MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

Department of Instrumentation and Control Engineering
B. Tech in Electronics and Instrumentation Engineering
Program Structure and curriculum-2022 scheme

Year	THIRD SEMESTER						FOURTH SEMESTER					
	Sub. Code	Subject Name	L	T	P	C	Sub. Code	Subject Name	L	T	P	C
II	MAT 2122	Engineering Mathematics - III	2	1	0	3	MAT 2228	Engineering Mathematics - IV	2	1	0	3
	ICE 2121	Analog Electronic Circuits	3	1	0	4	ICE 2221	Linear Integrated circuits	3	0	0	3
	ICE 2122	Digital Circuits & System Design	3	0	0	3	ICE 2222	Microcontrollers	3	1	0	4
	ICE 2123	Networks and Signals	3	1	0	4	ICE 2223	Industrial Instrumentation	3	0	0	3
	ICE 2124	Sensors and Transducers	3	0	0	3	ICE 2224	Digital Signal processing	2	1	0	3
	ICE 2125	Linear Control Theory	2	1	0	3	ICE 2229	Communication Techniques	3	0	0	3
	ICE 2141	Digital Circuits and Systems Lab	0	0	3	1	ICE 2241	Analog systems lab	0	0	3	1
	ICE 2142	Sensors and Circuits lab	0	0	3	1	ICE 2242	Microcontroller Lab	0	0	3	1
			16	**4**	**6**	**22**			**16**	**3**	**6**	**21**
	Total Contact Hours (L + T + P)		**26**				**Total Contact Hours (L + T + P)**		**25**			

Year	FIFTH SEMESTER						SIXTH SEMESTER					
	Sub. Code	Subject Name	L	T	P	C	Sub. Code	Subject Name	L	T	P	C
III	HUM 3022	Essentials of Management	3	0	0	3	HUM 3021	Engg Economics & Financial Management	3	0	0	3
	ICE 3121	Industrial Automation & Drives	3	1	0	4	ICE ****	Flexible Core – (A2/B2/C2)	3	0	0	3
	ICE 3122	VLSI Design	3	0	0	3	ICE ****	Flexible Core – (A3/B3)	3	0	0	3
	ICE 3123	Process Instrumentation and control	3	0	0	3	ICE ****	PE – 1 / Minor Specialization	3	0	0	3
	ICE ****	Flexible Core – (A1/B1/C1)	3	0	0	3	ICE ****	PE – 2 / Minor Specialization	3	0	0	3
	IPE 4302	OE 1– Creativity, Problem Solving and Innovation** (MLC)	3	0	0	3	*** ****	OE – 2** (MLC)	3	0	0	3
	ICE 3141	Industrial Instrumentation Lab	0	0	3	1	ICE 3241	Control and Signal Processing Lab	0	0	3	1
	ICE 3142	Process Control Lab	0	0	3	1	ICE 3242	Industrial automation lab	0	0	3	1
							ICE 3243	Virtual Instrumentation LAB	0	0	3	1
			18	**1**	**6**	**21**			**18**	**0**	**9**	**21**
	Total Contact Hours (L + T + P)		**25**				**Total Contact Hours (L + T + P)**		**27**			

*Courses of three independent tracks A, B, C
** Performance of students to be recorded in Eighth semester grade sheet

Year	SEVENTH SEMESTER						EIGHTH SEMESTER					
	Sub. Code	Subject Name	L	T	P	C	Sub. Code	Subject Name	L	T	P	C
IV	ICE ****	PE – 3 / Minor Specialization	3	0	0	3	ICE 4291	Industrial Training (MLC)				1
	ICE ****	PE – 4 / Minor Specialization	3	0	0	3	ICE 4292	Project Work				12
	ICE ****	PE – 5	3	0	0	3	ICE 4293	Project Work (B Tech – honours)* (V - VIII sem)				20
	ICE ****	PE – 6	3	0	0	3	ICE ****	B Tech – honours Theory – 1* (V semester)				4
	ICE ****	PE - 7	3	0	0	3	ICE ****	B Tech – honours Theory – 2* (VI semester)				4
	*** ****	OE – 3** (MLC)	3	0	0	3	ICE ****	B Tech – honours Theory – 3* (VII semester)				4
	ICE 4191	Mini Project (Minor specialization)***				8						
						18/26* **						**13/33***
	Total Contact Hours (L + T + P)		**18**				**Total Contact Hours (L + T + P)**					

*Applicable to eligible students who opted for and successfully completed the B Tech – honours requirements
** Performance of students to be recorded in Eighth semester grade sheet
***Applicable to students who opted for minor specialization

Flexible Core-A
Instrumentation (A)
ICE 3124 Smart sensors (A1)
ICE 3221 Micro Electro Mechanical Systems (A2)
ICE 3223 Wireless Sensor Networks (A3)
Flexible Core-B
Applied Electronics (B)
ICE 3125 Embedded Systems Design (B1)
ICE 3222 Internet of Things (B2)
ICE 3224 Digital Image Processing (B3)
Flexible Core C (L&T EduTech)

C1 ICE xxxx Fundamentals of EV and Hybrid Vehicles
C2 ICE XXXX Automotive mechanics of Electric Vehicles

Minor Specialization
I. Computational Intelligence
ELE 4409: Artificial Intelligence
ECE 4409: Machine Learning
ELE 4410: Soft Computing Techniques
ECE 4410: Computer Vision
II. Control Systems
ICE 4401: Modern Control Theory
ICE 4402: Nonlinear control theory
ICE 4403: Digital Control Systems
ICE 4404: System Identification
III. Embedded Systems
ECE 4411: Embedded System Design
ELE 4411: FPGA Based System Design
ECE 4412: Internet of Things
ELE 4412: Real Time Systems
IV. Sensor Technology
ICE 4405: Sensor Design
ICE 4406: Biosensors and BioMEMS
ICE 4407: Multi Sensor Data Fusion
ICE 4408: Automotive Sensors

V. Systems Engineering
ICE 4409: Introduction to Systems Engineering
ICE 4410: System architecture and Design
ICE 4411: SysML and MBSE
ICE 4412: System Verification and validation
VI. Smart Transportation Systems
ICE 4413: Automotive Electronics
ICE 4414: In-vehicle Networking
ICE 4415: Intelligent Transportation Systems
ICE 4416: Advanced Driver Assistance Systems
VII. Hybrid and Electric Vehicle technology(L&T EduTech)
*** ****EV Battery technology and Power train management
*** ****EV charging infrastructure, Vehicle testing and homologation
*** ****EV design and analysis
*** ****EV data analytics and cyber security.

Other Program Electives
ICE 4441: Advanced Sensor Technology
ICE 4442: Analytical and optical Instrumentation
ICE 4443: Biomedical Instrumentation and Equipment
ICE 4444: Cyber physical systems
ICE 4445: Data Structures and algorithms
ICE 4446: DSP algorithms and Architecture
ICE 4447: Electronic Measurement Systems
ICE 4448: Industrial Internet of Things
ICE 4449: Machine learning for control systems
ICE 4450: Neural Network and Fuzzy Logic
ICE 4451: Power Electronics
ICE 4452: Real Time Operating System
ICE 4453: Reliability and safety Engineering
ICE 4454: Robotic Control Systems
ICE 4455: Robust Control

Open Electives
ICE 4311 Feedback Control Theory
ICE 4312 Industrial Automation
ICE 4313 Industrial Instrumentation
ICE 4314 Sensor Technology
ICE 4315 Smart Sensor
ICE 4316 Virtual Instrumentation
ICE 4317 Farm Automation

THIRD SEMESTER

MAT 2122: ENGINEERING MATHEMATICS - III [2 1 0 3]

	CO Statements
CO1	Analyse signals using Fourier series and transforms.
CO2	Apply suitable matrix decomposition methods for dimension reduction process.
CO3	Apply the concepts of linear algebra to the linear systems of equations.
CO4	Analyse matrices as linear transformations.
CO5	Apply the concept of inner-product for geometrical interpretation of vectors.

Linear algebra: Systems of Linear Equations, Matrices, Solving Systems of Linear Equations, Vector Spaces, Linear Independence, Basis and Rank, Linear Mappings, Affine Spaces, Analytic geometry: Norms, Inner Products, Lengths and Distances, Angles and Orthogonality, Orthonormal Basis, Orthogonal Complement, Inner Product of Functions, Orthogonal Projections, Rotations. Matrix decompositions: Determinant and Trace, Eigenvalues and Eigenvectors, Cholesky Decomposition, Eigen decomposition and Diagonalization, Singular Value Decomposition, Matrix Approximation. Fourier Series and transforms: Periodic function, Fourier Series expansion. even and odd functions, functions with arbitrary periods, Half range expansions Fourier transform, basic properties, Parseval’s identity and applications.

References:

1. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.
2. Grewal B.S. - Higher Engineering Mathematics, Khanna Publishers, 43rd edition, 2015
3. Stephen H. Friedberg Lawrence E Spence, Arnold J Insel, Elementary Linear Algebra: A Matrix Approach Introduction to Linear Algebra, Second Edition, 2019.
4. David Lay, Steven Lay, Judi McDonald, Linear Algebra and Its Applications, Pearson, 2019.
5. Gilbert Strang, Introduction to Linear Algebra, Fifth Edition (2016), Wellesley-Cambridge Press.
6. Mordechai Ben-Ari, Mathematical Logic for Computer Science, Third Edition, Springer.
7. Narayanan, Ramaniah and Manicavachagom Pillay , Advanced Engineering Mathematics, Vol 2 and 3, Vishwanthan Publishers Pvt Ltd. 1998
8. Erwin Kreyszig, Advanced Engineering Mathematics, 5th edn., Wiley Eastern, 1985.

ICE 2121: ANALOG ELECTRONIC CIRCUITS [3 1 0 4]

	CO Statements
CO1	Analyse the characteristics of various transistor technologies.
CO2	Realize amplifier topologies using field effect transistors.
CO3	Perform small signal analysis of field effect transistors.
CO4	Analyse frequency response of amplifiers.
CO5	Design feedback and power amplifiers using transistors.

Structure and operation of MOSFET, I-V Characteristics, Channel-Length Modulation, Transconductance, Large-Signal and Small-Signal Model, Biasing, Amplifier topologies, Common-Source Amplifier, Common-Gate Amplifier, Source Follower, Cascode, Two stage CS Amplifiers, MOS Differential amplifier, Miller's Theorem, Frequency Response of CS, CG, CD, Cascode and differential amplifier Stage, Negative Feedback Amplifiers, Feedback Topologies, Power amplifiers, Push-Pull Stage, LC Oscillators, Hartley's and Colpitt's Oscillator, RC Phase Shift Oscillator, Ring Oscillator.

References:

1. Behzad Razavi, Fundamental of Microelectronics, Wiley, (2e), 2013.
2. S. Sedra, K. C. Smith, Microelectronic circuits, Oxford University Press, (6e), 2011.
3. R. L. Boylestad, L. Nashelsky, Electronic Devices and Circuit Theory, PHI, (11e), 2014.
4. *https://archive.nptel.ac.in/courses/108/106/108106084/
5. *https://archive.nptel.ac.in/courses/117/101/117101105/
6. *Reynaert, P., & Steyaert, M. (2006). RF power amplifiers for mobile communications. Springer Science & Business Media.

ICE 2122: DIGITAL CIRCUITS AND SYSTEM DESIGN [3 0 0 3]

	CO Statements
CO1	Design combinational circuits by applying fundamentals of Boolean algebra.
CO2	Realize sequential logic circuits.
CO3	Design programmable logic devices to implement digital circuits.
CO4	Evaluate Verilog as a hardware description language.
CO5	Implement digital logic circuits using Verilog.

Boolean Algebra – Theorems, DeMorgan's Law, Karnaugh map, Determination of Prime Implicants, Quine McCluskey method, Combinational Logic Design, Synchronous Sequential Logic Design, Introduction to Programmable circuits - Design of Read-Only Memory (ROM), Programmable Logic Arrays (PLA), Programmable Array Logic (PAL)., Programmable ASICs, Introduction to CAD Tools, Introduction to Verilog – Structural Specification; Behavioral Specification, Verilog for Combinational Circuits, Verilog for Sequential Circuits, Verilog Programming.

References:

1. Donald D. Givone, Digital Principles and Design, TMH, (1e), 2002.
2. C. H. Roth, Fundamentals of Logic Design, Thomson, (6e), 2000.
3. Anand Kumar, Switching Theory and Logic Design, PHI, (2e), 2014.
4. Samir Palnitkar, Verilog HDL: A guide to digital design and synthesis, Prentice Hall Professional, (2e), 2003.
5. J. Bhasker, A Verilog HDL Primer, BSP, (1e), 2001.
6. Stephen Brown, Fundamentals of Digital Logic with Verilog Design, TMH, (3e), 2013.
7. Cem Unsalan, Bora Tar, Digital System Design with FPGA, Mc Graw Hill Education (India) Private Limited, 2017.
8. Ming-Bo Lin, Digital System Designs and practices Using Verilog HDL and FPGAs, Wiley India Pvt. Ltd., 2012.

ICE 2123: NETWORKS AND SIGNALS [3 1 0 4]

	CO Statements
CO1	Apply network theorems for solving electrical networks.
CO2	Analyse transient performance of RLC circuits.
CO3	Apply Laplace transform to solve electrical circuits and evaluate two port network parameters.
CO4	Analyse Linear Time-Invariant (LTI) systems.
CO5	Apply Fourier transform to analyse frequency response of LTI systems.

Analysis of circuits with dependent sources, Network theorems, Initial conditions and transient analysis of RL, RC and RLC circuits, Analysis of networks by Laplace transform method, Network functions, Two port network parameters. Continuous time signals and systems, LTI systems - convolution integral, Response of Continuous time LTI systems to complex exponentials, Fourier series, Fourier transform, Properties of Fourier series and Fourier transform

References:

1. Van Valkenberg, Network Analysis, 3e, PHI, 2010
2. Fundamentals of Electric Circuits, Charles K. Alexander, Matthew N. O. Sadiku, McGraw Hill (7e), 2022.
3. Allan Oppenheim, Allan Willsky with Ian S Hamid, Signals and Systems, PHI, 1999.
4. Hayt W. H., J. E. Kemmerly & S. M. Durbin, Engineering Circuit Analysis, 7e, TMH, 2010.

ICE 2124: SENSORS AND TRANSDUCERS [3 0 0 3]

	CO Statements
CO1	Analyse the characteristics of sensors.
CO2	Analyse the working of resistive and capacitive sensors.
CO3	Interpret inductive and piezoelectric sensors.
CO4	Evaluate the electrochemical sensors for analytical and industrial sensing.
CO5	Investigate optical sensors for analytical and industrial measurements.

Configurations and functional description, Resistive Transducers, Capacitive Transducers, Inductive Transducers, Inductive Transducers, Piezo Electric Transducers, electrochemical sensors: use and design, optical sensors: use and design, miscellaneous industrial sensors for measurement of pH, gases, humidity.

References:

1. E.O. Doeblin, Measurement Systems: Application and Design, McGraw Hill, (5e), 2008.
2. DVS Murthy, Transducers & Instrumentation, PHI, (2e), 2008.
3. Skooj, Holler, Crouch, Principles of Instrumental Analysis (7e), Cengage Learning India, 2018.
4. B.G. Liptak, Process Measurement & Analysis, Chilton Book Company, (4e), 2003.

ICE 2125: LINEAR CONTROL THEORY [2 1 0 3]

	CO Statements
CO1	Develop mathematical models of LTI systems and build analogous systems.
CO2	Analyse time domain performance characteristics of first and second order systems.
CO3	Interpret the stability of systems using root locus technique.
CO4	Analyse systems in frequency domain and interpret stability and stability margins.
CO5	Elucidate compensator design methodology to meet desired performance requirements.

Mathematical modeling, transfer functions, Block diagram representation and reduction, signal flow graph, Masons gain formula, time domain specifications. Stability, Steady state errors, generalized error coefficients, Routh- Hurwitz criterion, Root-Locus plots, frequency domain specifications. Correlation between frequency domain and time domain specifications, Bode diagrams, Polar plots, Nyquist stability criterion, Qualitative analysis of compensator design using root-locus and frequency response approach. (Note: Theoretical concepts be demonstrated in class. Additional examples be solved using MATLAB on every topic during tutorials.)

References:
1. Norman S. Nise, Control Systems Engineering, Wiley India, (5e), 2009.
2. K. Ogata, Modern control engineering, PHI, (5e), 2011.
3. R.C Dorf and R.H Bishop, Modern Control Systems, Pearson, (11e), 2013.

ICE 2141: DIGITAL CIRCUITS AND SYSTEMS LAB [0 0 3 1]

	CO Statements
CO1	Implement Boolean functions and code converters using logic gates.
CO2	Implement combinational and sequential circuits.
CO3	Design combinational circuits and implement using Verilog HDL.
CO4	Design sequential circuits and implement using Verilog HDL.
CO5	Interface peripheral modules with FPGA.

Implementation of Boolean functions using logic gates, Code Conversion Circuits, Design and implementation of combinational circuits, Study of Flip-flops, Design and implementation of Counters, Study of Basic operators and data types in Verilog HDL, Combinational circuit design using Verilog HDL, Sequential circuit design using Verilog HDL, Keypad Interfacing, LCD Interfacing.

References:
1. Anand Kumar, Switching Theory and Logic Design, PHI, (2e), 2014.
2. M. Morris Mano, Digital Design, PHI, (5e), 2002.
3. Samir Palnitkar, Verilog HDL: A guide to digital design and synthesis, Prentice Hall Professional, (2e), 2003.
4. J. Bhasker, A Verilog HDL Primer, BSP, (1e), 2001.
5. Cem Unsalan, Bora Tar, Digital System Design with FPGA, Mc Graw Hill Education (India) Private Limited, 2017.

ICE 2142: SENSORS AND CIRCUITS LAB [0 0 3 1]

	CO Statements
CO1	Prove resonance properties and network theorems.
CO2	Determine the circuit parameters using comparison methods.
CO3	Verify the characteristics of photo devices and temperature transducers.
CO4	Characterize displacement, force and torque transducers.
CO5	Design a measurement system using commercial sensors.

AC bridges, network theorems, measurement of energy, measurement of self and mutual inductance, series and parallel resonance, characteristics of sensors and transducers – temperature, torque, force, displacement and intensity of light. Electrochemical sensor design. Optic fibre based sensor design.

References:
1. E.O. Doeblin, Measurement Systems: Application and Design, McGraw Hill, (5e), 2004.
2. C S Rangan, G R Sharma and V S V Mani, Instrumentation Devices & Systems, TMH, (2e), 2017.

FOURTH SEMESTER

MAT 2228: ENGINEERING MATHEMATICS IV [2 1 0 3]

	CO Statements
CO1	Apply the concept of probability and use them in engineering models.
CO2	Analyse the concept of random variables and their applications.
CO3	Quantify the uncertainty in the data using the aspects of probability.
CO4	Apply the concept of vector gradient in physical phenomenon.
CO5	Apply and analyse the optimistic solution for linear and non-linear programming problems.

Probability and Distributions: Construction of a Probability Space, Discrete and Continuous Probabilities, Sum Rule, Product Rule, and Bayes' Theorem, Summary Statistics and Independence, Distributions: Binomial, Poisson, uniform, normal, Chi-square and exponential distributions. Multivariate Random variables and Stochastic Process: Two and higher dimensional random variables, covariance, correlation coefficient. Moment generating function, functions of one dimensional and two dimensional random variables. Static probabilities: review and prerequisites generating functions, difference equations. Dynamic probability: definition and description with examples. Markov chains, transition probabilities. Vector Calculus: Differentiation of Univariate Functions, Partial Differentiation and Gradients, Gradients of Vector-Valued Functions, Gradients of Matrices, Useful Identities for Computing Gradients, Backpropagation and Automatic Differentiation, Higher-Order Derivatives, Linearization and Multivariate Taylor Series. Optimization: Basic solution, Convex sets and function, Simplex Method, Optimization Using Gradient Descent, Constrained Optimization and Lagrange Multipliers.

Reference Books:

1. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.
2. P L Meyer, Introductory Probability and Statistical Applications, Addison Wiley.
3. Medhi. J. Stochastic Processes, Wiley Eastern.
4. Murray R. Spiegel, Vector Analysis Theory and Problems, Schaum's Outline Series, 2019.
5. Hamdy A. Taha, "Operations Research: An Introduction", 8th Edn., Pearson Education (2008).
6. Sheldon M. Ross, Introduction to Probability Models Eleventh Edition Elsevier.
7. E. S. Page, L. B. Wilson, An Introduction to Computational Combinatorics, Cambridge University Press.
8. Bhat U R, Elements of Applied Stochastic Processes, John Wiley.

ICE 2221: LINEAR INTEGRATED CIRCUITS [3 0 0 3]

	CO Statements
CO1	Analyse Op-Amp circuits for linear applications.
CO2	Design active filters using Op-Amps.
CO3	Interpret Op-Amp circuits for non-linear applications.
CO4	Design waveform generators using Op-Amp and 555 timer.
CO5	Analyse the operation of data converters.

Op Amp fundamentals, Current to Voltage, Voltage to current Converters, Current amplifiers, Difference Amplifiers, Instrumentation Amplifiers, Active Filters, Voltage comparators, Schmitt trigger, Precision rectifiers, Peak detector, Multi vibrators, Monolithic Timers, Triangular wave generators, Sine wave generators, Voltage to frequency and Frequency to voltage converters, Digital to Analog and Analog to Digital Converters.

References:

1. Franco Sergio, Design with Op amps & Analog Integrated Circuits, McGraw Hill, (3e), 2017.
2. Ramakant A. Gayakwad, Op-Amps and Linear Integrated Circuits, PHI, (4e), 2015.
3. Robert F. Coughlin and Frederick S. Driscoll, Operational Amplifiers and Linear Integrated Circuits. Pearson Education Pvt Ltd., (6e), 2020.
4. Sedra and Smith, Micro Electronic Circuits, Oxford university press, (8e), 2019.

ICE 2222: MICROCONTROLLERS [3 1 0 4]

	CO Statements
CO1	Analyze the architecture and features of 8051 Microcontroller.
CO2	Apply the instruction set of 8051 microcontroller to develop assembly language programs.
CO3	Illustrate timers/counters, serial communication and interrupts using 8051 programming.
CO4	Analyze the architecture and features of ARM LPC 2148 microcontroller.
CO5	Interface I/O devices with 8051/LPC 2148 microcontrollers.

Computer Architecture, Architecture of 8051, 8051 Addressing Modes, 8051 Instruction Set, Programming 8051 using Assembly Language and C, 8051 Timer, Serial Port and Interrupt Programming using Assembly Language and C. Introduction to ARM, ARM Architecture, Introduction to LPC2148, Architecture of LPC2148 and Programming, Interfacing of I/O ports, ADC, DAC, LCD, Keyboard, Stepper motor, DC motor using 8051/LPC2148.

References:

1. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, The 8051 Microcontroller and Embedded Systems Using Assembly and C, Pearson Education, (2e), 2007.
2. Kenneth J. Ayala, The 8051 Microcontroller, Cengage Learning, (3e), 2004.
3. Steve Furber, ARM System - on – Chip Architecture, Pearson, (2e), 2015
4. William Hohl, Hinds Christopher, ARM Assembly Language, CRC Press, (2e), 2014.
5. LPC21XX User Manual, 2007.

ICE 2223: INDUSTRIAL INSTRUMENTATION [3 0 0 3]

	CO Statements
CO1	Analyse different temperature sensors for industrial measurements.
CO2	Apply various pressure measurement techniques for industrial applications.
CO3	Analyse various flow measurement techniques in industrial settings.
CO4	Scrutinize level and speed measurement technologies in industries.
CO5	Analyse sensor and transmitter wiring, and industrial hazard classifications.

Temperature Measurement, Pressure Measurement: Manometers, Elastic types, Bell gauges, Electrical types, Differential Pressure transmitters, Dead weight Pressure gauges. Low Pressure Measurement. Flow Measurement. Multiphase flow meters, Measurement of Speed, velocity and Acceleration, Level Measurement, NEMA, ISA standards, IEI – hazard classifications and standards.

References:
1. Liptak B. G, Handbook of Process Measurement and Analysis, Chilton Book Company, (3e), 1995.
2. Gioia Falcone, Geoffrey Hewitt, C Alimonti, Multiphase Flow Metering- Principles and Applications, Elsevier Publication, 2009.
3. Patranabis D, Principles of Industrial Instrumentation, TMH, (3e), 2005.

ICE 2224: DIGITAL SIGNAL PROCESSING [2 1 0 3]

	CO Statements
CO1	Analyse discrete time signals and systems using Z-transform.
CO2	Implement efficient algorithms to compute Discrete Fourier Transform
CO3	Design Finite Impulse Response filters
CO4	Design Infinite impulse response filters using transformation methods
CO5	Interpret the architecture of digital signal processor

Z-transform, its properties, inverse Z-transform, solving difference equation, discrete Fourier transform, and its properties, FFT algorithms, Frequency response of analog and digital filters, FIR and IIR filter design, FIR filter design using windows, digital Butterworth and Chebyshev filter design, realization of FIR and IIR filters, architecture of C6x processor, various addressing modes, programs.

References:
1. John G Proakis, Dimitris G Manolakis, Digital Signal Processing, Pearson Education,(4e), 2007.
2. Sanjit K Mitra, Digital Signal Processing: A Computer - Based Approach, McGraw Hill Education,(4e), 2013
3. Thomas J. Cavicchi, Digital Signal Processing, Wiley, 2009
4. Steven W Smith, Digital Signal Processing: A Practical Guide for Engineers and Scientists, Elsevier, 2002
5. Rulph Chassaing, Digital Signal Processing and Applications with the C6713 and C6416 DSK. Vol. 16. John Wiley & Sons, 2004.

ICE 2229: COMMUNICATION TECHNIQUES [3 0 0 3]

	CO Statements
CO1	Explore analog modulation and demodulation schemes in time and frequency domain.
CO2	Analyse pulse modulation and demodulation techniques.
CO3	Interpret digital modulation and demodulation techniques.
CO4	Compare the effects of channel noise in analog and digital communication systems.
CO5	Realize spread spectrum and multiple access techniques.

Elements of communication systems; Analog Communication techniques: Amplitude modulation schemes, Power distribution, Angle modulation-frequency and phase, frequency spectrum, Sampling, Quantization, Pulse modulation schemes; Shift keying techniques – frequency, phase and amplitude, Noise in analog and digital communication systems, Detection of signal in noise, Spread spectrum and mobile communications.

References:
1. Simon Haykin, Communication Systems, John Wiley & Sons, (4e), 2009.
2. Tomasi W, Electronic communication systems, Pearson, 2012.
3. Simon Haykin and Michael Moher, Introduction to analog and digital communications, John Wiley & Sons, (2e), 2013.

ICE 2241: ANALOG SYSTEMS LABORATORY [0 0 3 1]

	CO Statements
CO1	Implement amplifier circuits using transistors.
CO2	Design Op-Amp circuits for linear applications.
CO3	Implement Op-Amp circuits for non-linear applications.
CO4	Demonstrate waveform generators using 555 timer.
CO5	Design data converter circuits.

RC Coupled Amplifier, Applications of Op-Amp: Inverting Amplifier, Non-inverting amplifier, Integrator, Differentiator, Voltage follower, Active Filters, Instrumentation amplifier, Precision Rectifier, Schmitt trigger, Multivibrators. Astable/Monostable Multivibrators using IC 555 Timer, Data converters, IC Regulators

References:

1. Albert Malvino, *Electronic Principles,* McGraw Hill, (7e), 1999.
2. Ramakant A. Gayakwad, *Op-Amps and Linear Integrated Circuits,* PHI, (4e), 2015.
3. Sedra and Smith- *Micro Electronic Circuits*, Oxford university press, (6e), 2000.

ICE 2242: MICROCONTROLLERS LAB [0 0 3 1]

	CO Statements
CO1	Analyze data transfer and arithmetic instructions using 8051 Microcontroller.
CO2	Develop code conversion and array handling programs using 8051 Microcontroller.
CO3	Create programs for I/O configuration and waveform generation using 8051 Microcontroller.
CO4	Develop programs for controlling display devices using ARM LPC2148 Microcontroller.
CO5	Interface ARM LPC2148 for controlling motors.

8051 programming for data transfer, arithmetic operations, code conversion, array handling, delay generation and waveform generation. Interfacing of LED, stepper motor, DC motor, seven segment displays, alphanumeric LCD panel and hex keypad to LPC 2148.

References:

1. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, The 8051 Microcontroller and Embedded Systems Using Assembly and C, Pearson Education, (2e), 2007.
2. Kenneth J. Ayala, The 8051 Microcontroller, Cengage Learning, (3e), 2004.
3. Steve Furber, ARM System - on – Chip Architecture, Pearson, (2e), 2015
4. William Hohl, Hinds Christopher, ARM Assembly Language, CRC Press, (2e), 2014.
5. LPC21XX User Manual, 2007.

FIFTH SEMESTER
HUM 3022: ESSENTIALS OF MANAGEMENT [3 0 0 3]

	CO Statements
CO1	Understand the roles of managers, principles of management, managerial skills, and strategies required to run a business successfully with social and ethical responsibilities
CO2	Develop an organizational structure and plan for manpower in a given business organization
CO3	Apply leadership and motivational theories in the organizational contexts
CO4	Acquire budgetary skills through process and techniques of controlling
CO5	Differentiate the managerial practices internationally; Prepare a business plan by identifying business opportunities, conducting market analysis and preparing feasibility reports; Business Ethics, Ethical and Social Responsibilities

Definition of management and systems approach, Nature & scope. The Functions of managers, Principles of Management. Planning: Types of plans, steps in planning, Process of MBO, how to set objectives, strategies, policies and planning premises, Strategic planning process and tools. Nature and purpose of organizing, Span of management, factors determining the span, Basic departmentation, Line and staff concepts, Functional authority, Art of delegation, Decentralization of authority. HR theories of planning, Recruitment, Development and training. Theories of motivation, Special motivational techniques. Leadership – leadership behavior & styles, Managerial grid. Basic Control Process, Critical Control Points & Standards, Budgets, Non-budgetary control devices. Profit and Loss control, Control through ROI, Direct, Preventive control. PROFESSIONAL ETHICS - Senses of Engineering Ethics, Variety of moral issues, Types of inquiry, Moral dilemmas, Moral Autonomy, Kohlberg's theory, Gilligan's theory, Consensus and Controversy, Models of professional roles, Theories about right action, Self-interest, Customs and Religion, Uses of Ethical Theories. GLOBAL ISSUES - Managerial practices in Japan and USA & application of Theory Z. The nature and purpose of international business & multinational corporations, unified global theory of management, Entrepreneurship and writing business plans. Multinational Corporations, Environmental Ethics, Computer Ethics, Weapons Development, Engineers as Managers, Consulting Engineers, Engineers as Expert Witnesses and Advisers, Moral Leadership, Code of Conduct, Corporate Social Responsibility.

References:

1. Harold Koontz & Heinz Weihrich (2020), "Essentials of Management", McGraw Hill, New Delhi.
2. Peter Drucker (2004), "The practice of management", Harper and Row, New York.
3. Vasant Desai (2007), "Dynamics of entrepreneurial development & management", Himalaya Publishing House.
4. Poornima M Charantimath (2006), "Entrepreneurship Development", Pearson Education.
5. Mike W. Martin & Ronald Schinzinger (2003), "Ethics in engineering", Tata McGraw Hill, New Delhi.
6. Govindarajan M, Natarajan S, & Senthil Kumar V S (2004), "Engineering Ethics", Prentice Hall of India, New Delhi.
7. R. S. Nagarazan. (2004), "A text book on professional ethics and human values", New age international publishers, New Delhi.

ICE 3121: INDUSTRIAL AUTOMATION & DRIVES [3 1 0 4]

	CO Statements
CO1	Illustrate AC-DC drives and interfacing with PLC
CO2	Analyse the architecture of industrial computers and program them for diverse applications.
CO3	Analyse various industrial communication protocols.
CO4	Develop the drive logics for the motor control using PLC.
CO5	Interpret the architecture of DCS, communication in DCS and its application.

Drives, Computers in Process Control, Interface and Backplane Bus Standards for Instrumentation Systems, Programmable Logic Controller (PLC), Ladder logic Programming, Alternate Programming Languages, Distributed Control Systems (DCS), PLC Maintenance, Interface and Backplane Bus Standards, Field bus, HART protocol, Smart transmitters, Valves and Smart actuators, Communications for DCS

References:

1. John. W. Webb Ronald A Reis, Programmable Logic Controllers - Principles and Applications, PHI, (4e). 1998.
2. Lukcas M.P, Distributed Control Systems, Van Nostrand Reinhold Co., 1986.
3. Frank D. Petruzella, Programmable Logic Controllers, MGH, (2e), 1997.

ICE 3122: VLSI DESIGN [3 0 0 3]

	CO Statements
CO1	Interpret the working of MOSFETs and integrated circuits with CMOS fabrication technology.
CO2	Analyze electrical properties of MOSFETs.
CO3	Implement combinational and sequential circuits using CMOS logic.
CO4	Analyze VLSI design problems with programmable logic devices.
CO5	Evaluate working of integrated circuits using different testing techniques.

Introduction to integrated circuit technology, CMOS logic, fabrication techniques, basic electrical properties of MOS circuits, CMOS circuit design processes and design parameters, Delay estimation, stick diagrams, VLSI Design methodologies, problems associated with VLSI Design, Design for testability.

References:

1. Douglas A. Pucknell & Kamran Eshraghian, Basic VLSI Design, Prentice-Hall of India, 1995.
2. Neil H.E. Weste, David Harris, Ayan Banerjee, CMOS VLSI Design, A Circuits and Systems Perspective, Pearson Education, 2006.
3. Sung-Mo Kang, Yusuf Leblebici, CMOS Digital Integrated Circuits Analysis and Design Tata Mc-Graw-Hill, 1993.
4. John P. Uyemura. Introduction to VLSI Circuits and Systems, Wiley Publishers, 2001.
5. Jab M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, Digital Integrated Circuits: A Design Perspective, Prentice-Hall of India Pvt. Limited, 2003.
6. Michal John Sebastian smith, Application-Specific Integrated Circuits, Pearson Education, 2004.

ICE 3123: PROCESS INSTRUMENTATION AND CONTROL [3 0 0 3]

	CO Statements
CO1	Analyse the basics of process modelling and control
CO2	Interpret the operation of different controller modes
CO3	Implement analog and pneumatic controller circuits
CO4	Tune the controllers using classical and performance-based methods
CO5	Interpret advanced control strategies

Process control terminology – mathematical model, self-regulation, control actions, control modes, electronic controllers, Two Degrees of Freedom PID controllers, Anti-Reset windup, I/P converter, Control Valves, performance based controller design, tuning, advanced control strategies, multivariable control, RG Analysis, model based controller design.

References:

1. Stephanopoulis, G, Chemical Process Control, Prentice Hall of India, New Delhi, 1990.
2. Eckman. D.P., Automatic Process Control, Wiley Eastern Ltd., New Delhi, 1993.
3. Curtis D. Johnson, Process Control Instrumentation Technology, (8e) PHI, 2009.
4. Pollard A. Process Control, Heinemann educational books, London, 1971.
5. Harriott. P., Process Control, Tata McGraw-Hill Publishing Co., New Delhi, 1991.
6. Donald Coughanower, Process Systems Analysis and Control, McGraw-Hill Inc., 1991.

FLEXI CORE A1 - ICE 3124: SMART SENSORS [3 0 0 3]

	CO Statements
CO1	Interpret the architecture of smart sensors
CO2	Analyse communication techniques for smart sensing
CO3	Interpret various smart sensor standards
CO4	Analyse smart measurement chains
CO5	Incorporate smart sensors for industrial applications

Introduction: Block diagram of smart sensor, Sensor interface needs, sensor electronics, sensor models, sensor signal enhancement, Compensation schemes, sensor integration, Need for smart sensing, Sensor IQ. Sensor Communication, Standards and Implications of Smart Sensors, Smart Sensor systems: Centralised and decentralised system of the measurement chains, Process control over the Internet, intelligent transportation system- ITS user services, ADAS, Smart grid, case studies.

References:

1. Randy Frank, Understanding Smart Sensors, (2e). Artech House Publications, 2000.
2. Paul W. Chapman, Smart Sensors, ISA Press, 1996.
3. Krzystof Iniewski, Smart Sensors for Industrial Applications, CRC Press, 2013.
4. Raghavendra C S, Sivalingam Krishna, Wireless Sensor Network, Springer, 2004.

FLEXI CORE B1 - ICE 3125: EMBEDDED SYSTEM DESIGN [3 0 0 3]

	CO Statements
CO1	Interpret the fundamentals of embedded systems.
CO2	Interpret the architectural features and instructions of ARM Cortex-M Processor.
CO3	Program ARM Cortex-M.
CO4	Examine RTOS for embedded systems applications.
CO5	Implement control systems for robotic applications.

Introduction to embedded systems, Core of embedded systems and firmware, Architecture of ARM Cortex-M processor, Features and Instructions of ARM Cortex-M, Input/Ouput Programming, Phase-locked loop, Real-time operating systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Communication MicroC/OS II, Robotic systems, PID controller, Fuzzy logic control.

References:

1. Joseph Yiu, The Definitive Guide to the ARM Cortex-M3, 2nd Edition, Newnes, (Elsevier), 2010.
2. Shibu K V, Introduction to Embedded Systems, Tata McGraw Hill Education Private Limited, 2nd Edition.
3. J. W. Valvano, Embedded Systems: Real-Time Operating. Systems for ARM ® Cortex - M Microcontrollers, Volume 3, ISBN: 978-1466468863

ICE 3141: INDUSTRIAL INSTRUMENTATION LAB [0 0 3 1]

	CO Statements
CO1	Implement signal conditioning circuit for measurement of temperature and liquid level.
CO2	Design signal conditioning circuit for measurement of load and pressure.
CO3	Implement signal conditioning circuit for measurement of distance and flow.
CO4	Analyse the performance of differential pressure transmitter, Hall effect transducer, float level transducer and viscometer.
CO5	Analyse amperometric techniques.

Design of measurement system for Temperature, flow, level, pressure, thickness, torque, humidity, vibration, load, distance/ speed/ volume, and object detection using optical sensor.

References:

1. C S Rangan, G R Sharma and V S V Mani, Instrumentation Devices & Systems, TMH, (2e), 2004.
2. E. O. Doeblin, Measurement Systems – Application and Design, McGraw Hill, (4e), 1992.

ICE 3142: PROCESS CONTROL LAB [0 0 3 1]

	CO Statements
CO1	Analyse the operation of Temperature and Flow pilot plants
CO2	Analyse the operation of Pressure and Level pilot plants
CO3	Implement various advanced control techniques
CO4	Design model-based controller for linear and non-linear systems.
CO5	Interface pilot plants with MATLAB / LabVIEW using DAQ systems.

Study of control actions using temperature, flow, pressure and level Control Trainers, Study of Control valve characteristics, cascade control, Feed Forward Control, Ratio Control and gain scheduling control, Empirical model estimation PID tuning, Smith Predictor control, Study of PID control in a heat exchanger system, Study of DAQ system.

References:

1. Curtis D. Johnson, Process Control Instrumentation Technology, PHI, (8e), 2009.
2. Donald R Coughanower, Process Systems Analysis and Control, MGH, (3e), 2017.
3. Wayne Bequette, Process control, Modelling, simulation & Control, PHI, (1e), 2004.

SIXTH SEMESTER

HUM 3021: ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT [3 0 0 3]

	CO Statements
CO1	Compute the worth of money at various points of time
CO2	Apply various depreciation methods in determining the value of an asset
CO3	Describe and apply the basic techniques of financial statement analysis.
CO4	Evaluate the replacement of an existing asset based on standard replacement analysis techniques.
CO5	Evaluate the best alternative in Engineering Economics problems considering risk and safety

Time value of money, Interest factors for discrete compounding, Nominal & effective interest rates, Present and future worth of Single, Uniform, and Gradient cash flow. Related problems and case studies. Bases for comparison of alternatives, Present worth amount, Capitalized equivalent amount, Annual equivalent amount, Future worth amount, Capital recovery with return, Rate of return method, Incremental approach for economic analysis of alternatives, Replacement analysis. Break even analysis for single product and multi product firms, Break even analysis for evaluation of investment alternatives. Physical & functional depreciation, Straight line depreciation, declining and double declining balance method of depreciation, Case Study. Balance sheet and profit & loss statement. Meaning & Contents. Ratio analysis, financial ratios such as liquidity ratios, Leverage ratios, Turn over ratios, and profitability ratios, Drawbacks. Safety and Risk, Assessment of Risk and safety, Case study, Risk Benefit Analysis and Reducing Risk.

References:

1. Chan S. Park, "Contemporary Engineering Economics", 4th Edition, Pearson Prentice Hall, 2007.
2. Thuesen G. J, “Engineering Economics”, Prentice Hall of India, New Delhi, 2005.
3. Blank Leland T. and Tarquin Anthony J., “Engineering Economy”, McGraw Hill, Delhi, 2002.
4. Prasanna Chandra, “Fundamentals of Financial Management”, Tata McGraw Hill, Delhi, 2006.
5. Mike W. Martin and Roland Schinzinger, “Ethics in Engineering”, Tata McGraw Hill, New Delhi, 2003.
6. Govindarajan M, Natarajan S, Senthil Kumar V. S, “Engineering Ethics”, Prentice Hall of India, NewDelhi,2004.

FLEXI CORE A2 - ICE 3221: MICRO ELECTROMECHANICAL SYSTEMS [3 0 0 3]

	CO Statements
CO1	Interpret microelectrochemical systems design consideration
CO2	Design MEMS based devices using finite element analysis tools
CO3	Synthesis MEMS fabrication process and techniques
CO4	Validate MEMS Sensors and Actuators
CO5	Illustrate MEMS characterisation and packaging techniques

Introduction to micro electromechanical systems (MEMS) Microsystem design considerations, MEMS design using COMSOL Multiphysics and finite elements. Microsystem Fabrication Processes and techniques: mask writing, lithography and advanced fabrication processes, MEMS Sensors and Actuators, case studies, Microsystem Characterization and Packaging.

References:
1. Thomas Jones and Nenad Nenadic, Electromechanics and MEMS, Cambridge University Press, (1e), 2013.
2. Tai-Ran-Hsu, MEMS & Microsystems Design and Manufacture, TMH, 2002.
3. Chang Liu, Foundations of MEMS, Pearson International Edition, 2006.
4. Sergey Edward Lyshevski, MEMS and NEMS systems, Devices and Structures, CRC Press, 2002.
5. Stephen D. Senturia, Microsystem Design, Kluwer Academic Publishers, Springer, 2000.

FLEXI CORE B2 - ICE 3222: INTERNET OF THINGS [3 0 0 3]

	CO Statements
CO1	Interpret the architecture of Internet of Things.
CO2	Examine sensors and actuators in IoT and their associated protocols.
CO3	Interpret cloud platforms and their services
CO4	Realize front and back-end programming methods.
CO5	Analyze different programming tools used in IoT applications.

IOT Platform, Interfaces, API, clouds, Architectures of IOT, IOT System components, Role of sensors in IOT, sensor architecture, special requirements, Protocols, IOT cloud platforms, Business models, web security, Security model, Node.js programming for developers, JSON file format. Introduction to Arduino and Raspberry Pi, Node-Red, Interfacing sensors / actuators and accessing clouds. Python for windows, programming, control statement, string operation, list, tuple, tkinter GUI.

References:
1. Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach", Universities Press, 2014.
2. Nasreddine Bouhai, "Internet of Things: Evolutions and Innovations", Wiley, 2017.
3. Bernd Scholz-Reiter, Florian, Michahelles, "Architecting the Internet of Things", Springer, 2011.
4. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press, 2018
5. Qusay F. Hassan, "Internet of Things A to Z: Technologies and Applications", Wiley, 2018.
6. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", Willy Publications, 2013.

FLEXI CORE A3 - ICE 3223: WIRELESS SENSOR NETWORKS [3 0 0 3]

	CO Statements
CO1	Interpret the architecture of wireless sensor network
CO2	Analyse sensor networks
CO3	Design sensor networks using WSN protocols
CO4	Apply the concept of sensor communication technology
CO5	Analyse sensor network platforms

Overview of wireless sensor techniques, Challenges for Wireless Sensor, Enabling Technologies, Architectures, Networking sensors: Physical Layer and Transceiver Design Considerations, MAC Protocols for Wireless Sensor Networks, WSN protocols: IEEE 802.15.4 MAC – Zigbee, Wakeup Radio Concepts, Address and Name Management, Assignment of MAC Addresses, Routing Protocols- Energy-Efficient Routing, Geographic Routing, Introduction to Time Synchronization, Localization and Positioning, Sensor Tasking and Control. Sensor network platforms and tools: Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms, Node-level Simulators, State-centric programming, Tiny OS for WSN and IOT, M2M communication, Alljoyn network, Case studies. Wired Equivalent Privacy (WEP) and Wi-Fi Protected Access (WPA)

References:

1. Holger Karl & Andreas Willig, Protocols and Architectures for Wireless Sensor Networks, John Wiley, 2005.
2. Feng Zhao & Leonidas J. Guibas, Wireless Sensor Networks- An Information Processing Approach, Elsevier, 2007.
3. Kazem Sohraby, Daniel Minoli, & Taieb Znati, Wireless Sensor Networks- Technology, Protocols and Applications, John Wiley, 2007.
4. Anna Hac, Wireless Sensor Network Designs, John Wiley, 2003.

FLEXI CORE B3 - ICE 3224: DIGITAL IMAGE PROCESSING [3 0 0 3]

	CO Statements
CO1	Explore the fundamental concepts of digital image processing and mathematical transforms.
CO2	Analyze various image enhancement and restoration techniques.
CO3	Analyze various image compression and coding techniques.
CO4	Analyze various image segmentation techniques.
CO5	Develop algorithms for various digital image processing applications.

Digital image fundamentals, Intensity transformations, Spatial filtering, Fuzzy techniques for intensity transformations, Filtering in frequency domain, Image restoration, Various noise models, Inverse filtering, Image Segmentation using thresholding, region growing, clustering and superpixels.

References:

1. Rafael C Gonzalez, Richard E Woods, Digital Image Processing, Pearson, (4e), 2018.
2. Anil K. Jain, Fundamentals of Digital Image Processing, Pearson, (1e), 2015.

ICE 3241: CONTROL AND SIGNAL PROCESSING LAB [0 0 3 1]

	CO Statements
CO1	Develop MATLAB programs for time domain and steady state analysis.
CO2	Design Lag and Lead compensator for given specifications.
CO3	Implement controllers on various hardware kits.
CO4	Analyse signals and systems in time and frequency domain.
CO5	Implement IIR and FIR filters for a given specification.

Time domain analysis, and steady state errors, Compensator design, PID controller design, State - space analysis, System modeling and controller design for dynamic systems, Convolution, DFT computation and filter design.

References:

1. K. Ogata, Modern Control Engineering, PHI, (5e), 2011.
2. R.C. Dorf and R. H. Bishop, Modern Control systems, Wesley Longman, 1998.

3.John G Proakis, Dimitris G Manolakis, Digital Signal Processing, Pearson Education,(4e), 2007

4.Sanjit K Mitra, Digital Signal Processing: A Computer - Based Approach, McGraw Hill Education,(4e), 2013

5. Thomas J. Cavicchi, Digital Signal Processing, Wiley, 2009

ICE 3242: INDUSTRIAL AUTOMATION LAB [0 0 3 1]

	CO Statements
CO1	Analyse basic operations on various industrial PLC.
CO2	Implement timer and counter operations.
CO3	Design front panel for benchmark process stations using SCADA.
CO4	Develop logics for controlling various motors using PLC.
CO5	Interface HMI with PLC in real-time.

Implementation of logic gates, flip flops, multiplexers and de multiplexers, Timers, Counter, Compare, arithmetic instructions in L&T and Siemens PLCs, study of ON/OFF control simulation using delta DIAView SCADA, Interfacing process station with HMI, Real time implementation of PLC with SCADA, Control of bottle filling station and conveyor control using PLC, Motor control with VFD and VVFD, Understanding features of CENTUM DCS, interfacing process stations with DCS.

References:

1. John. W. Webb Ronald A Reis, Programmable Logic Controllers - Principles and Applications, PHI, (4e), 1998.
2. Lukcas M.P, Distributed Control Systems, Van Nostrand Reinhold Co., New York, 1986.
3. Yokogawa Centum VP R6 Manual: https://web-material3.yokogawa.com/TI33J01A11-01EN.pdf
4. Yokogawa Centum VP R6 Manual: https://web-material3.yokogawa.com/TI33J01A10-01EN.pdf

ICE 3243: VIRTUAL INSTRUMENTATION LAB [0 0 3 1]

	CO Statements
CO1	Execute arithmetic and logical operations using LabVIEW fundamentals.
CO2	Develop modular programs with loops and shift registers.
CO3	Create iterative logics for multi data type handling and feedback nodes.
CO4	Execute string operations, structure programming and file management.
CO5	Implement measurement and acquisition using DAQ cards.

Introduction to Lab VIEW, Arithmetic and logical operations, Operations on arrays, Operations on Clusters, Operations using Loops, Types of structures and operations using them, Types of Graphs and use of graphs and timing pallets, Operations using strings and file I/O, Basics of Imaq vision, Measurement and automation explorer, Simulation of DAQ, acquisition and control using USB DAQ, NI c-RIO and PXI.

References:

1. Jovitha Jerome, Virtual Instrumentation using LabVIEW, PHI learning, 2010.
2. Gary Johnson, LabVIEW Graphical Programming, McGraw Hill, (2e), 1997.

MINOR SPECIALIZATION

Minor: I Control Systems

ICE 4401: MODERN CONTROL THEORY [3 0 0 3]

	CO Statements
CO1	Model systems in State variable representation and obtain transfer function
CO2	Perform Similarity transformation to obtain canonical forms
CO3	Evaluate time response, stability, controllability and observability
CO4	Design LTI systems in State variable forms using Pole placement technique
CO5	Design state observer

State Space Analysis, Phase variable and canonical form representation, Derivation of state models, Stability analysis, Eigen values, Eigen vectors, Solution of state equations, Cayley Hamilton theorem, Controllability and observability, Pole placement, Observer design,

References:

1. K. Ogata, Modern Control Engineering, Prentice Hall India, (5e), 2011.
2. Nagrath and Gopal, Control System Engineering, New age international Limited, (2e), 1984.
3. M Gopal, Control Systems Engineering: Principles and Design, McGraw Hill, (4e), 2012.
4. Thomas Kailath, Linear Systems, Prentice-Hall, 1980

ICE 4402: NONLINEAR CONTROL THEORY [3 0 0 3]

	CO Statements
CO1	Grasp nonlinear system behaviour, perform linerization and analyse systems using Phase plane technique
CO2	Analyse stability of equilibrium point using describing function method.
CO3	Apply Lyapunov stability criteria and construct of Lyapunov functions
CO4	Interpret feedback linearization and assess internal dynamics of nonlinear systems.
CO5	Interpret various advanced control design procedure for nonlinear systems.

Non Linear Systems, Phase plane analysis, Construction of the phase trajectory, Describing function, Lyapunov's stability analysis, Sylvester's criterion, Lyapunov theorems of stability, Lyapunov function for continuous time state equations. L stability, L stability of state models, L2 gain, feedback systems, small gain theorem, Feedback linearization, Internal dynamics, Zero dynamics, State feedback control- Stabilization, Tracking, Sliding mode Control, sliding surfaces, continuous approximations of switching control laws, Modelling performance trade off. Lyapunov based controller design, back stepping algorithm.

References:

1. H.K. Khalil, Nonlinear Systems, (3e), PHI, 2002.
2. R. Marino and P. Tomei Nonlinear Control Design - Geometric, Adaptive and Robust, Prentice Hall, 1995.
3. J.J.E. Slotine and W.Li, Applied Nonlinear control, Prentice Hall, 1998.
4. Alberto Isidori, Non-linear Control Systems, Springer Verlag, 1999.
5. Zoran Vukic, Ljubomir Kuljaca, Nonlinear Control Systems, Marcel Dekker Inc., 2003.

ICE 4403: DIGITAL CONTROL SYSTEMS [3 0 0 3]

	CO Statements
CO1	Develop Pulse transfer functions of systems involving sampler and zero order hold, Apply block diagram reduction technique for different configuration
CO2	Anayse time domain response, steady state error and stability of discrete time systems
CO3	Interpret stability of discrete time systems using Root locus and frequency domain plots and design compensators and PID controllers
CO4	Represent systems in discrete time state variable models, transform to various canonical forms, obtain response and analyse stability.
CO5	Design pole placement controller design for discrete time systems in state variable form.

Sampling, Data acquisition, Quantization, sample and hold, zero order hold, frequency domain consideration in sampling and reconstruction, Difference equations, pulse transfer function, Block diagram analysis of sample data systems, time response of discrete time control systems, Steady State error analysis, Stability, Jury's stability test, bilinear transformation, Root locus technique, W transformation, Bode Plot. Nyquist Stability analysis, Design of Lag, Lead, Lag-lead compensator using root locus and Bode plot, Design of PID controller, Lyapunov Stability Analysis, State Space Analysis, Diagonalization, Solution of state equations, Controllability, Observability, Representation of the system in different canonical forms, Pole Placement-Ackermann's Formula, Dead beat Algorithm.

References:

1. K. Ogata, Discrete time control systems, PHI, (7e), 2011.
2. M. Gopal, Digital control and state variable methods, TMH, 2001.
3. C.H Houpis and G.B Lamont, Digital Control Systems – Theory and Hardware, MGH, 1992.
4. G.F.Franklin, J.David Powell, M. L.Workman, Digital Control of Dynamic Systems, A-Wesley Publishing Company, (2e), 1990.
5. V. I. George and C.P. Kurian, Digital Control Systems, Cengage publishers, 2012.

ICE 4404: SYSTEM IDENTIFICATION [3 0 0 3]

	CO Statements
CO1	Explore the concept of the identifiability and identification procedure.
CO2	Model LTI systems using Time and Frequency domain Techniques.
CO3	Estimate transfer function and correlation models
CO4	Realize structures of autoregressive analysis and its types
CO5	Implement and validate output error models.

Introduction to system modeling, Types of system models, Importance of system models, Model development techniques – first principle based and data driven based, Introduction to System Identification, Procedure for identification, Concept of Identifiability, Signal to Noise Ratio, Overfitting, LTI System Modeling using time and frequency, Direct impulse response identification, Direct step response identification, Impulse response Identification using step response, Empirical Transfer function Identification, Correlation Methods, Linear Regression, Least Square Estimation, Equation Error Models – ARX Models, ARMAX Models, ARIMAX Models, OE Models, Box Jenkins Model, Model Validation Techniques.

References:

1. L. Ljung, System Identification: Theory for the User, Prentice Hall, 1992.
2. Arun. K. Tangirala, Principles of System Identification Theory and Practice, CRC Press, 2016.

3. Karel. J. Keesman, System Identification – An Introduction, Springer, 2011.
4. Philip D. Cha, Fundamentals of Modeling and Analyzing Engineering Systems, Cambridge, 2000.

Minor:II SENSOR TECHNOLOGY

ICE 4405: SENSOR DESIGN [3 0 0 3]

	CO Statements
CO1	Grasp the basic sensor characteristics
CO2	Interpret the concept of multi spectral sensors
CO3	Design the dedicated sensor system
CO4	Develop the CONOPS system for targeted techniques.
CO5	Analyze and design sensor packaging

Review of basic performance characteristics of sensors, Fractional order elements and electrochemical sensor design, Design and development of a dedicated sensor system: Requirement analysis; Definition of technical and functional requirements; Cost analysis; Development of a measurement system prototype using necessary tools, Practical realization of a sensor system; Planning and documenting. Factors Influencing Sensor-based System Design. Limited field trials and sensor calibrations. Case studies of novel sensor design. Multi-spectral sensor Concept of Operation (CONOPS) development, sensor requirements allocation and derived requirement development, Sensor Architecture development, hardware and software partitioning, functional and physical interface requirements and design, signal processing requirement definition, subcomponent performance modeling and testing, observable measurement definition, Key sensor design trade parameters, Multi-spectral sensor systems design methodology, Modern target tracking techniques. Design of sensor packaging, installation and wiring considerations based on hazard classifications. Safety considerations in sensor design and commissioning.

Reference:

1. Jacob Fraden - Handbook of Modern Sensors, Physics, Designs, and Applications, Springer, 2010.
2. T. Grandke, W. H. Ko, Sensors: Fundamentals, Volume 1, Wiley publisher, 1990.

ICE 4406: BIOSENSORS AND BIOMEMS [3 0 0 3]

	CO Statements
CO1	Analyze use of bio recognition elements in biosensors design
CO2	Analyze various bioconjigation chemistries in biosensors design
CO3	Analyze use of various transduction platforms in biosensing application
CO4	Interpret microfabrication processes in biosensor and lab on chip design
CO5	Design the layout of novel biosensing systems

Bio-recognition elements: Whole cells, Enzymes, Antibodies, Nucleic Acids, Aptamers and Molecularly Imprinted Polymers. Nanostructured substrates for biosensing and integration of the bio-recognition elements on the substrates. Transduction Platforms: Electrochemical, Optical, Mass, Thermal, Hybrid and Lateral Flow Assays. Fundamentals of microfabrication, Lab on chip for biosensing applications and case studies.

References:

1. Mohamed Gad-el-Hak (R), MEMS handbook, CRC Press, 2002.
2. Anthony P.F.Turner, Isao Karube and George S. Wilson, Biosensors: fundamentals and applications, Oxford University Press, 1987.

3. A Sadana, Engineering biosensors: kinetics and design applications, Academic Press, 2002.
4. D Voet & JG Voet, Biochemistry, J Wiley & Sons, 1990.

ICE 4407: MULTI SENSOR DATA FUSION [3 0 0 3]

	CO Statements
CO1	Interpret the concept of sensor and data fusion
CO2	Grasp and evaluate the role of agents and how it is related to various environments
CO3	Apply concept of data association and decision making
CO4	Describe data fusion frameworks
CO5	Illustrate data filtering techniques

Concept of fusion, Role of fusion, comparison between sensor and data fusion, fusion types, I/O types, Sensor configuration, Architecture of fusion nodes, fusion topologies, Benefits of fusion. Fusion Architectures - Centralized Fusion, Distributed Fusion, Hybrid Fusion, Introduction to process of data fusion: Need for data refinement, Spatial alignment, Temporal alignment, Semantic and radiometric alignment, Concept and need for data association and decision making, data registration, data association techniques, Decision making techniques - Biological and puzzle solving types, Command and control, Evidence combination, Information requirement for decision making. Bayesian and Dempster–Shafer Fusion Methods - Bayesian Method, Bayesian Method for Fusion of Data from Two Sensors, Dempster–Shafer Method, Comparison of the Bayesian Inference Method and the Dempster–Shafer Method. JDL framework, Revised JDL, Dasarathy's model, Boyd model, Thompolus framework, Luo-Key framework, Pau's framework, Waterfall and omnibus framework, Distributed black box, Esteban framework. Introduction to data filters, Kalman filter, Baysien filter, extended information filter, estimation, Approximate agreement, Optimization filter, Distributed dynamic fusion, Dynamic data flow analysis

References:

1. David L. Hall, Mathematical Techniques in Multisensor Data Fusion, Artech House, 2004.
2. H B Mitchell, Data Fusion: Concepts and Ideas, Springer Publishers, 2012.
3. Multi Sensor Data Fusion with MATLAB, Jitendra R. Raol, CRC Press, 2009.
4. Sensor and Data Fusion, Lawrence A. Klein, (2e), SPIE Press, 2012.

ICE 4408: AUTOMOTIVE SENSORS [3 0 0 3]

	CO Statements
CO1	Demonstrate the application of electronics and sensing in automobiles
CO2	Interpret and evaluate the role of sensors in power train and chassis management
CO3	Apply different measurement principle in vehicle body management
CO4	Acquire the knowledge of sensors in passenger safety systems.
CO5	Analyze and design a real-world vehicle communication

Automotive Management systems, Application areas of electronics in the automobiles, Possibilities and challenges in the automotive industry, Power train sensors, sensors for chassis management, Sensors for vehicle body management, Sensors for automotive vehicle convenience and security systems, Two wheeler and Four wheeler security systems, parking guide systems, anti-lock braking system, future safety technologies, Vehicle diagnostics and health monitoring, Safety and Reliability, Traction Control, Vehicle dynamics control, Air Bag and Seat Belt Pre tensioner Systems, Principal Sensor Functions, Passenger Convenience Systems, Electromechanical Seat, Seat Belt Height, Steering Wheel, and Mirror Adjustments, Central Locking Systems, Electromechanical Window Drives. Enabling Connectivity by

Networking:-In vehicle communication standards (CAN & LIN), Telematic solutions, Portable or embedded connectivity- Endorsing Dependability in Drive-bywire systems - Terminology and concepts, Why by-wire, FLEXRAY, Requirements on cost and dependability, Drive-by-wire case studies- prototype development-future of In vehicle communication.

References:

1. Automotive Electrics, Automotive Electronics: Systems & Components, (5e), BOSCH, 2014.
2. Automotive Sensors Handbook, (8e), BOSCH, 2011.
3. Jiri Marek, Hans-Peter Trah, Yasutoshi Suzuki, Iwao Yokomori, Sensors for Automotive Technology, (4e), Wiley, New York, 2010.
4. John Turner, Automotive Sensors (1e), Momentum Press, New York, 2010.

Minor: III SYSTEMS ENGINEERING

ICE 4409 INTRODUCTION TO SYSTEMS ENGINEERING [3 0 0 3]

	CO Statements
CO1	Introduce systems science and systems engineering theory pertaining to create multidisciplinary solutions for complex systems
CO2	Appreciate and provide insights into key system engineering practices
CO3	Provide an overview of various development life cycle activities pertaining to systems engineering of complex systems
CO4	Analyze the system under development for safety
CO5	Design systems in an end to end manner

Definitions and concepts of system-system science and systems engineering, life cycle stages, definitions of requirement, architecture, design. System analysis, interface management, system integration, system verification, system transition, system validation, system operation, system maintenance, system disposal. Project planning, project management and control, decision management, risk management, configuration management, quality assurance, acquisition/supply, tailoring processes and application. Introduction to system modeling and simulation, lean and agile systems engineering, specialty areas (interoperability/logistics/safety /reliability/maintainability/security/usability)

References:

1. Kossiakof, Alexander and William N. Sweet; Systems Engineering: Principles and Practice, Wiley, 2011.
2. INCOSE Systems Engineering handbook, (4e), Wiley, 2015.
3. System Engineering Book of Knowledge, V 2.6, www.sebokwiki.org, 2022.
4. National Aeronautics and Space Administration, NASA Systems Engineering Handbook, (Rev 1), 2007.
5. Faulconbridge, R. I. and Ryan, M. J, Systems Engineering Practice, Canberra: Argos Press, Revised Edition, 2018.
6. ISO/IEC/IEEE 1528-Systems and Software engineering- System life cycle processes, https://www.iso.org/standard/63711.html
7. Blanchard, Benjamin S., Wolter J Fabrycky Systems Engineering and Analysis, Pearson (5e), 2010.

ICE 4410: SYSTEM ARCHITECTURE AND DESIGN [2 1 0 3]

	CO Statements
CO1	Interpret System architecture and Design Processes
CO2	Appreciate various frameworks, methodologies and approaches for system architecture
CO3	Identify and arrive at the architecture of systems, critique them and learn from them
CO4	Design and create architectures for new or improved systems
CO5	Apply and execute the role of a system architect

Architecture definition, architecture view points, concept analysis, models and views of architecture (functional/behavioral/data/performance etc.) – Structure and behavior-Evaluating candidate architectures-System/subsystem analysis- tradeoff analysis- Architecture frameworks and standards-design progression-architecture domains (software/IT/ Manufacturing/social etc)-architecture heuristics- acquisition management-tailoring processes-industrial design-design for manufacturability-robustness design-patents and intellectual property.

References:

1. Rechtin, E., and M.W.Maier, The art of Systems Architecting, Boca Raton, FL: CRC Press, 2000.

2. Oliver, D. W., T. P. Kelliher, and J. G. Keegan, Jr., Engineering Complex Systems with Models and Objects, McGraw Hill, 1997.

3. Ulrich K. T and S D Eppinger Product Design and Development, 2ed, NY, McGraw Hill Inc, 2000.

4. ISO/IEC/IEEE 42010:2011-Systems and software engineering- Architecture and description, https://www.iso.org/standard/50508.html.

5. 1220-2005-IEEE standard for application and Management of the systems engineering process, https://standards.ieee.org/ieee/1220/3372/

ICE 4411 SYSML AND MBSE [2 0 2 3]

	CO Statements
CO1	Interpret and appreciate the need and advantages of model based approach
CO2	Grasp SysML notation
CO3	Apply various modeling approaches and methodologies
CO4	Design and develop various types of models pertaining to requirements, architecture and design of complex systems
CO5	Design and produce deliverables of the architect needed to define the architecture of a system

Introduction to MBSE-MBSE concepts- MBSE Ontology-Introduction to Object Process modelling OPM- Object process language-Overview of SysML-Block definition diagrams-Internal block diagrams-Use case diagrams-Activity diagrams-Sequence diagrams-State machine diagrams-Parametric diagrams-Requirements diagram-package diagrams-Operational analysis modeling-functional analysis modeling-logical architecture modeling-Physical architecture modeling-architecture frameworks-Case studies of MBSE-MBSE deployment-Introduction to Digital Twins.

References:
1. SysML distilled: A brief guide to the Systems modeling language. Lenny Deligatti-Addison Wesley Professional, (1e), 2013.
2. Jon Holt and Simon Perry, SysML for Systems Engineering- A model based approach. IET 2013.
3. Jean-Luc Voirin, Model based System and Architecture Engineering with the Arcadia Method (Implementation of Model Based System Engineering) ISTE Press, Elsevier, 2017.
4. Dov Dori, Model-Based Systems Engineering with OPM and SysML. Springer, 2016.

ICE 4412 SYSTEM VERIFICATION AND VALIDATION [3 0 0 3]

	CO Statements
CO1	Articulate importance and key aspects of verification /validation in Systems Engineering and Project Management as applied to System design and capability acquisition lifecycles
CO2	Appreciate validation methods, verification methods and categories, configuration baselines and functional and physical configuration
CO3	Compare the types of verification/validation and their contemporary issues
CO4	Develop hierarchical and traceable verification/validation measures for systems-measures of effectiveness/performance(MOEs/MOPs)
CO5	Interpret formal methods of verification

System verification-System validation-various approaches to system validation and verification-inspection/testing/analysis/demonstration-Generation of Test cases using the Markov Chain model-Writing verification/validation plans-introduction to formal methods-formal approaches to system validation/verification-focus on specialty areas(eg.. EMI/EMC)-test automation models (computation/timed automation)-simulation-model checking verification-verification validation activities prescribed in standards for safety critical systems (DO-178C/DO-254/APR4754)

References:
1. Engel, Avner, Verification, Validation and Testing of Engineered Systems, John Wiley & Sons, 2010.
2. Jean Francois Monin, Understanding Formal Methods, Springer, 2003.
3. Jean-Louis Boulanger (Editor), Industrial use of Formal Methods: Formal Verification, Wiley, 2012.
4. Eds. Alex Gorod, Leonie Hallo Vernon Ireland, Indra Gunawan, Evolving Toolbox for Complex Project Management, CRC press, Taylor and Francis Group, Auerbach, 2019.
5. McShea, R. E. Test and Evaluation of Aircraft Avionics and Weapon Systems, (2e), IET, 2010.

Minor IV Smart Transportation System

ICE 4413: Automotive Electronics [3 0 0 3]

	CO Statements
CO1	Grasp and interpret the electrical and electronic system in vehicle
CO2	Illustrate different control strategies in e-vehicle
CO3	Evaluate the different lighting technologies in vehicle
CO4	Analyze different stability program in vehicle

CO5	Analyze the adaptive cruise control in vehicle

Introduction to electric and electronic systems in vehicle, motronic engine-management system, ignition system, Electronic diesel control, system blocks, data processing, Torque controlled EDC, Lighting technology- litronic, headlamp levelling control, adaptive lighting system, cornering lights, Electronic stability program –antilock brake system – control loop, Traction control system – TCS interventions, Adaptive cruise control – Ranging radar, seat belts and seat belt pretensioners, rollover protection systems

References:

1. Bosch, Automotive Electrics and Automotive Electronics. System and components, Networking and Hybrid drive, (5e), Springer view 2014
2. Najamuz Zaman, Automotive Electronics Design Fundamental (1e), Springer 2015.
3. Hillier's, Fundamentals of Motor Vehicle Technology on Chassis and Body Electronics, (5e), Nelson Thrones, 2007.

ICE 4414: In-vehicle Networking [3 0 0 3]

	CO Statements
CO1	Illustrate data communication networks and automotive communication protocols.
CO2	Recognize the fundamentals of vehicular communication networks and standards
CO3	Evaluate the different network topologies in vehiclular communication
CO4	Analyze the concept of automotive network and coupling of network
CO5	Analyze the process of automotive vehicle system and diagnostics protocol

Basics of Data Communication Networks and Automotive Communication Protocols, Need for networks, Types of networks, Need for standards, TCP/IP model, Topologies, Controller Area Network (CAN) Protocol, CAN Higher Layer Protocols and LIN, FlexRay and MOST Protocol, Process of Automotive Fault Diagnostics, Fault Codes, Vehicle Systems (open-loop and closed-loop) On- and Off- Board Diagnostics, OBD-I, OBD-II, Engine Analyzers, Steps taken to diagnose a fault, Diagnostics Protocol-KWP2000, SAE-J1587, SAE-J1708 and Case Study.

References:

1. Gilbert Held. Inter- and Intra-Vehicle Communications, CRC Press, (2007)
2. Behrouz Forouzan. Data Communications and Networking, McGraw-Hill. 2003
3. Ronald k. Jurgen. Automotive Electronics Handbook, McGraw-Hill. 1999

ICE 4415: Intelligent Transportation Systems [3 0 0 3]

	CO Statements
CO1	Analyze different traffic flow and control mechanisms in Intelligent transport systems (ITS).
CO2	Interpret various ITS user services and their functionalities.
CO3	Evaluate traffic and incident management systems.
CO4	Analyze the challenges of ITS planning.
CO5	Apply ITS principles to traffic/incident management, sustainable mobility (TDM, ETC), and road pricing strategies.

Fundamentals of ITS, Definition of ITS, the historical context of ITS from both public policy and market economic perspectives, Types of ITS; Historical Background, Benefits of ITS, Sensor technologies and Data requirements of ITS, ITS User Needs and Services and Functional areas, ITS Architecture, Regional and Project ITS architecture; Concept of operations; ITS Models and Evaluation Methods, ITS applications, Traffic and incident management systems; ITS and sustainable mobility, travel demand management, electronic toll collection, ITS and road-pricing.

References:

1. Mashrur A. Chowdhury, Adel Wadid Sadek, Fundamentals of intelligent transportation systems planning, ARTECH House, 2013.
2. Lawrence A. Klein, Sensor technologies and Data requirements of ITS, Artech House, 2011.

ICE 4416: Advanced Driver Assistance Systems [3 0 0 3]

	CO Statements
CO1	Analyze core principles of Advance driver Assistance system (ADAS).
CO2	Evaluate various techniques employed for object tracking in ADAS systems.
CO3	Evaluate the human factors of vehicle automation.
CO4	Analyze the legal issues and challenges of automated driving technologies.
CO5	Examine the implications of different ADAS technologies for autonomous vehicle.

Advanced driver assistance system, human factors of automated driving systems, human factor of vehicle automation, legal issue surrounding cyber security and privacy on automated vehicle, user perspective on autonomous driving systems, ADAS technology A review on challenges, legal risk mitigation and solutions, localization and mapping for autonomous driving, open pit mine autonomous bot.

References:

1. Chapmann and Hall, Autonomous driving and advanced driver assistance system (ADAS), CRC Press, 2021

2. Dietmar P.F. Möller, Roland E. Haas, Guide to Automotive Connectivity and Cybersecurity: Trends, Technologies, 2017

OTHER PROGRAM ELECTIVES

ICE 4441 ADVANCED SENSOR TECHNOLOGY [3 0 0 3]

	CO Statements
CO1	Interpret advanced sensing techniques and classify sensors and Illustrate various advanced sensing materials used for sensing in different domain
CO2	Design sensor for measuring physical parameters using resistive, capacitive and inductive principles and elabaorate commissioning considerations
CO3	Illustrate Sensors used in Aerospace applications
CO4	Design sensors using Optical, hall effect and chemical principles
CO5	Analyse the implementation of bio sensors and microfluidic sensors.

Features of Advanced sensing techniques, Sensor classifications according to the energy domains, Introduction of advanced sensing materials, Properties (physical, electrical, chemical, and biological) of materials which make it suitable for sensing in different domain. Review of sensors for measurement of temperature, level, pressure and flow. Design and commissioning considerations of such sensors. Optical Sensors: Sources and detectors in optical systems. Aerospace Sensor: Accelerometers: Capacitive, Piezoelectric, Piezoresistive, Thermal, Chemical sensor.

References:

1. Jacob Fraden, Handbook of Modern Sensors: Physics, Designs, and Applications, Springer, 2010.
2. P Ripka, A Tipek, Modern Sensors Handbook, Wiley Publication, 2007.
3. Sabaree Soloman, Sensors Hand Book, MGH, 1998

ICE 4442: ANALYTICAL AND OPTICAL INSTRUMENTATION [3 0 0 3]

	CO Statements
CO1	Grasp the different radiation sources and monochromators used in spectroscopy
CO2	Illustrate functioning of UV, Visible and Infrared Spectrometers
CO3	Assess the working of chromatography and other spectrometers
CO4	Analyze nuclear magnetic resonance principle and related instrumentation systems.
CO5	Understand the principles of sophisticated analytical instruments for microscopy and crystallography and comprehend related case studies.

Optical Instrumentation Systems, UV-Vis Spectroscopy, IR Spectroscopy, Chromatography and mass spectroscopy, Nuclear Magnetic Resonance, Electron Microscopy, Crystallography and elemental analysis, Case studies with sophisticated analytical instrumentation systems.

References:

1. Skooj, Holler, Crouch, Principles of Instrumental Analysis (7e), Cengage Learning India, 2018.
2. R S Kandpur, Handbook of Analytical Instruments, (2e), TMH, 2003.
3. Willard, Merritt, Dean and Settle, Instrumental Methods of Analysis, (7e), CBS Publishers, 1988.
4. J.Wilson & J F B Hawkes, Opto Electronics: An Introduction, (2e), PHI, 1993.

ICE 4443: BIO-MEDICAL INSTRUMENTATION & EQUIPMENT [3 0 0 3]

	CO Statements
CO1	Analyze the concept of bio-potentials and their measurement.
CO2	Explore cardiovascular system and related measurements.
CO3	Analyze various bio signals related to central nervous and muscular systems.
CO4	Grasp the principles of therapeutic equipment and life saving devices.
CO5	Illustrate and Compare the working of modern imaging systems

Bioelectric Potential measurement: Cell structure, basic cell functions, origin of bio-potentials, electrical activity of cells, biological control concept, electrode-electrolyte interface, half-cell potential, polarizable and non-polarizable electrode, The Cardiovascular system: Structure of heart, rhythmicity, Electrocardiograph (ECG), ECG electrodes, vector cardiograph, ECG analysis, Central Nervous System and muscular system Receptors, sensory pathways and motor systems, processing sensory information, neural, neuromuscular, sensory muscular and sensory measurements, biofeedback, evoked response, Electroencephalography (EEG), Therapeutic equipment's and life saving devices Blood flow meter, oximeter, cardiac output measurement, plethysmography, ultrasound therapy unit, nerve stimulators, Modern Imaging systems, Failure in medical devices and prevention, standards for developing medical devices.

References:

1. R.S. Khandpur, Handbook of Biomedical Instrumentation, McGraw Hill, (2e), 2008.
2. Leslie Cromwell, Fred J. Weibell and Erich A. Pfeiffer, Biomedical Instrumentations and Measurements, Prentice Hall, (2e), 2012.
3. J.G. Webster, Medical instrumentation application & design, Wiley, (4e), 2009.
2. Joseph J. Carr & John. M. Brown, Introduction to Biomedical Equipment technology, Pearson education, (4e), 2003.
3. J.G. Webster, Encyclopedia of Medical Devices and Instrumentation, John Willey and Sons, 1988.

ICE 4444: CYBER PHYSICAL SYSTEMS [3 0 0 3]

	CO Statements
CO1	Analyse the building blocks of cyber physical systems.
CO2	Design of synchronous and asynchronous CPS models.
CO3	Analyse the system performance under dynamic conditions.
CO4	Interpret hybrid CPS models with real time scheduling.
CO5	Evaluate secure deployment of CPS.

Overview of cyber physical system, key features, Applications, The Design Process. CPS - Platform components, Synchronous Model, Asynchronous Model: Asynchronous Processes, Asynchronous Design Primitives, Asynchronous Coordination Protocols, Dynamical Systems, Timed Model and Real-Time Scheduling: Timed Processes, Hybrid systems: Hybrid Dynamical Models, Designing Hybrid Systems, Linear Hybrid Automata, Secure Deployment of CPS.

References:

1. Rajeev Alur, Principles of Cyber-Physical Systems, MIT Press, 2015.

2. Lee, Edward Ashford, Sanjit Arunkumar Seshia, Introduction to embedded systems: A cyber-physical systems approach, MIT Press, 2016.
3. Platzer, André. Foundations of Cyber-Physical Systems, Lecture Notes CMU, Carnegie Mellon University, Pittsburgh, PA, USA, 2014.

ICE 4445: DATA STRUCTURES AND ALGORITHMS [3 0 0 3]

	CO Statements
CO1	Grasp the basic structure of C++ program and demonstrate concepts of classes
CO2	Develop C++ programs using inheritance.
CO3	Analyze the concepts of linked list and recursion.
CO4	Interpret the concepts of trees and queues.
CO5	Demonstrate the sorting and searching algorithms.

Structure of C++ Program: Data Types. Basic, user-defined and derived, operators: assignment, arithmetic, relational, logical, increment/decrement, conditional, precedence of operators, manipulators, decision statements, programming control statements, Functions. Main Function, Function Prototyping, Call and return by reference, Inline functions, Default and constant arguments, Pointers, Classes, Inheritance, Linked List Data structure, Linked list traversal, insert function, remove function, Linked list with tail and doubly linked lists, Recursion, Trees, Stacks, Queues, Sorting and searching algorithms: Sorting, Searching, hashing, Radix sort.

References:

1. Nell Dale, C++ Plus Data Structures, Jones and Bartlett Publishers, (4e), 2010.
2. Maria Litvin, Gary Litvin, Programming with C++ and Data Structures, Vikas Publishing House Pvt. Ltd., 2001.
3. E Balagurusamy, Object-oriented Programming with C++, TMH, (2e), 2001.
4. Yashavant P Kanetkar, Let us C++, BPB Publications, 2003.

ICE 4446: DSP ARCHITECTURE AND APPLICATION [3 0 0 3]

	CO Statements
CO1	Interpret the architecture, features, and computational blocks of DSP processors.
CO2	Grasp various addressing modes, on-chip peripherals, interrupts, and pipeline operation of TMS320C54xx processor.
CO3	Implement various DSP algorithms.
CO4	Illustrate interfacing various peripherals to TMS320C54xx processor.
CO5	Elucidate real world applications using DSP processor.

Architectures for Programmable Digital Signal Processing Devises, Data Addressing Capabilities, Address Generation Unit, Programmability and Program Execution, Speed Issues, Features for External Interfacing, Programmable Digital Signal Processors, Architecture of DSP processors, Data Addressing Modes, On-chip Peripherals, Interrupts, Pipeline Operation, Implementation of Basic DSP Algorithm, FIR Filters, IIR Filters, Interpolation and Decimation Filters, FFT Algorithm for DFT Computation, Bit-Reversed Index Generation, Signal Spectrum, Interfacing Peripherals to DSP Devices, External Bus Interfacing Signals. Memory Interface, Parallel I/O Interface, Programmed I/O, Interrupts and I/O, Direct Memory Access (DMA), Synchronous Serial Interface, Multichannel Buffered Serial Port. Applications of DSP Processor.

References:

1. Avatar Singh and S. Srinivasan, Digital Signal Processing Implementations: Using DSP Microprocessors with Examples from TMS320C54xx, Thomson/Brooks/Cole, 2004.
4. B. Venkataramani, M. Bhaskar, Digital Signal Processors: Architecture, Programming and Applications, Tata McGraw-Hill Education, 2002.
5. Sen-Maw Kuo, Woon-Seng Gan Digital Signal Processors: Architectures, Implementations, and Applications, Pearson Prentice Hall, 2005.

ICE 4447: ELECTRONIC MEASUREMENT SYSTEMS [3 0 0 3]

	CO Statements
CO1	Recognize and illustrate functions of different building blocks of electronics measurement systems
CO2	Elucidate digital time measurement and PC based industrial process measurements
CO3	Illustrate different ports and select from them to specific applications
CO4	Interface a measuring system with display unit and controller
CO5	Analyze the subsystems of transmission measurement modules

Signal Conditioning, Instrumentation and isolation amplifiers, analog filters, analog switches. Signal measurement in the presence of noise: synchronous detection, signal averaging. Noise in electronic systems, Digital Time Measurement Techniques Parallel Port Buses: PC based DAS, Data loggers; PC based industrial process measurements like flow, temperature, pressure and level development system, CRT interface and controller with monochrome and colour video display. Transmission measurements.

Reference:

1. Derek Frederick Alfred Edwards, Electronic Measurement Techniques, Butterworths, 1971.
2. T. S. Rathore, Digital Measurement Techniques, CRC Press, 2003.
3. Nihal Kularatna, Digital and Analogue Instrumentation: Testing and Measurement, IET, 2003.

ICE4448 INDUSTRIAL INTERNET OF THINGS [3 0 0 3]

	CO Statements
CO1	Illustrate the concepts of IIoT, Network services, architecture and key enabling technologies
CO2	Design IoT systems using smart sensors
CO3	Investigate different communication protocols
CO4	Explore data exchange file formats, front and back end programming methods
CO5	Design and develop IoT systems using a variety of hardware and software platforms

IOT Vs. IIOT, Components of IIOT -Sensors, Interface, Networks, People &Process, Real life examples, IOT Platform, Interfaces, API, clouds, Data Management, Analytics, Mining &Manipulation; Challenges & Benefits in implementing IIOT. Various Architectures of IOT and IIOT, Industrial Internet - Reference Architecture; IIOT System components: Sensors, Gateways, Routers, Modem, Cloud brokers, servers and its integration, WSN, WSN network design for IOT. Roles of sensors in IIOT, sensor architecture, special requirements for IIOT sensors, types of actuators. Hardwire the sensors with different protocols such as HART, MODBUS-Serial & Parallel, Ethernet, BACNet, Current, M2M etc**.,** Wi-Fi, Wi-Fi direct, Zigbee, Z wave, Bacnet, BLE, Modbus, SPI, I2C, IIOT protocols –COAP, MQTT,6lowpan, lwm2m, AMPQ, IIOT cloud platforms : Overview of cots cloud platforms, predix, thingworks, azure. Data analytics, cloud services, Business models: Saas, Paas, Iaas. Introduction to web security, Conventional web technology and relationship with IIOT, Vulnerabilities of IoT, Privacy, Security requirements, Threat analysis, Trust, IoT security tomography and layered attacker model, Identity establishment, Access control, Message integrity, Non-repudiation and availability, Security model for IoT, Network security techniques, Management aspects of cyber security. Role of Analytics in IOT, Data visualization Techniques, Introduction to R Programming, Statistical Methods. Internet of Things Applications.

References

1. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Willy Publications.
2. Bernd Scholz-Reiter, Florian, Michahelles, "Architecting the Internet of Things", ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer.
3. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press, 2018
4. Qusay F. Hassan, "Internet of Things A to Z: Technologies and Applications", Wiley, 2018

ICE 4449: MACHINE LEARNING FOR CONTROL SYSTEMS [3 0 0 3]

	CO Statements
CO1	Apply the concepts of Machine Learning for Modeling the Linear and Nonlinear Systems
CO2	Apply the reggression techniques for accurate modeling with the dataset available for the modeling and control
CO3	Interpret the state estimation, Kalman filtering along with reinforcement learning concepts.
CO4	Solve for optimal control problem with SVM/SVR
CO5	Illustrate Robust Control, RNN based MPC for the trajectory tracking problems.

Machine learning fundamentals - Support Vector Machines, Kernel methods–Clustering, Principal Component Analysis, Singular Value Decomposition, Independent Component - Analysis semi supervised learning – Reinforcement Learning-Applications to Control Problems: State estimation using neuro observer- Kalman Filter and reinforcement learning - Identification of non-linear dynamical systems using neural networks - Reinforcement learning Modelling - Optimal control problems using support vector machines, regression methods, Monte-Carlo method - Model Predictive Control and Adaptive reinforcement learning - Robust control using differential neural networks - Path planning using dynamic neural networks, density based machine learning techniques - Adaptive control using self-organizing map or RBF networks -Trajectory tracking using dynamic (recurrent) neural networks.

References:
1. Frank Leroy Lewis, Suresh Jagannathan, A. Yeşildirek, Neural Network Control of Robot Manipulators and Non-Linear Systems, Taylor and Francis group, 1999.
2. Frank L. Lewis, Derong Liu, Reinforcement Learning and Approximate Dynamic Programming for Feedback Control, Wiley and IEEE press, 2013.
3. Zi-Xing Cai, Intelligent Control: Principles, Techniques and Applications World Scientific, 1997.
4. Bishop, C. M., Pattern Recognition and Machine Learning, Springer, 2006.
5. Alexander S. Poznyak, Edgar N. Sanchez, Wen Yu, Differential Neural Networks for Robust Nonlinear Control Identification, State Estimation and Trajectory tracking, World Scientific, 2001.
2. Alex Smola, S.V.N. Vishwanathan, Introduction to Machine Learning, Cambridge University Press, 2010.
3. Simon Haykins, Neural Networks and Learning Machines, Prentice Hall, 2009.

ICE 4450: NEURAL NETWORK AND FUZZY LOGIC [3 0 0 3]

	CO Statements
CO1	Analyze the operation of basic neuron, learning algorithms, and supervised models.
CO2	Realize several unsupervised learning models.
CO3	Explore the fundamentals of Fuzzy theory.
CO4	Analyze various fuzzy models employed in fuzzy Inference system.
CO5	Develop fuzzy logic controller for various applications.

Introduction, ANN, BNN and difference between ANN and BNN, McCulloch–Pitts model, Activation functions, Feedforward and feedback networks, Learning rules, Supervised Learning network, Multi-layer Feedforward Networks, Back propagation network, Unsupervised Learning network, Maxnet, Mexican Hat net, Kohonen self-organizing feature map, Vector quantization, Fuzzy sets, Membership functions, Fuzzification, Defuzzification methods, Fuzzy rule base and approximate reasoning, Fuzzy inference systems, Fuzzy logic control system, Applications.

References:
1. Laurence Fausett, Fundamentals of Neural networks, Architecture, Algorithm and Applications, Pearson Education India, (1e), 2004.
2. Timothy J. Ross, Fuzzy logic with engineering applications, John Wiley & Sons, (4e), 2016.
3. S. N. Sivanandan, S. N. Deepa, Principles of soft computing, Wiley India, 2010.
4. B. Yegnanarayana, Artificial Neural Networks, PHI, 2004.

ICE 4451: POWER ELECTRONICS [3 0 0 3]

	CO Statements
CO1	Grasp working and characteristics of thyristors
CO2	Contrast various power electronic devices
CO3	Analyse working of AC-DC converters
CO4	Illustrate the principle of operation of DC-DC converters and AC-AC converters
CO5	Analyse the working of DC-AC converters

Introduction to power electronics, SCR: device structure, characteristics and design, UJT trigger circuits, GTO, Power MOSFET, IGBT, single-phase half converters, single-phase full converters, semi-converters, three-phase half converters, three-phase full converters, dual converters, step-up choppers, step-down choppers, step up/down choppers, morgans' chopper, AC voltage converters, cyclo-converters, bridge inverters, three-phase inverters, series, and parallel inverters.

References:

1. M. H. Rashid, Power Electronics, PHI, (3e), 2005.
2. Ned Mohan, Undeland, Robbins, Power Electronics, John Wiley, (3e), 2002.
3. Bimbhra P.S, Power Electronics, Khanna Publication, (3e), 1999.
4. M. Ramamurthy, Thyristors and their Application, East-West Press, 1977.

ICE 4452: REAL TIME OPERATING SYSTEMS [3 0 0 3]

	CO Statements
CO1	Realize the characteristics of real time operating systems.
CO2	Analyze process management and multithreaded programming models.
CO3	Develop various task scheduling algorithms.
CO4	Analyze classical problems of synchronization
CO5	Apply strategies for handling deadlocks and memory management

RTOS introduction, Essential features of an OS and batch processing, Process scheduling, scheduling queues, Types of schedulers, Multithreaded programming, Threading issues, scheduling criteria and algorithms, synchronization, classical problem of synchronization, deadlocks, methods for handling deadlocks, memory management strategies and virtual memory management.

References:

1. Abraham Silberschatz, Peter Galvvin, Grag Gagne, Operating System principles, John Wiley Publications, (7e), 2006.
2. Allan Burns, Andy Wellings, Real-Time Systems and Programming Languages, Addison Wesley, (3e), 2001.
3. Milan Milenkovic, Operating Stems Concepts and Design, McGraw Hill Education, (2e), 2001.
4. Maurice Bach, Design of Unix Operating System, Pearson, (1e), 1986.
5. Rajib Mall, Real Time Systems, Pearson Education, 2007.

ICE 4453: RELIABILITY AND SAFETY ENGINEERING [3 0 0 3]

	CO Statements
CO1	Grasp the importance of different distribution functions and distributions in reliability engineering
CO2	Illustrate the basic concepts of reliability engineering and analyse the importance of redundancy and maintenance
CO3	Implement the different types of reliability tests
CO4	Explore the basic concepts of safety engineering.
CO5	Analyse and Carry out different types of Safety techniques.

Sampling distributions, Testing of hypotheses, Failure data, Failure modes, Hazard rates and failure density function, Hazard models and bath-tub curve, Reliability of systems, Redundancy, Fault Tree Analysis, Reliability improvement methods, Reliability Tests, Test - retest method, Split half method, Alternate or parallel forms Method, Rational Equivalence Method, Component reliability and MIL standards, Safety policy, Safety Organization, Measurement and prediction of human reliability and operator training, Safety margins in critical devices, Incident Recall Technique, Disaster control, Job Safety Analysis, Safety Audit.

References:

1. Govil, A.K., Reliability Engineering, TMH, 1983.
2. Sinha and Kale, Introduction to Life-Testing, Wiley Eastern, New Delhi, 1992.
3. Wisley, Human Engineering - Guide for Equipment Designers, University of California Press, 1973.
4. Hoang Pham, Handbook of Reliability Engineering, Springer, 2003.
5. Krishnan N.V, Safety Management in Industry, Jaico Publishing House, Bombay, 1997

ICE 4454: ROBOTIC CONTROL SYSTEMS [3 0 0 3]

	CO Statements
CO1	Interpret parts and types of robots used in industrial automation
CO2	Compute the kinematics (direct and inverse) of robot for any serial-link topology
CO3	Design/plan simple trajectory(ies) for any given robot arm
CO4	Model the equations of motion for any given (anthropomorphic) robot system
CO5	Apply the various (classical) control schemes implemented on robotic systems

Robotic Systems: Components and Structures of Robots, Degrees of Freedom and Workspace, Rotation representation, Homogenous Transformations. Types of Joints, Kinematics of Manipulators, Differential transformation and Jacobian, Static force and torque, Trajectory Planning, Dynamics of Manipulators (Lagrangian and Newton-Euler methods), Feedback control of a single link manipulator, PID control of multi-link manipulator, Force control.

References:

1. Mark. W. Spong, Robotics Dynamics and Control, Wiley, (1e), 1989.
4. John. J. Craig, Introduction to robotics – Mechanics and Control, Pearson Education, (4e), 2017.
5. Ashitava Ghosal, Robotics: Fundamental Concepts and Analysis, Oxford Press, (1e), 2006.
6. S.K Saha, Introduction to Robotics, TMH, (1e), 2008.
7. D.K Pratihar, Fundamentals of Robotics, Narosa, (1e), 2017.

ICE 4455: ROBUST CONTROL [3 0 0 3]

	CO Statements
CO1	Grasp the mathematical prerequisites like norms, sensitivity, complementary sensitivity, eigen values, singular values etc
CO2	Analyse uncertainty and model parameter variations with respect to stability
CO3	Design Robust controller via controller parameterisation
CO4	Analyse robust stability and robust performance of the system
CO5	Perfom case studies for modified cases.

Issues in Control System Design, need for Robust control, Norms for signals and systems, Input- Output Relationships, Computing the Norm by State-Space Methods, Eigen values and singular values, Condition for Internal stability, sensitivity and complementary sensitivity function, Asymptotic tracking, Performance, Sources of Model Uncertainties, Plant Uncertainty Model, Small Gain Theorem, Robust Stability, Robust Performance, Trade-off between robust stability and robust performance, Existence of Stabilizing Controllers, Parameterization of All Stabilizing Controllers, Coprime Factorization. Loop shaping Controllers, Shaping S, T, or Q, P^{-1} Stable, P^{-1} Unstable, The Modified Problem, Spectral Factorization, Case Studies-Robust Control for Mass Damper Spring Systems, Spacecraft and Inverted Pendulum.

References:

1. Doyle, J.C., B.A. Francis and A. Tannenbaum, Feedback Control Theory, Macmillan publishing co., 1990.
2. Kemin Zhou, Doyle J.C and Glover K., Robust and Optimal Control, Prentice Hall Inc, 1995.
3. Willian A. Wolovich, Automatic Control Systems, Saunders college publishing, 1994.
4. Kemin Zhou and Doyle J.C, Essential of Robust Control", Prentice Hall Inc, 1998.

OPEN ELECTIVES

ICE 4311: FEEDBACK CONTROL THEORY [3 0 0 3]

	CO Statements
CO1	Apply mathematical modelling techniques to derive transfer functions for electrical and mechanical systems
CO2	Analyze feedback control systems using signal flow graphs and Mason's gain formula
CO3	Interpret and utilize state variable representations of linear systems
CO4	Evaluate control system performance in both time and frequency domains
CO5	Assesss the stability of linear feedback control systems

Feedback control systems, Mathematical modeling, Derivation of transfer functions for electrical networks, Mechanical systems, Signal flow graph, Masons gain formula, State variable representation of linear systems, Solution of state equations, Time domain specifications for second order systems, Steady state errors of unity feedback systems, Definitions of stability, Routh Hurwitz criterion, Frequency response - gain margin, phase margin.

References:

1. Nagrath and Gopal, Control Systems Engineering, New age international Limited, (2e), 1984.
2. Norman S. Nise, Control Systems Engineering, (5e), Wiley India, 2009.
3. R.C Dorf and R.H Bishop, Modern Control Systems, (11e), Addison- Wesley Longman Inc., 2013.

ICE 4312: INDUSTRIAL AUTOMATION [3 0 0 3]

	CO Statements
CO1	Illustrate role of computer in data acquisition and process control
CO2	Grasp PLC architecture and perofrm basic PLC programming
CO3	Develop PLC programming for process applications
CO4	Analyse structure and working of various communication protocols used in automation
CO5	Illustrate the architecture of DCS, SCADA and its application

Evolution of PLC, PLC Vs PC, Architecture of PLC - I/O Modules, CPU, Program Memory, Process Image Tables, Bus System and Power Supply, Sequential Flow Chart technique for programming style, Programming a PLC, Timers & Counters, Special Instructions, Levels of Industrial control, Networking, Buts Networks, Protocols., SCADA & DCS, Profibus, Modbus, SMART devices.

References:

1. John W.Webb and Ronald A.Reis, Programmable Logic Controllers – Principles and Applications, (5e), PHI, 2003.
2. W. Bolton, Programmable Logic Controllers, 94e), Newnes Publications, 2006.
3. Frank D. Petruzella, Programmable Logic Controllers, MGH, 1989.

ICE 4313: INDUSTRIAL INSTRUMENTATION [3 0 0 3]

	CO Statements
CO1	Illustrate the fundamental concepts of industrial Instrumentation
CO2	Describe the working principles of various transducers
CO3	Elaborate the working of instruments used of measurement of temperature, pressure
CO4	Elucidate the instruments used to measure level, thickness and flow
CO5	Illustrate working of instruments used to measure velocity, PH, Force and optical based devices.

Measurement System, Classification of transducers, Temperature and Pressure measurement, Level and Thickness measurement, Flow measurement-Variable head type, variable area type, Mass flowmeters, Measurement of Thermal conductivity, velocity, acceleration, pH and Force, Semiconductor sensors, Optical sensors.

References:

1. E.O. Doeblin, Measurement Systems: Application and Design, McGraw Hill, (5e), 2004.
2. Patranabis D, Principles of Industrial Instrumentation, TMH, (3e), 2005.
3. A.K. Sawhney, A course in Mechanical Measurement and Instrumentation, (7e), Dhanpat Rai and Co, 2002.

ICE 4314: SENSOR TECHNOLOGY [3 0 0 3]

	CO Statements
CO1	Illustrate the basic concepts and fundamentals of sensor technology
CO2	Describe the working principles of sensors for displacement, temperature, force/torque
CO3	Describe the working principles of sensors for Humidity, moisture, flow, acceleration, vibration etc
CO4	Illustrate working of chemical and biosensors, optical and radiation sensors
CO5	Describe wirelelss sensor networks and its application.

Basic sensor technology, characteristics, Capacitive and Inductive Sensors, Displacement Sensors, Temperature Sensors, Force/Torque Sensors, Humidity and Moisture Sensors, Acoustic Sensors, Flow Sensors, Occupancy-Motion Detectors, Acceleration and Vibration

Sensors, Chemical and Biosensors, Optical and radiations Sensors, Introduction to Wireless Sensor Networks (WSN) and Applications.

References:

1. Jon S Wilson, Sensor Technology Handbook, Newnes Elsevier Publication, 2005.
2. Jacob Fraden, Handbook of Modern Sensors: Physical, Designs, and Applications, Springer, 2004.

ICE 4315: SMART SENSOR [3 0 0 3]

	CO Statements
CO1	Illustrate requirements and architecture of smart sensors
CO2	Grasp and compare various smart sensor standards
CO3	Analyse different sensor communication interfaces
CO4	Analyse sensor signal processing and feature extraction techniques
CO5	Demonstrate smart sensor application cases.

MCUs and DSPs, integrated signal conditioning, IEEE1451 standards, Plug and play, Sensor Communication, Wireless zone sensing, Surface acoustical wave devices, Intelligent transportation system, RF-ID, RF MEMS basics, Micro optics, Micro grippers, Microprobes, Micro mirrors, FEDs, Centralized and decentralized measurement chains, Intelligent sensors, Nano sensors, Biosensors

References:

1. Randy Frank, Understanding Smart Sensors, (2e), Artech House Publications, 2000.
2. Paul W. Chapman, Smart Sensors, ISA Press, 1996.
3. Krzystof Iniewski, Smart Sensors for Industrial Applications, CRC Press, 2013.

ICE 4316: VIRTUAL INSTRUMENTATION [3 0 0 3]

	CO Statements
CO1	Illustrate the concept of Virtual instrumentation and compare it with classical instrumentation
CO2	Develop VI, Sub-VI, arrays, clusters, case structures, loops etc using LabVIEW
CO3	Analyse simulation problems on LabVIEW
CO4	Illustrate the basics of instrument control interfaces
CO5	Recognize the real time signal acquisition and processing

Architecture of a virtual instrument, Virtual instruments V/s Traditional instruments, Advantages of VI, Graphical programming, Creating Virtual Instruments using LabVIEW-Loops, Arrays, Clusters, String and file I/O, Graphs, Data Acquisition, Common Instrument Interfaces, Current loop, System buses, Interface buses, VISA, Image acquisition and processing, Design of ON/OFF controller for a mathematically described processes using VI software

References:

1. Gary Johnson, LabVIEW Graphical Programming, (2e), MGH, 1997.
2. Lisa K. wells & Jeffrey Travis, LabVIEW for everyone, National Instruments, 1997.
3. S. Sumathi, P Surekha, LabVIEW based Advanced Instrumentation systems, Springer, 2007.
4. Rick Bitter, Taqi Mohiuddin, Matt Nawrocki, LabVIEW Advanced Programming Techniques, CRC Press, 2007.
5. Jovitha Jerome, Virtual Instrumentation using LabVIEW, PHI, 2010.

ICE 4317: FARM AUTOMATION [3 0 0 3]

	CO Statements
CO1	Grasp various farm operations and their mechanization
CO2	Illustrate agricultural water management system
CO3	Design post harvest processing machines
CO4	Design and analyse automated farm management systems
CO5	Analyse various parameters affecting farming/farm produce through modeling and simulation.

Farm mechanization, sources of farm power, renewable energy sources, IC engines, tillage, sowing, plant protection, intercultural operations, harvesting, threshing, biomass management techniques. Watershed concept and theory, soil erosion, measures, hydrological cycle, irrigation methods, devices, Water conveyance systems, Water harvesting, aquifer and its types, interaction of water resources with the changing environment. Engineering properties of biological materials, heat and mass transfer, devices for cleaning, grading, milling and storage of farm produce. Drying and dehydration, function and features of green house. Resource conservation management, precision farming, automated irrigation scheduling, variable rate seed and chemical applicators, robotics, Rainfall-runoff prediction models, watershed modeling, climate change impact analysis on bio-resources, drying characteristics, storage or process kinetics, simulation and modeling in tillage implements.

References :

1. Jagdshwar Sahay, Elements of Agricultural Engineering, (4e), Standard Publishers Distributors, 2006
2. A. M. Michael & T. P. Ojha, Principles of Agricultural Engineering, Vol I & II., (10e), Jain Brothers, 2018
3. K M Sahay, K. K. Singh, Unit operations of Agricultural Processing, (2e),Vikas Publishing House Pvt Ltd, 2004.
4. Qin Zhang, Francis J. Pierce, Agricultural Automation Fundamental and Practices, CRS Press, Taylor and Francis group, 2013.
5. Darwin Caldwell, Robotics & Automation in the food Industries (Current & Future Technologies), Wood Head Publishing Ltd, Oxford, 2012.
5. A. M. Chandra, S. K. Ghosh, Remote Sensing and Geographical Information System, Alpha Science, 2006