B Tech Curriculum – 2022

Flexible Total Credits: 160/168/180/188
Mandatory Learning Courses (MLC): 12 Credits (2+9+1)
Flexible Core - Choice Based Credit System (CBCS)
Provisions for awarding credits to students for their performance in NCC and Major Projects (optional) - OEs
Scope for Component level Self Directed Learning (SDL) in a few courses
Mandatory Mini Project for Minor Specialization

ACADEMIC YEAR	NO. OF CREDITS	REMARKS
FIRST	22 + 22 = 44	EG-I & EG-II – 1 credit each Universal Human Values & professional ethics– 1 credit Human Rights and Constitution – 1 credit
SECOND	22 + 21 = 43	ODD SEM: Core + Labs EVEN SEM: Core + Labs
THIRD	21 + 21 = 42	ODD SEM: FLEXIBLE Core + Labs + OE EVEN SEM: FLEXIBLE Core + OE + PEs + Labs CHOICE BASED CREDIT SYSTEM FOR CORE COURSES MANDATORY OE - CPI
FOURTH	18 + 13 = 31	ODD SEM: PEs + OE EVEN SEM: Project Work/Practice School, Industrial Training

FIRST YEAR B Tech CURRICULUM 2022 (Common to all branches)

PHYSICS CYCLE

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub. Code	Subject Name	L	T	P	C	Sub. Code	Subject Name	L	T	P	C
I		Engineering mathematics - I	3	1	0	4		Engineering mathematics - II	3	1	0	4
		Engineering Physics	2	1	0	3		Engineering Chemistry	2	1	0	3
		Mechanics of Solids	2	1	0	3		Biology for Engineers	3	0	0	3
		Basic Electronics	2	1	0	3		Basic Electrical Technology	2	1	0	3
		Basic Mechanical Engineering	2	1	0	3		Problem Solving Using Computers	2	1	0	3
		Communication Skills in English	2	0	0	2		Environmental Studies	2	0	0	2
		Universal Human Values and Professional Ethics (MLC)	1	0	0	1		Human Rights and Constitution (MLC)	1	0	0	1
		Engineering Physics Lab	0	0	3	1		Engineering Chemistry Lab	0	0	3	1
		Workshop Practice	0	0	3	1		PSUC Lab	0	0	3	1
		Engineering Graphics - I	0	0	3	1		Engineering Graphics - II	0	0	3	1
		Creativity, Problem Solving & Innovation*(MLC)	1	0	0	--*		Creativity, Problem Solving & Innovation* (MLC)	1	0	0	--*
			15	**5**	**9**	**22**			**16**	**4**	**9**	**22**
	Total Contact Hours (L + T + P)		**29**				**Total Contact Hours (L + T + P)**		**29**			

*After completing a project work along with other activities which are assessed periodically the students would earn 3 credits which would be considered in lieu of an open elective for Fifth semester B Tech

FIRST YEAR B Tech CURRICULUM 2022 (Common to all branches)

CHEMISTRY CYCLE

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub. Code	Subject Name	L	T	P	C	Sub. Code	Subject Name	L	T	P	C
I		Engineering mathematics - I	3	1	0	4		Engineering mathematics - II	3	1	0	4
		Engineering Chemistry	2	1	0	3		Engineering Physics	2	1	0	3
		Biology for Engineers	3	0	0	3		Mechanics of Solids	2	1	0	3
		Basic Electrical Technology	2	1	0	3		Basic Electronics	2	1	0	3
		Problem Solving Using Computers	2	1	0	3		Basic Mechanical Engineering	2	1	0	3
		Environmental Studies	2	0	0	2		Communication Skills in English	2	0	0	2
		Human Rights and Constitution (MLC)	1	0	0	1		Universal Human Values and Professional Ethics (MLC)	1	0	0	1
		Engineering Chemistry Lab	0	0	3	1		Engineering Physics Lab	0	0	3	1
		PSUC Lab	0	0	3	1		Workshop Practice	0	0	3	1
		Engineering Graphics – I	0	0	3	1		Engineering Graphics - II	0	0	3	1
		Creativity, Problem Solving & Innovation (MLC)*	1	0	0	--*		Creativity, Problem Solving & Innovation (MLC)*	1	0	0	--*
			16	**4**	**9**	**22**			**15**	**5**	**9**	**22**
	Total Contact Hours (L + T + P)		**29**				**Total Contact Hours (L + T + P)**		**29**			

*After completing a project work along with other activities which are assessed periodically the students would earn 3 credits which would be considered in lieu of the open elective for Fifth semester B Tech

B Tech in Cyber Physical Systems

Year	THIRD SEMESTER						FOURTH SEMESTER					
	Sub. Code	Subject Name	L	T	P	C	Sub. Code	Subject Name	L	T	P	C
II	MAT ****	Engineering Mathematics - III	2	1	0	3	MAT ****	Engineering mathematics - IV	2	1	0	3
	ICE ****	Core – 1 Analog Electronic Circuits	3	1	0	4	ICE ****	Core – 6 Microcontroller	3	1	0	4
	ICE ****	Core – 2 Digital Logic Design	3	0	0	3	ICE ****	Core –7 Digital Transmission	3	0	0	3
	ICE ****	Core – 3 Computer Architecture and Organization	3	0	0	3	ICE ****	Core – 8 Introduction of Cyber Physical Systems	3	0	0	3
	ICE ****	Core – 4 Data Structures and Algorithms	3	1	0	4	ICE ****	Core – 9 Communication systems	3	0	0	3
	ICE ****	Core – 5 Sensor Technology	3	0	0	3	ICE ****	Core – 10 Control Systems	3	0	0	3
	ICE ****	Lab – 1 Sensors and Circuit Lab	0	0	3	1	ICE ****	Lab – 3 Communication Networks lab	0	0	3	1
	ICE ****	Lab – 2 Data Structure Lab	0	0	3	1	ICE ****	Lab – 4 Microcontroller Lab	0	0	3	1
			17	**3**	**6**	**22**			**17**	**2**	**6**	**21**
	Total Contact Hours (L + T + P)		**26**				**Total Contact Hours (L + T + P)**		**25**			

B Tech in Cyber Physical Systems

Year	FIFTH SEMESTER						SIXTH SEMESTER					
	Sub. Code	Subject Name	L	T	P	C	Sub. Code	Subject Name	L	T	P	C
III	HUM ****	HUM – 1 EOM	3	0	0	3	HUM ****	HUM – 2 EEFM	3	0	0	3
	ICE ****	Core – 11 Cyber Physical system design	3	1	0	4	ICE ****	Flexible Core – 2 (Unsupervised intelligence in CPS/ Design of Safe systems)*	3	0	0	3
	ICE ****	Core – 12 Data Communication and networks	3	1	0	4	ICE ****	Flexible Core – 3 (CPS Interface/ Automation)*	3	0	0	3
	ICE ****	Core – 13 Embedded systems design and programming	3	0	0	3	ICE ****	PE – 1 / Minor Specialization	3	0	0	3
	ICE ****	Flexible Core – 1 (Industry 4.0 / Smart Sensor/ VLSI Design)*	3	0	0	3	ICE ****	PE – 2 / Minor Specialization	3	0	0	3
	ICE ****	OE – Creativity, Problem Solving and Innovation** (MLC) - mandatory	3	0	0	3	ICE ****	OE – 1** (MLC)	3	0	0	3
	ICE ****	Lab – 5 Cyber physical systems design Lab	0	0	3	1	ICE ****	Lab – 7 CPS Interface Lab	0	0	3	1
	ICE ****	Lab – 6 Embedded system programming Lab	0	0	3	1	ICE ****	Lab – 8 Networking lab	0	0	3	1
			18	**2**	**6**	**22**			**18**	**0**	**6**	**20**
	Total Contact Hours (L + T + P)		**26**				**Total Contact Hours (L + T + P)**		**24**			

*Courses of three independent tracks A, B, C

** Performance of students to be recorded in Eighth semester grade sheet

B Tech in Cyber Physical Systems

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 ****	Industrial Training (MLC)				1
	ICE ****	PE – 4 / Minor Specialization	3	0	0	3	ICE ****	Project Work				12
	ICE ****	PE – 5	3	0	0	3	ICE ****	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
	ICE ****	OE – 2** (MLC)	3	0	0	3	ICE ****	B Tech – honours Theory – 3* (VII semester)				4
	ICE ****	Mini Project (Minor specialization)***				8						
			18	**0**	**0**	**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

Minor Specialization

I. Computational Intelligence

ELE **** : Artificial Intelligence
ECE **** : Computer Vision
ECE **** : Machine Learning
ELE **** : Soft Computing Techniques

II. Control Systems

ICE **** : Modern Control Theory
ICE **** : Nonlinear control theory
ICE **** : Digital Control Systems
ICE **** : System Identification

III. Embedded Systems

ECE **** : Embedded System Design
ELE **** : FPGA based system Design
ECE **** : Internet of Things
ELE **** : Real Time Systems

IV. Illumination Technology

ELE **** : Integrated Lighting Design
ELE **** : Lighting Controls: Technology & Applications
ELE **** : Lighting Science: Devices and Systems
ELE **** : Solid State Lighting

V. Sensor Technology

ICE **** : Sensor Design
ICE **** : Biosensors and BioMEMS
ICE **** : Multi Sensor Data Fusion
ICE **** : Automotive Sensors

VI. Systems Engineering

ICE ****: Introduction to Systems Engineering
ICE ****: System architecture and Design
ICE ****: Introduction to SysML and MBSE
ICE ****: System Verification and validation

VII. Signal Processing

ECE **** : Advanced Digital Signal Processing
ELE **** : Digital Image Processing
ECE **** : Digital Speech Processing
ELE **** : Linear Algebra for Signal Processing

VIII. VLSI Design

ECE **** : Analog & Mixed Signal Design
ECE **** : Digital Design Verification
ECE **** : Low power VLSI Design
ECE **** : Semiconductor Device Theory

IX. Business Management

HUM **** : Financial Management
HUM **** : Human Resource Management
HUM **** : Marketing Management
HUM **** : Operation Management

X. Smart Transportation Systems

ICE **** : Automotive Electronics
ICE **** : In-vehicle Networking
ICE **** : Intelligent Transportation Systems
ICE **** : Advanced Driver Assistance Systems

XI. Electric mobility

Other Electives

ICE **** : Cyber Security
ICE **** : Wireless Sensor Technology
ICE **** : Blockchain Technology
ICE **** : Intelligent Manufacturing Automation
ICE **** : Smart Grid
ICE **** : CPS Assurance
ICE **** : Next Generation Networks
ICE **** : Design Of Safe Systems
ICE **** : Virtual and Augmented Reality
ICE **** : Metaverse
ICE **** : Smart Infrastructure
ICE **** : E-Vehicles
ICE **** : Big Data Analytics
ICE **** : Smart Farming and Agriculture
ICE **** : Business Models For Cyber Physical Systems
ICE **** : CPS for internal and external security

Open Electives

ICE **** : Feedback Control Theory
ICE **** : Industrial Automation
ICE **** : Industrial Instrumentation
ICE **** : Sensor Technology
ICE **** : Smart Sensor
ICE **** : Virtual Instrumentation
ICE**** : Farm Automation

THIRD SEMESTER

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Graduates demonstrate proficiency in computation, communication and controls by applying theory to practice for meeting the expectations of industry.

PEO2: Graduates possess capability to take up research work in multi-disciplinary areas with environment protection and safety concern.

PEO3: Graduates are adaptable to diverse working environment, possess good communication skills and leadership quality.

PEO4: Graduates are capable of adopting latest developments by life-long learning with professional and ethical uprightness and socio-economic concerns.

PROGRAMME OUTCOMES (POs)

The graduates of Cyber physical systems will be able to

PO_01: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO_02: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO_03: Design solutions for complex engineering problems and Design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO_04: Having an ability to design and conduct experiments, as well as to analyse and interpret data, and synthesis of information.

PO_05: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO_06: Apply reasoning informed by the contextual knowledge to assess Societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO_07: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO_08: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO_09: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO_10: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO_11: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO_12: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

On completion of B. Tech. in Cyber Physical Systems programme, graduates will be able to

PSO_1: Acquire the ability to identify, investigate, understand and analyse complex problems pertaining to Cyber Physical Systems in industries and identify solution strategies for implementation.
PSO_2: Develop professional skills that prepare them for immediate employment and for life-long learning in advanced areas of Cyber Physical Systems and related domains.
PSO_3: Impart an eagerness to conduct investigation and research in the field of Cyber Physical Systems.

ICE ****: Analog Electronic Circuits [3 1 0 4]

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, Fundamentals of Microelectronics, Wiley, (2e), 2013.
2. A. 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.

ICE ****: Digital Logic Design [3 0 0 3]

Performance metrics of logic families, Binary codes, Boolean Algebra, Karnaugh map, Quine-McCluskey method, Arithmetic circuits, Code convertors, Multiplexers, De-multiplexers, Encoders, Decoders, Comparators, Parity generators and checker. Latches, flip-flops, Synchronous and Asynchronous circuits - Counters, Shift registers, Cycles, Races and Hazards, Finite State Machines, ASM Chart, Timing issues.

References:

1. Donald D. Givone, Digital Principles and Design, MGH, (1e), 2002.
2. M. Morris Mano, Digital Design, PHI, (5e), 2002.
3. C. H. Roth, Fundamentals of Logic Design, Thomson, (6e), 2000.
4. A. Anand Kumar, Switching Theory and Logic Design, PHI, (2e), 2014.

ICE ****: Computer Architecture and Organization [3 0 0 3]

Number Representation and Arithmetic Operations, Character Representation, Memory locations and addresses, Memory operations, Addressing modes, CISC and RISC. Hardware for addition and subtraction, Multiplication, Hardware implementation, Booth's algorithm, Division, Floating point representation, IEEE standard floating-point representation. Bus organization, comparison of hardwired and micro-programmed approach, hardwired control design, Booths multiplier design, Micro-programmed multiplier control unit. Internal organization of memory chips, Structure of Larger Memories, Cache mapping functions, Replacement algorithms, and Virtual memories. Accessing I/O devices, Interrupts, Enabling and disabling Interrupts, DMA. Pipeline Organization, Data dependencies, Handling data dependencies, Hardware multithreading, SIMD Processing, Graphics processing units, Shared memory multiprocessors, Interconnection Networks, Cache Coherence, Write-Through Protocol, Write-Back protocol, Directory-Based Cache Coherence.

References:

1. Carl Hamacher, ZvonkoVranesic and SafwatZaky, Computer Organization and Embedded Systems, (6e), McGraw Hill Publication, 2012.

2. William Stallings, Computer Organization and Architecture – Designing for Performance, (9e), PHI, 2015.
3. Mohammed Rafiquzzaman and Rajan Chandra, Modern Computer Architecture, Galgotia Publications Pvt. Ltd., 2010.

ICE ****: Data Structures and Algorithm [3 1 0 4]

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.

ICE ****: Sensor Technology [3 0 0 3]

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 ****: Sensors and Circuit Lab [0 0 3 1]

Characteristics of sensors and transducers, measurements of temperature, pressure, flow, torque, force, displacement and intensity of light.

References:

1. E.O. Doeblin, Measurement Systems: Application and Design, McGraw Hill, (5e), 2004.

ICE ****: Data Structure lab [0 0 3 1]

Linked list implementation, Implementation of Binary Trees, Implementation of Binary search trees, Application of Stacks, Implementation of Queues, Breadth first search, depth first search, Application of graphs, Bubble sort, insertion sort, Hashing

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.

ICE ****: Microcontroller [3 1 0 4]

Processor 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 and 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, Addison Wesley, (2e), 2000.
4. LPC21XX User Manual, 2007.

ICE ****: Digital Transmission Systems [3 0 0 3]

Introduction to Digital Transmission, Signals and systems, Baseband Pulse Transmission, Carrier Transmission, Synchronization, Communication channels, baseband digital transmission, passband digital transmission, wideband transmission techniques, error-correcting codes, advanced topics.

References:

1. Anderson, John B. Digital transmission engineering. Vol. 12. John Wiley & Sons, 2006.
2. Guimaraes, Dayan Adionel. Digital transmission: a simulation-aided introduction with VisSim/Comm. Springer Science & Business Media, 2010.

ICE ****: Introduction to Cyber Physical System [3 0 0 3]

Principles behind CPS, Concept of Synchronization in Complex Systems, Known Networks II, Graph Theory and CPS Communication Structure, Graph Theory, Eigen structure of Graph Laplacian Matrix, Single Integrator Dynamics and Average Consensus, Leader and Leaderless Cases, Motion Invariants for First-Order Consensus, Comparison of Discrete and Continuous Time Systems, Double Integrator Dynamics, Bipartite Consensus, Time Varying Graphs, Matrix Analysis of Graphs, Control Loops and Importance of Control and Actuation in CPS, Control and Estimation over Lossy and Attacked Networks, Timed Model and Real-Time Scheduling, Hybrid systems, Secure Deployment of CPS.

References:

1. Rajeev Alur, Principles of Cyber-Physical Systems, MIT Press, 2015.
2. E. A. Lee, Sanjit Seshia, Introduction to Embedded Systems – A Cyber–Physical Systems Approach, MIT Press, (2e), 2017.
3. Andre Platzer, Logical Foundations of Cyber-Physical Systems, (2e), Springer Publishing, 2018.

ICE **: Communication Systems [3 0 0 3]**

Elements of communication systems; Analog Communication techniques : Amplitude modulation Schemes, Angle (Non-Linear) Modulation; Pulse Modulation schemes ; Data transmission using analog carriers- Shift Keying techniques ; Channel Encoding & decoding technologies; Conceptual idea of encryption & decryption; Communication Protocols& Networking; Internet of Things; Wireless sensor actuator networks, Applications: Spread Spectrum & Mobile Communications - Optical fiber communication- Digital telephony , Basic principles of Digital TV Broadcasting.

References:

1. Haykin, Simon, and Michael Moher, Introduction to analog & digital communications, John Wiley & Sons. 2007.
2. Haykin, Simon, Communication systems, John Wiley & Sons, (4e), 2008.
3. Stallings, William, Cryptography and network security: principles and practices, Pearson Education India, (4e), 2006.

ICE **: Control Systems [3 0 0 3]**

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, compensator design using root-locus, frequency domain specifications. Correlation between frequency domain and time domain specifications, Bode diagrams, Polar plots, Nyquist stability criterion, compensator design by frequency response approach. State Space Analysis, Phase variable and canonical form representation, Derivation of state models.

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 **: Microcontroller Lab [0 0 3 1]**

8051 Programming - Timer, Serial Port and Interrupt Programming, ARM programming, Peripherals Interfacing to 8051 and 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, Addison Wesley, (2e), 2000.
4. LPC21XX User Manual, 2007.

ICE ****: Communication Networks Lab [0 0 3 1]

Error detection and correction mechanisms, Flow control mechanisms, IP addressing Classless addressing, Observing Packets across the network and Performance Analysis of Routing protocols Socket programming (TCP and UDP) Multi client chatting, Simulation of unicast routing protocols Simulation of Transport layer Protocols and analysis of congestion control techniques in network Develop a DNS client server to resolve the given host name or IP address

References:

1. Computer Networks: A Systems Approach, Larry Peterson and Bruce Davie, (5e), The Morgan Kaufmann Series, Elsevier, 2011.
2. Computer Networking: A Top-Down Approach Featuring the Internet, J.F. Kurose and K. W. Ross, (6e), Pearson Education, 2012.

ICE ****: Cyber Physical System Design [3 1 0 4]

Introduction, Understanding and complexity, information vs data, modelling, Multi-level hierarchies, Communication systems, interface and design, Wireless sensor networks: basics and fundamentals, Cyber-physical systems: basics and fundamentals, Integrating wireless sensor networks and cyber-physical systems: challenges and opportunities, Mobile sensors in wireless sensor network cyber-physical systems, Medical cyber-physical systems.

References:

1. Kopetz, H., and Simplicity Is Complex, Foundations of Cyber-physical System Design, 2019.
2. Zeadally, Sherali, and Nafaa Jabeur, Cyber-physical system design with sensor networking technologies. Institution of Engineering and Technology, 2016.

ICE ****: Data Communication and Networks [3 1 0 4]

Communications Model, Circuit and Packet switching. Switched Communications Networks. Data Link Layer. Error Detection and Correction. Network Layer IPV4 Address Space. Routing Protocols. Transport Layer. TCP and UDP, Application Layer, Case Study, Recent Trends in Network Security.

References:

1. Computer Networks: A Systems Approach, Larry Peterson and Bruce Davie, (5e), The Morgan Kaufmann Series, Elsevier, 2011.

2. Computer Networking: A Top-Down Approach Featuring the Internet, J.F. Kurose and K.W.Ross, (6e), Pearson Education, 2012.

ICE ****: Embedded Systems Design and Programming [3 0 0 3]

Typical embedded system: Core of the embedded system, memory, sensors & actuators, communication interface, Serial/Parallel Communication protocols, Hardware and software co-design: Data-path and controller design, Architecture design; Development Environment: OS and non-OS based firmware embedding techniques; Firmware Design and Development; operating system basics; Embedded development life cycle, Programming concepts, and embedded programming, Real-Time Operating systems and Task Scheduling algorithms, Hardware Software Co-simulation: Co-simulation approaches, Embedded System Development Life Cycle (EDLC).

References:
1. Vahid F and Givargis T, Embedded System Design, Wiley Publication, 2002.
2. Shibu K. V, Introduction to Embedded Systems, McGraw Hill Publication, 2013.
3. Frank Vahid and Tony Givargis, “Embedded system Design – A Unified Hardware/Software Introduction”, Wiley India Pvt. Ltd, 2014.

ICE ****: Industry 4.0 [3 0 0 3]

Introduction, Theoretical background, The concept Industry 4.0, Technologies and functions of the concept Industry 4.0, Technology potential and recommendations for action, Introduction to the Industrial Internet, The Technical and Business Innovators of the Industrial Internet, IIoT, Examining the Access Network Technology and Protocols, Middleware Industrial Internet of Things Platforms, Traditional Simulation Applications in Industry 4.0, Distributed Simulation of Supply Chains in the Industry 4.0 Era: A State of the Art Field Overview, Product Delivery and Simulation for Industry 4.0, IoT Integration in Manufacturing Processes, Smart Combat Simulations in Terms of Industry 4.0, Simulation for the Better: The Future in Industry 4.0.

References:
1. Jan, Bartodziej Christoph, The Concept Industry 4.0: An Empirical Analysis of Technologies and Applications in Production Logistics, 2016.
2. Gilchrist, Alasdair. Industry 4.0: the industrial internet of things. Apress, 2016.
3. Gunal, Murat M, Simulation for Industry 4.0 Past, Present, and Future, Springer 2019.

ICE ****: Smart Sensor [3 0 0 3]

Introduction, Signal conditioning, Separate versus integrated signal conditioning, Digital conversion, MCU control, MCUs for sensor interface, Techniques and Systems Considerations for MCUs, DSP control, Sensor integration, lEEE standards, Plug and play, Automated/ Remote sensing, Process control over the Internet, Other communication standards with case studies, Wireless zone sensing, Surface acoustical wave devices, Intelligent transportation system, RFID, RF MEMS basics, Varactors, Micro optics, Micro grippers, Microprobes, Micro mirrors, FEDs, Data processing, Pattern recognition and classification, Centralized and decentralized system of the measurement chains.

References:
1. Gerard Merjer, Smart Sensor Systems, Wiley Publisher, 2008.
2. Randy Frank, Understanding Smart Sensors, Artech House Publications, 2e, 2000.
3. Paul W. Chapman, Smart Sensors, ISA Press, 1996.
4. Krzystof Iniewski, Smart Sensors for Industrial Applications, CRC Press, 2013.

ICE **: VLSI Design [3 0 0 3]**

CMOS fabrication, Bi-CMOS technology, Basic electrical properties of MOS circuits, Ids – Vds relationship, MOS transistor threshed voltage Vt, Transconductance and output conductance, stick diagrams, Delay estimation, logical efforts, Scaling models and scaling factors, limitation of scaling, Limits of miniaturization. n-MOS CMOS NAND Gates, n-MOS CMOS NOR gates. Combinational circuit design, sequential circuit design, design considerations Full Custom Design, Semi-Custom Design, Programmable Logic structures, Field Programmable Gate arrays (FPGA), Configurable Logic Block (CLB), Application-Specific Integrated Circuits (ASICs), Design for Testability, Faults types and Models, Controllability and Observability, AD HOC Design Techniques.

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.

ICE **: Cyber Physical Systems design Lab [0 0 3 1]**

Communication systems: interface and design, Wireless sensor networks, Cyber-physical systems, integrating wireless sensor networks and cyber-physical systems, Mobile sensors in wireless sensor network cyber-physical systems, Medical cyber-physical systems.

References:
1. Kopetz, H., and Simplicity Is Complex, Foundations of Cyber-physical System Design, 2019.
2. Zeadally, Sherali, and Nafaa Jabeur. Cyber-physical system design with sensor networking technologies, Institution of Engineering and Technology, 2016.

ICE **: Embedded system programming lab [0 0 3 1]**

Programming concepts, and embedded programming, Real-Time Operating systems and Task Scheduling algorithms, Hardware Software Co-simulation: Co-simulation approaches, Embedded System Development Life Cycle (EDLC).

References:
1. Frank Vahid and Tony Givargis, Embedded system Design – A Unified Hardware/Software Introduction, Wiley India Pvt. Ltd, 2014.
2. Shibu K.V, Introduction to Embedded Systems, TMH, New Delhi, 2010.

ICE ****: Unsupervised Intelligence in CPS [3 0 0 3]

Overview of Reinforcement Learning, Comparison of Different Reinforcement Learning Methods, Reinforcement Learning Problems, and Model Based Reinforcement Learning Introduction, Dynamic Programming Principles & Applications, Deep Reinforcement Learning Introduction, Reinforcement Learning for Cyber Security. CASE STUDY, Unsupervised Learning Using Scikit-Learn, Dimensionality Reduction.

References:

1. Chong Li, Meikang Qiu, Reinforcement Learning for Cyber-Physical Systems and Cybersecurity Case Studies, 1st Edition, CRC Press.
2. Ankur A. Patel, Hands-On Unsupervised Learning Using Python, 1st Edition, O'Reilly Media, Inc., March 2019.

ICE ****: Design of Safe Systems [3 0 0 3]

Composition and Compositionality in CPS, Evolving Security, Cybersecurity for Commercial Advantage, Reasoning about Safety and Security: The Logic of Assurance, From Risk Management to Risk Engineering: Challenges In Future Ict Systems, A Design Methodology for Developing Resilient Cloud Services, Cloud and Mobile Cloud Architecture, Security And Safety, Smart Grid Safety And Security, The Algebra Of Systems And System Interactions With An Application To Smart Grid.

References:

1. Griffor, Edward, ed. Handbook of system safety and security: cyber risk and risk management, cyber security, threat analysis, functional safety, software systems, and cyber physical systems. Syngress, 2016.
2. Gullo, Louis J., and Jack Dixon. Design for safety. John Wiley & Sons, 2017.

ICE ****: CPS Interface [3 0 0 3]

Basic Concepts on Systems of Systems, Interfaces in Evolving Cyber-Physical Systems-of-Systems, Emergence in Cyber-Physical Systems-of-Systems (CPSoSs), AMADEOS SysML Profile for SoS Conceptual Modeling, AMADEOS Framework and Supporting Tools, Time and Resilient Master Clocks in Cyber-Physical Systems, Managing Dynamicity in SoS.

Reference:

1. Andrea Bondavalli, Sara Bouchenak and Hermann Kopetz. Cyber-Physical Systems of Systems, Foundations – A Conceptual Model and Some Derivations: The AMADEOS Legacy, Springer, 2016.
2. Vikram Bali, Vishal Batnagar, Cyber-Physical, IoT, and Autonomous Systems in Industry 4.0, CRC Press, 2021

ICE ****: Networking lab [0 0 3 1]

Networking commands, Socket Program for Echo/Ping/Talk commands, File transfer, Remote Command Execution, Create a socket (UDP), Simulation of ARP, Web page downloading, TCP Module Implementation, Implementation of RMI, Implementation of Client in C Server in Java, Case study of routing algorithms.

References:

1. Computer Networks: A Systems Approach, Larry Peterson and Bruce Davie, (5e), The Morgan Kaufmann Series, Elsevier, 2011.
2. Computer Networking: A Top-Down Approach Featuring the Internet, J.F. Kurose and K. W. Ross, (6), Pearson Education, 2012.

ICE ****: CPS Interface Lab [0 0 3 1]

Hours /week: 3 **Number of credits: 1**

CPS Model of an Analog to Digital Converter, Digital to Analog Converter, Implementation Finite state Machine, implantation of Digital Communication Network, Cyber-Physical System Model for Estimation Over a Network, CPS implantation on process loops.

Reference:

1. Andrea Bondavalli, Sara Bouchenak and Hermann Kopetz. Cyber-Physical Systems of Systems, Foundations – A Conceptual Model and Some Derivations: The AMADEOS Legacy, Springer, 2016.
2. Vikram Bali, Vishal Batnagar, Cyber-Physical, IoT, and Autonomous Systems in Industry 4.0, CRC Press, 2021

Minor specialization

ICE ****: Automotive Electronics [3 0 0 3]

Introduction to Electronic systems in Automotives, Sensors and Actuators for body electronics, power train and chassis systems, Power train and chassis control domain, Engine management, Transmission control Battery- types and maintenance, Automotive Electronics, Sensors and Actuators, Basic sensor arrangement, Types of sensors, Electronic Fuel Injection and Ignition Systems, Digital engine control systems, Open loop and closed loop control 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 ****: In-vehicle Networking [3 0 0 3]

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 **: Intelligent Transportation Systems [3 0 0 3]**

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 **: Advanced Driver Assistance Systems [3 0 0 3]**

Introduction to connected, automated and intelligent cars, sensor technology, Sensor Technology for Advanced Driver Assistance System, wireless technology, Overview of Wireless Technology: Wireless System Block Diagram and Overview of Components, Transmission Systems, recent driver assistance system and vehicles, Basics of Theory of Operation, Applications – Legacy, Applications – New, Applications – Future.

References:
1. G. Mullett, Wireless Telecommunications Systems and Networks, Thomson – Delmar Learning, ISNB#1-4018-8659-0, 2006
2. G. Mullett, Basic Telecommunications: The Physical Layer, Thomson – Delmar Learning, ISBN#1-4018-4339-5, 2003
3. Dietmar P.F. Möller, Roland E. Haas, Guide to Automotive Connectivity and Cybersecurity: Trends, Technologies 4. Tom Denton, Automobile Electrical and Electronic Systems.

Electives

ICE **: Cyber Security [3 0 0 3]**

Digital securities-Types Of Cyber Attacks- Privacy Laws-Phishing - Definition And Working Principle, online anonymity-Anonymous Networks-VPN Design And Architecture, cryptography and secure communication-Cryptographic Functions-Disk Encryption Using Open Source Tools, cybercrime issues and investigation-Internet Hacking And Cracking-Digital Laws And Legislation, Law Enforcement Roles And Responses, digital forensics.

References:
1. Nihad Hassan and Rami Hijazi, Digital Privacy and Security Using Windows: A Practical Guide, Apress Publications, 2017
2. Digital Forensics, DSCI - Nasscom, 2012.
3. Cyber Crime Investigation, DSCI - Nasscom, 2013.

ICE ****: Wireless Sensor Technology [3 0 0 3]

Single-Node Architecture, Energy Consumption, Operating Systems and Execution, Optimization Goals and figures of merit, Gateway Concepts, Networking sensors, WSN protocols, Wakeup Radio Concepts, Address and Name Management, Routing Protocols, Time Synchronization, Localization and Positioning, Sensor Tasking and Control, Sensor Node Hardware, Programming Challenges, Node-level software platforms, Node-level Simulators, State-centric programming.

References:
1. Holger Karl & Andreas Willig, Protocols and Architectures for Wireless Sensor Networks, John Wiley, 2012.
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.

ICE ****: Blockchain Technology [3 0 0 3]

Introduction to cryptographic hash functions and cryptocurrencies, Mechanics, Storage and Use of Bitcoins, Bitcoin Mining and Anonymity, Blockchain contracts-Crowd funding, bitcoin prediction markets, smart contracts, blockchain 2.0 protocol projects, wallet development projects, Blockchain Development Platforms and APIs, Blockchain Ecosystem, Ethereum: Turing-Complete Virtual Machine, Blockchain markets and applications, Blockchain economy and variants, Blockchain Challenges, Recent Trends.

References:
1. Melanie Swan, Blockchain: Blueprint for a New Economy, O'Reilly, 2015.
2. Josh Thompsons, Blockchain: The Blockchain for Beginners-Guide to Blockchain Technology and Leveraging Blockchain Programming, 2017

ICE ****: Intelligent Manufacturing Automation [3 0 0 3]

Introduction to Automation and Digital Manufacturing-Automation principles and strategies-- Basic Elements of an Automated System, Levels of Automations, Concepts of Industry 4.0 and Connected Machines, Digital Design and Fabrication, Intelligent Manufacturing Support Systems-Online Predictive Modeling - Monitoring and Intelligent Control of production and Logistics/Supply Chain Processes, Automated Inventory and Production, Automated Inspection and Testing, Intelligent Manufacturing Systems-Artificial Intelligence based systems.

References:
1. Andrew Kusiak, Smart Manufacturing, Publisher, Taylor & Francis, 2018.
2. Mikell P. Grover, Automation, Production Systems and Computer Integrated Manufacturing (2016), Fourth Edition, Pearson Education.
3. William MacDougall, Industrie 4.0: Smart Manufacturing for the Future, Germany Trade & Invest, 2014.

4. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress, 2016.

ICE ****: Smart Grid [3 0 0 3]

Smart Grid Basics-main features and challenges of smart grid, Energy resources - centralized vs. distributed generation- renewable energy- solar, wind, hydropower, biomass, geothermal, ocean wave; Plug-in Electric Vehicle (PEV)-history of EV- PEV challenges and potential solutions- EV and electric power grid, Demand-side management: -load profile of the power grid;-market pricing-peak shaving and valley filling-load forecasting- regulations and policies, Monitoring and Protection.

References:

1. J. Duncan Glover, Mulukutla S. Sarma, and Thomas J. Overbye, Power System Analysis and Design, 4th Ed.,Stamford, CT: Cengage Learning, 2008.
2. Jan Machowski, JanuszBialek, and James R. Bumby, Power Systems Dynamics, Stability and Control, 2nd Ed.New York, New York: John Wiley, 2008.
3. B. Droste-Franke, et al., Balancing Renewable Electricity – energy storage, demand side management, and network extension from an interdisciplinary perspective. Heidelberg, Germany: Springer, 2012.
4. T. Ackermann, Wind Power in Power Systems. New York, New York: Wiley, 2005.

ICE ****: CPS Assurance [3 0 0 3]

Cyber Physical Systems - Risk analysis, Cryptographic Components-Cryptographic components – Hash functions – Asymmetric key cryptography – Digital signatures – Security to state machines – Certified security by design for IOT applications, CPS Assurance-CPS Quality Assurance - Co-Verification Interface Design for High-Assurance CPS - High Assurance Aerospace CPS - Safety Assurance for Machine Learning in CPS , Trust Management in CPS, CPS Secured Implementation, Secure Deployment of CPS, Intelligent CPS.

References:

1. Cyber Physical Systems: Architecture, Protocol and Applications, Edited by Chi (Harold) Liu and Yan Zhang, CRC Press, 2016.
2. Cyber Physical Systems: Foundations, Principles and Applications, Edited by Houbing Song, and others, Elsevier, 2017.
3. Raj Rajkumar, Dionisio De Niz, and Mark Klein, Cyber-Physical Systems, Addison-Wesley Professional, 2016.
4. Rajeev Alur, Principles of Cyber-Physical Systems, MIT Press, 2015.

ICE ****: Next Generation Networks [3 0 0 3]

Introduction to Next Generation Networks, NGN Functional Architecture, NGN Key Development Areas, Corporate Responsibility. 5G Mobile Network, Software Defined Networks, Network Function Virtualization, Recent Trends / Contemporary Issues related to 5G mobile networks / Software Defined Networks/ Network Function Virtualization.

References:

1. Next Generation Networks: Perspectives and Potentials, Dr Jingming Li Salina Pascal Salina, John Wiley & Sons, Ltd, 2007.
2. Fundamentals of 5G Mobile Networks, Jonathan Rodriguez, Wiley, (1e), 2015.
3. Foundations of Modern Networking, William Stallings, Addison-Wesley Professional, (1e), 2015.

ICE ****: Augmented Reality [3 0 0 3]

Introduction of Virtual Reality, Multiple Models of Input and Output Interface in Virtual Reality, Visual Computation in Virtual Reality, Interactive Techniques in Virtual Reality, Development Tools and Frameworks in Virtual Reality, Application of VR in Digital Entertainment, Augmented and Mixed Reality, Taxonomy, technology and features of augmented reality, difference between AR and VR, Augmented reality methods.

References:

1. Burdea, G. C. and P. Coffet. Virtual Reality Technology, Second Edition. Wiley-IEEE Press, 2006.
2. Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann, 2013.

ICE ****: Metaverse [3 0 0 3]

Teaching and learning in the networked society, network learning culture and the emerging paradigm, reflections about reality, systemic thinking and complexity, epistemological conceptions, metaverse: 3D digital virtual worlds, metaverse technology and the nature of 3d digital virtual worlds, second life metaverse, open source metaverses, avatar: building a “digital virtual self”, the construction of a digital virtual identity, representation/action of the “digital virtual self” through the technologicized body, immersion, telepresence, and digital virtual presence in metaverses, presence and proximity, relational presence and social presence, telepresence and digital virtual presence, interaction and interactivity in metaverse, languages and interaction/interactivity forms in metaverse, autopoietic machines: human beings, alopoietic machines: the nature of the metaverse, structural coupling, cognition and socio-cognition in metaverse, doing, understanding, and awareness in metaverse

References:

1. Eliane Schlemmer and Luciana Backes, Learning in Metaverses: Co-Existing in Real Virtuality, IGI Global, 2014.
2. Nelson Zagalo, Leonel Morgado and Ana Boa-Ventura. Virtual Worlds and Metaverse Platforms: New Communication and Identity Paradigms, IGI Global, 2011.

ICE ****: Smart Infrastructure [3 0 0 3]

CPS and IoT, Physical Infrastructures of Cyber Physical Systems, Energy and Reliability Issues in Cyber Physical Systems, Robotics and Smart Systems in Cyber Context, Ubiquitous and Cloud Computing for Monitoring Cyber Physical Systems, Security Issues in Cyber Physical Systems, Role of Cyber-Physical Systems in Big Data Analytics, Social Network Analysis, and Healthcare.

Reference:

1. Gaddadevara Matt Siddesh, Ganesh Chandra Deka, Krishnarajanagar GopalaIyengar Srinivasa, Lalit Mohan Patnaik, “Cyber-Physical Systems A Computational Perspective”, (1e), 2016, CRC Press, Taylor and Francis.

ICE **: E-Vehicles [3 0 0 3]**

Introduction to Electric Vehicles, Electric Drive trains, Power Converters, Electric Motor Drives, Energy storage technologies and Auxiliary systems, Automotive networking and Communication, In-vehicle networks, CAN, ADAS, V2X- Internet of things technologies, M2M communication. Cyber–Physical systems Design for Electric vehicles, Contemporary issues.

References:

1. Iqbal Hussain, "Electric and Hybrid Vehicles-Design Fundamentals", CRC Press, (2e), 2021.
2. Mehrdad Ehsani, Yimin Gao, and Ali Emadi, "Modern Electric, Hybrid and Fuel Cell Vehicles: Fundamentals", CRC Press, (2e), 2018.

ICE **: Big Data Analytics [3 0 0 3]**

Introduction to big data-Characteristic features, Big Data Applications, web data, Modern Data Analytic Tools, Hadoop framework, Data analysis- statistical methods, classification, Mining data streams-Stream data model and architecture, Mining data streams, Real Time Analytics Platform (RTAP) Applications, Big data frameworks.

References:

1. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.
2. Bill Franks, ―Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics‖, Wiley and SAS Business Series, 2012.
3. David Loshin, Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph, 2013.

ICE **: Smart Farming and Agriculture [3 0 0 3]**

Information communication technologies for Agriculture, Automation in Smart agricultural monitoring, Internet of Things practices for Agriculture, Smart Irrigation models, Wireless Sensor Networks Technologies and Applications for Smart Farming, Sustainable Smart-Farming Framework: Smart Farming, Soil monitoring, Pest and weed control.

References:

1. Ramesh C. Poonia, Xiao-Zhi Gao, Linesh Raja, Sugam Sharma, Sonali Vyas, Smart Farming Technologies for Sustainable Agricultural Development, IGI Global, 2018.
2. Internet of Things and Analytics for Agriculture, edited by Pattnaik, Prasant Kumar, Kumar, Raghvendra, Pal, Souvik (Eds), Springer, 2020.

ICE ****: CPS for internal and external security [3 0 0 3]

Introduction to Cyber Physical Systems- Cyber Physical Systems Design Recommendations - CPS system requirements and its Applications. Security and Vulnerabilities-Cyber Security Vulnerabilities, Cyber Security Safeguards, Attacks. Physical Security, Cloud Computing Security, Interconnection- Hardware platforms for Cyber Physical Systems, Policy Issues- Policy issues in security management.

References:

1. John R.Vacca, Computer and Information Security Handbook, (2e), Elsevier 2013.
2. Richard E.Smith, Elementary Information Security, Second Edition, Jones and Bartlett Learning, 2016.