.	

Text Books:	
[1]	Simon Haykins and Barry Van Veen, “Signals and Systems”, John Wiley and sons
[2]	Michael J. Robert, “Introduction to Signals and Systems”, TMH, Second ed., 2003
[3]	Tarun Kumar Rawat “Signals and Systems”, Oxford University Press, first edition 2010
Reference Books:	
[1]	Alan V Oppenhein, Alan S Wiilsky, “Signals and systems” PHI, Second ed. 2009
[2]	Shaila Dinkar Apte “Signals and Systems: Principles and Applications”, Cambridge University Press.

Multidisciplinary Minor Measurement Techniques					
Course Code		**Examination Scheme**			
Teaching Scheme	3-0-0-1	**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	-	**Laboratory**	-	-	-

Course Outcomes: At the end of the course, students will demonstrate the ability to:

1. Describe working principles of various measuring instruments [PEO1][PO1]
2. Interpret the characteristics of the transducers/sensors [PEO2][PO2]
3. Identify various blocks of electronic instruments for measurement and testing
1. 4. Select appropriate electronic instrument for specific applications [PEO3] [PO6]

Unit-1: Measurement System and Electrical Transducers **[08 Hrs]**

Measurement system: Concepts and terminology of measurement system, transducer, sensor, range and span, classification of transducers, static and dynamic characteristics, selection criteria, sources of errors and their statistical analysis, Importance of sensing. Electrical transducers for measuring flow, temperature, level, pressure etc.

Unit-2: Signal Conditioning **[05 Hrs]**

Introduction, Block diagram of data acquisition and signal processing system, Signal Amplification, Noise Attenuation, Signal Filtering, Analysis of signals, Data converters.

Unit-3: Digital instruments **[08 Hrs]**

Role of digital instruments in measurement system, Advantages of Digital instruments over Analog instruments, Block diagram, principle of operation, significance of digit, Automation in digital instruments, Universal counter and their applications like event, ratio, totalizing and timers Digital Multimeter.

Unit-4: Recording & Integrating instruments **[07 Hrs]**

Role of recording instruments in measurement system, General purpose oscilloscope Block Diagram, Cathode Ray Tube, deflection sensitivity, front panel controls, Oscilloscope Probes 1:1 and 10:1, Dual trace CRO, ALT and CHOP modes, measurement of electrical parameters like voltage, current, frequency and phase, frequency measurement by Lissajous pattern, Digital Storage oscilloscope block diagram, sampling rate, bandwidth, roll mode.

Textbooks:

[1]	David Bell; “Electronic Measurement and Instrumentation” Prentice Hall 2nd ed. 2000.
[2]	A.J. Bowens; “Digital Instrumentation” McGraw-Hill, 1st ed. 1986.
[3]	C.S. Rangan, G.R. Sarma, V.S.V. Mani; “Instrumentation Devices and Systems” Tata McGraw Hill 2nd ed. 1997.

Reference Books:

[1]	J.J.Carr; “Elements of Electronic Instrumentation and Control” Prentice Hall 3rd ed. 2009.
[2]	W.Cooper, A.Helfric; “Electronic Instrumentation and Measurement Techniques” PHI 3rd ed. 2005.