NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY GREATER NOIDA, GAUTAM BUDDH NAGAR

(An Autonomous Institute)

Affiliated to

Dr. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY UTTAR PRADESH LUCKNOW

Evaluation Scheme & Syllabus

For

B. Tech in Electronics & Communication Engineering (ECE)

Third Year

(Effective from the Session: 2026-27)

NOIDA INSTITUTE OF ENGINEERING & TECHNOLOGY, GREATER NOIDA
(An Autonomous Institute)

B. TECH (ECE)
Evaluation Scheme
SEMESTER V

S. No.	Subject Codes	Subject Name	Types of Subjects	Periods			Evaluation Schemes				End Semester		Total	Credit
				L	T	P	CT	TA	TOTAL	PS	TE	PE		
1	BEC0501	Electromagnetic Field Theory and Antenna	Mandatory	3	1	0	30	20	50		100		150	4
2	BCSE0502A	Computer Networks	Mandatory	3	1	0	30	20	50		100		150	4
3	BCSCC0501Y	Design Thinking - II	Mandatory	2	0	0	60	40	100				100	2
4		Departmental Elective - II	Departmental Elective	3	0	0	30	20	50		100		150	3
5		Departmental Elective - III	Departmental Elective	3	0	0	30	20	50		100		150	3
6	BCSE0552A	Computer Network Lab	Mandatory	0	0	4				50		50	100	2
7	BEC0553	Embedded System Design Lab	Mandatory	0	0	2				25		25	50	1
8		Departmental Elective - II Lab	Departmental Elective	0	0	2				25		25	50	1
9	BEC0551X	Wireless Communication Networks	Departmental Elective	0	0	6				50		100	150	3
10	BCSCC0552	Research Methodology, Ethics and Writing	Mandatory	0	0	2				50			50	1
11	BEC0559X	Internship - II	Mandatory	0	0	2				50			50	1
12	BVAC0551	Professional Practice & Employability - I	Compulsory Audit	0	0	6								NA
		*Massive Open Online Courses (For B.Tech. Hons. Degree)	*MOOC's											
			TOTAL	**14**	**2**	**24**	**180**	**120**	**300**	**250**	**400**	**200**	**1150**	**25**

*** List of MOOCs (Infosys) Based Recommended Courses for third year B. Tech Students**

S. No.	Subject Code	Course Name	University/ Industry Partner Name	N. of Hours	Credits
1.	BMC0104	Wireless Evolution and 4G LTE Overview	Infosys Wingspan (Infosys Springboard)	52h 4m	4
2.	BMC0070	C on Linux	Infosys Wingspan (Infosys Springboard)	10h 20m	0.5
3.	BMC0118	Gen AI 101	NASSCOM	15h	1

PLEASE NOTE: -

- **A 3-4 weeks Internship shall be conducted during summer break after semester-IV and will be assessed during semester-V.**
- **Compulsory Audit (CA) Courses (Non-Credit - BVAC0551)**
    - All Compulsory Audit Courses (a qualifying exam) do not require any credit.
    - The Total and obtained marks are not added in the Grand Total.

Abbreviation Used:

L: Lecture, T: Tutorial, P: Practical, CT: Class Test, TA: Teacher Assessment, PS: Practical Sessional, TE: Theory End Semester Exam.
CE: Core Elective, OE: Open Elective, DE: Departmental Elective, PE: Practical End Semester Exam, CA: Compulsory Audit,
MOOCs: Massive Open Online Courses.

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B. TECH (ECE)
Evaluation Scheme
SEMESTER VI

S. No.	Subject Codes	Subject Name	Types of Subjects	Periods			Evaluation Schemes				End Semester		Total	Credit
				L	T	P	CT	TA	TOTAL	PS	TE	PE		
1	BEC0602	Digital Signal Processing	Mandatory	3	1	0	30	20	50		100		150	4
2	BEC0603	IoT Architecture and Protocols	Mandatory	3	1	0	30	20	50		100		150	4
3		Departmental Elective – IV	Departmental E lective	3	0	0	30	20	50		100		150	3
4		Departmental Elective – V	Departmental Elective	3	0	0	30	20	50		100		150	3
5		Open Elective – I	Open Elective	2	0	0	30	20	50		50		100	2
6	BEC0653	IoT Architecture and Protocols Lab	Mandatory	0	0	4				50		50	100	2
7	BEC0652N	Digital Signal Processing Lab	Mandatory	0	0	4				50		50	100	2
8		Departmental Elective - IV Lab	Departmental Elective	0	0	2				25		25	50	1
9	BEC0655	5G Technology	Mandatory	0	0	6				50		100	150	3
10	BEC0659X	Applied Research with Mini Project	Mandatory	0	0	2				50			50	1
11	BVAC0651	Professional Practice & Employability - II	Compulsory Audit	0	0	6								NA
		*Massive Open Online Courses (For B.Tech. Hons. Degree)	*MOOC’s											
			TOTAL	**14**	**2**	**24**	**150**	**100**	**250**	**225**	**450**	**225**	**1150**	**25**

*** List of MOOCs (Infosys Springboard) Based Recommended Courses for third year B. Tech Students**

S. No.	Subject Code	Course Name	University/ Industry Partner Name	N. of Hours	Credits
1.	BMC0129	Data Science for Beginners	NASSCOM	30 h	2
2.	BMC0103	Wireless 5G Overview	Infosys Wingspan (Infosys Springboard)	55h 44m	4
3.	BMC0084	Introduction to ML and AI	Infosys Wingspan (Infosys Springboard)	62h 54m	4

PLEASE NOTE: -

- **A 3-4 weeks Internship shall be conducted during summer break after semester-VI and will be assessed during Semester-VII**
- **Compulsory Audit (CA) Courses (Non-Credit - BVAC0651)**
  - All Compulsory Audit Courses (a qualifying exam) do not require any credit.
  - The Total and obtained marks are not added in the Grand Total.

Abbreviation Used:

L: Lecture, T: Tutorial, P: Practical, CT: Class Test, TA: Teacher Assessment, PS: Practical Sessional, TE: Theory End Semester Exam.
CE: Core Elective, OE: Open Elective, DE: Departmental Elective, PE: Practical End Semester Exam, CA: Compulsory Audit,
MOOCs: Massive Open Online Courses.

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List of Department Elective:

S. No.	Subject Code	Subject Name	Types of Subjects	Bucket Name	Semester
1	BEC0512	Machine Learning	DE-II	Artificial Intelligence	V
2	BEC0517	Data Analytics	DE-III		V
3	BEC0512ZP	AI & ML Lab	DE-II		V
4	BEC0612	Image Processing and Pattern Recognition	DE-IV		VI
5	BEC0615	ANN & Deep Learning	DE-V		VI
6	BEC0612P	Image Processing and Pattern Recognition Lab	DE-IV		VI
7	BEC515N	VLSI Testing and Testability	DE-II	Embedded & VLSI	V
8	BEC0518	Low Power VLSI Design	DE-III		V
9	BEC0518P	Low Power VLSI Design Lab	DE-II		V
10	BEC0616	Real Time Operating System	DE-IV		VI
11	BEC0618	Semiconductor Memories	DE-V		VI
12	BEC0616P	Real Time Operating System Lab	DE-IV		VI
13	BEC0511	Embedded System Design	DE-II	Embedded & Robotics	V
14	BEC0516	Control System & Automation	DE-III		V
15	BEC0516P	Control System & Automation Lab	DE-II		V
16	BEC0616	Real Time Operating System	DE-IV		VI
17	BEC0614	Robotics Design Mechanism	DE-V		VI
18	BEC0616P	Real Time Operating System Lab	DE-IV		VI

NOIDA INSTITUTE OF ENGINEERING & TECHNOLOGY, GREATER NOIDA
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AICTE Guidelines in Model Curriculum:
A student will be eligible to get Under Graduate degree with Honours only, if he/she completes the additional MOOCs courses such as Infosys Springboard/NASSCOM/CISCO (as applicable) certifications, or any other online courses recommended by the Institute (Equivalent to 20 credits). During Complete B.Tech. Program Guidelines for credit calculations are as follows.

1. For 6 to 12 Hours =0.5 Credit
2. For 13 to18 =1 Credit
3. For 19 to 24 =1.5 Credit
4. For 25 to 30 =2 Credit
5. For 31 to 35 =2.5 Credit
6. For 36 to 41 =3 Credit
7. For 42 to 47 =3.5 Credit
8. For 48 and above =4 Credit

For registration to MOOCs Courses, the students shall follow Infosys Springboard/NASSCOM/CISCO (as applicable) registration details as per the assigned login and password by the Institute these courses may be cleared during the B. Tech degree program (as per the list provided). After successful completion of these MOOCs courses, the students shall provide their successful completion status/certificates to the Controller of Examination (COE) of the Institute through their coordinators/Mentors only.

The students shall be awarded Honours Degree as per following criterion.
i. If he / she secures 7.50 as above CGPA.
ii. Passed each subject of that degree program in the single attempt without any grace.
iii. Successful completion of MOOCs based 20 credits

Course Code: BEC0501	Course Name: Electromagnetic Field Theory and Antenna	L	T	P	C
Course Offered in: B.Tech. ECE		3	1	0	4
Pre-requisite: Basic Vector Algebra and electromagnetic spectrum					
Course Objectives:					
The course aims to provide a strong foundation in electromagnetic field theory, including vector calculus, electrostatics, magnetostatics, and Maxwell's equations. It enables students to understand electromagnetic wave propagation and analyze the principles, characteristics, and applications of antennas used in modern communication systems.					

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Develop the ability to apply various coordinate systems and vector calculus in solving problems related to electromagnetic fields.	K3
CO2	Apply the fundamental concepts of static electric and magnetic fields to analyze and solve problems involving charge and current distributions.	K3
CO3	Comprehend Maxwell's equations and explore their applications in electromagnetic theory.	K3
CO4	Analyze fundamental parameters and radiation characteristics of an antenna.	K4
CO5	Evaluate the design, operating principles, and real-world applications of various antenna types for effective electromagnetic radiation and reception.	K5

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	-	-	-	-	-	-	-	-	2	2	2
CO2	3	3	2	-	-	-	-	-	-	-	-	2	2	2
CO3	3	3	2	-	-	-	-	-	-	-	-	2	3	2
CO4	3	3	2	-	-	-	-	-	-	-	-	2	3	2
CO5	3	3	3	-	-	-	-	-	-	-	-	2	3	2

Course Contents / Syllabus

Unit 1	Coordinate Systems and Transformation	9 hours
Coordinates transformation: Cartesian, Cylindrical and Spherical. Vector calculus: Differential length, area and volume, line, surface and volume integrals, Del operator, Gradient, Divergence of a vector, Divergence theorem, Curl of a vector, Stokes's theorem, Laplacian of a scalar.		
Unit 2	**Electrostatic fields and Magnetostatic fields**	**9 hours**
Electric field intensity, Electric field due to charge distribution, Electric flux density, Gauss's Law Maxwell's equations, Continuity equation and relaxation time, boundary conditions, Magnetostatic fields, Ampere's circuit law, Maxwell's equation, magnetic scalar and vector potential, Magnetic boundary conditions.		
Unit 3	**Electromagnetic waves**	**9 hours**
Maxwell's equations in final form, plane wave propagation in different medium: lossy dielectrics, lossless dielectrics, free space and good conductor, wave polarization, Poynting's theorem, radiation from small current element, power density and radiation resistance of short electric dipole and half wave dipole.		
Unit 4	**Antenna fundamental**	**9 hours**
Introduction, Basic antenna parameters, Patterns, Beam area, Radiation intensity, Beam efficiency, Directivity and Gain, Directivity and resolution, Antenna apertures, Effective height, The radio communication link.		
Unit 5	**Practical Antennas**	**9 hours**
The Loop Antenna, Design and its Characteristic, Application of Loop Antennas. Horn Antennas, Helical Antennas, The Log-Periodic Antenna, Design of Microstrip Antenna, Parabolic Reflector Antennas, Feed Methods for Parabolic Reflectors.		

	Total Lecture Hours	**45 hours**

Textbook:

	Authors Name
1. Elements of Electromagnetics	MNO Sadiku
2. Antennas and Wave Propagation	John D Kraus, Ronald J Marhefka and Ahmad S. Khan
3. Antenna Theory Analysis and Design	C. A. Balanis

Reference Books:

Book Title	**Authors Name**
1. Engineering Electromagnetics	W H Hayt and JA Buck
2. Antennas and Wave Propagation	A. R. Harish, M. Sachidananda,
3. Electromagnetic Waves	R. L. Yadava
4. Microwave Engineering	A. Das, Sisir K. Das

Self-Study Content Links:		**Duration (in Hrs)**
MOOCs		
Video Lectures	**Unit 1** https://youtu.be/aOfDF_nGlgU?si=_RaZTCGbB0fJZ4VR	00Hrs29Min
	Unit 2 https://youtube.com/playlist?list=PLgwJf8NK-2e55N-BGrOe2gDzoRLbQJCHh&si=XIlftIdZJA4sos0U	02Hrs40Min
	Unit 3 https://youtu.be/xkhoSLYJjjk?si=bJNhgMp4a84X-RH1	00Hrs30Min
	Unit 4 https://youtu.be/k3GQYBD5hbI?si=BSvHptIj2J4wdyhX	00Hrs37Min
	Unit 5 https://youtu.be/Yo29MI8oieg?si=NWx-Tv15H5-YFh3h	00Hrs17Min
Web References		

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.

Course Code: BCSE0502A	Course Name: Computer Networks	L	T	P	C
Course Offered in B. Tech: CSE/CS/IT /CSE(AI)/CSE(AIML)/ CSE(DS)/ CSE(CYS) /MCT/ECE Semester		3	1	0	4

Pre-requisite: Knowledge of basic computing

Course Objectives:

The course aims to provide students with a comprehensive understanding of computer network fundamentals, protocol architectures, addressing and routing mechanisms, transport and application layer services, and network security concepts. It also enables students to analyze, design, configure, and evaluate network systems and protocols to support efficient and secure data communication in modern computer networks.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Understand fundamentals of computer networks, components, performance metrics, multiplexing, topologies, and compare OSI and TCP/IP models with layer-wise responsibilities.	K2
CO2	Analyze data link layer mechanisms, MAC protocols, switching, VLANs, trunking, DTP, VTP, and STP operation for loop prevention and port state transitions.	K4
CO3	Model IPv4 and IPv6 networks, addressing schemes and configure routing protocols, while evaluating routing metrics, administrative distance, and loop prevention mechanisms.	K4
CO4	Analyze TCP and UDP behavior, congestion control, traffic shaping, and their impact on QoS, including connection management, flow control, and port usage.	K4
CO5	Apply application-layer and security solutions using core network services, NAT/PAT, cryptography, firewalls, ACLs, and threat mitigation techniques.	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	-	-	-	-	-	-	1	-	3	2	2
CO2	2	2	2	2	3	-	-	-	1	1	1	3	2	2
CO3	3	3	3	1	2	-	-	-	1	1	1	3	2	2
CO4	2	2	1	1	2	-	-	1	1	1	1	3	2	2
CO5	2	2	2	1	2	1	1	2	1	1	1	3	2	2

Course Contents / Syllabus

Unit 1	**Introduction to Networks and Data Communication**	**08 hours**

Introduction to Computer Networks: Definition, evolution, goals, advantages, disadvantages, Client-server, peer-to-peer networks, modes of communications.
Types of networks: PAN, LAN, WAN, MAN.
Network components: End devices (PCs, servers, printers), Intermediary devices (gateways, routers, switches, APs), NICs.
Network media: Wired and Wireless media, along with performance metrics bandwidth, latency, throughput, and jitter.
Multiplexing Techniques: Frequency Division Multiplexing (FDM), Time Division Multiplexing (TDM).
Network representations: Topology diagrams including Bus, Ring, Star, Mesh, Hybrid, Physical vs. Logical Topologies.
Network Communication Model: ISO/OSI and TCP/IP protocol suite with responsibilities of each layer, comparison between models, PDU at each layer.

Unit 2	**Data Link Layer, Ethernet Switching, VLANs & STP**	**09 hours**

Data Link Layer: Framing, Error Detection and Correction, Flow control (Elementary Data Link Protocols, Sliding Window protocols).
Medium Access Control and Local Area Networks: Channel allocation, Multiple access protocols (ALOHA, Slotted ALOHA, CSMA/CD, CSMA/CA, Binary-backoff algorithm, LAN standards, Protocols and frame formats.
Switching and Techniques: Circuit, Message and Packet switching techniques.

Virtual Local Area Networks (LAN): VLAN concepts, VLAN types, VLAN configuration, 802.1Q trunking: VLAN tagging, native VLAN on trunk, Dynamic Trunking Protocol (DTP), VLAN Trunking Protocol (VTP), Static vs Dynamic VLANs. **STP (IEEE 802.1D):** BPDU, root bridge election, port roles (Root, Designated, Non-Designated), port states (Blocking, Listening, Learning, Forwarding, Disabled). **Wireless Networking:** WLAN standards, Wireless security standards, CSMA/CA: Hidden/exposed terminal problem, RTS/CTS mechanism, Wireless Security, Bluetooth.		
Unit 3	**Network Layer: IP Addressing, Subnetting & Routing**	**09 hours**
Role of the Network Layer: Logical addressing, Path determination, Packet encapsulation. **IP Addressing:** Need of IP address, Classification of IP addresses. **IPv4 Address:** Notation, IPv4 classes, Public vs. Private address, Classes of IPv4 addresses, Loop back address, IPv4 Header format, ICMPv4. **Subnetting and VLSM:** Need of subnetting, Subnet mask, Classless Inter-Domain Routing (CIDR), Variable Length Subnet Masking (VLSM). **IPv6 Addressing:** Need of IPv6, difference between IPv4 and IPv6, unicast, multicast, anycast, IPv6 Header format, ICMPv6. **IPv4-to-IPv6 transition:** Dual-stack, tunneling techniques (6-to-4, Intra-Site Automatic Tunnel Addressing Protocol (ISATAP), Teredo). **Routing Concepts:** Router functions, Routing protocol metrics, Routing table structure, Split Horizon, Route Poisoning, Holddown Timers, Triggered Updates Distance vector vs Link state routing and its examples, Static Routing and its Configuration, Route types, Default route, Administrative Distance, Dynamic Routing Protocols, RIPv1, RIPv2, OSPF, EIGRP, BGP, IS-IS, Packet Forwarding methods.		
Unit 4	**Transport Layer**	**10 hours**
Role of the Transport Layer: End-to-end communication, multiplexing/demultiplexing. **Transmission Control Protocol (TCP):** Key Characteristics, packet format, flow control (window size), error recovery, Application areas, **Handshaking Techniques:** TCP 3-Way Handshaking, four-way Teardown. **User Datagram Protocol (UDP):** Key Characteristics, packet format, working, Application areas. **Port numbers:** Well-known ports, Registered ports, Dynamic/Private ports. **TCP Socket:** Life cycle, Socket programming basics, port scanning & enumeration, banner grabbing, socket-based attacks, man-in-the-middle attacks, packet sniffing, SSL/TLS, socket/session hijacking, firewall & socket filtering, intrusion detection systems, reverse shells & backdoors, Netcat usage, secure socket coding, encryption in socket communication, DoS/DDoS attacks. **Congestion Control Techniques:** Open Loop and Closed Loop. **Traffic Shaping:** Leaky Bucket Algorithm, Token Bucket Algorithm, Traffic shaping in Quality of Service (QoS).		
Unit 5	**Application Layer and Security**	**09 hours**
Application Layer Protocols: DNS, DHCP, HTTP/HTTPS: request/response model, methods (GET, POST, PUT, DELETE), status codes, TLS/SSL, FTP (active/passive modes), SFTP, TFTP. **Email and its protocols:** User Agent (UA), Message Transfer Agent (MTA), Message Access Agent (MAA), SMTP, POP3, IMAP. **Network management:** SNMP (v1/v2c/v3). **NAT and PAT concepts**: Static NAT and its configuration, Dynamic NAT and its configuration, PAT and its configuration **Security:** Network threats: DoS/DDoS, reconnaissance, access attacks, MITM, social engineering, phishing, IPSec, **Introduction to Cryptography:** Definition and goals of cryptography; Security services: Confidentiality, Integrity, Authentication, Non-repudiation; Types of attacks (passive vs active); Basic terminology: plaintext, ciphertext, key, encryption, decryption; Substitution techniques, Transposition techniques; Symmetric Key Cryptography: Concepts of symmetric encryption, Block ciphers and stream ciphers, Data Encryption Standard (DES); Asymmetric Key Cryptography: Public key cryptography concepts; RSA algorithm; Digital Signature.		

Firewall: Types of Firewalls, Packet filtering concepts, Stateful vs stateless inspection, Firewall policies and rules; Access Control List (ACL): Purpose, packet filtering, traffic classification, QoS marking, Standard ACL, Extended ACL, Named ACLs, ACL wildcard masks, IPv6 ACLs: differences from IPv4 ACLs; implicit deny and permit ICMPv6.	
Total Lecture Hours	**45 hours**

Textbook	
	Author
1. Data Communications and Networking	Behrouz A Forouzan.
2. Computer Networking: A Top-Down Approach	Hoboken
3. Introduction to Networks Companion Guide (CCNAv7)	Cisco Networking Academy
4. Switching, Routing, and Wireless Essentials (SRWE), (CCNAv7)	Cisco Networking Academy, Allan Johnson

Reference Books:	
	Author
1. Data and Computer Communications	

Self-Study Content Links:		**Duration**
MOOCs	1. CCNA: Introduction to Networks 2. CCNA: Switching, Routing, and Wireless Essentials (SRWE) Supplemental Module 3. CCNA: Enterprise Networking, Security, and Automation (ENSA)	70 Hours each
Video Lectures	https://youtu.be/q3Z3Qa1UNBA?si=vKfge2O9cE_ggBTf https://youtube.com/playlist?list=PLh94XVT4dq02frQRRZBHzvj2hwuhzSByN&si=BV7VBwTKSrzSq3yG https://youtube.com/playlist?list=PLxCzCOWd7aiGFBD2-2joCpWOLUrDLvVV_&si=Y92NOYkQaFM41rMW	6Hrs 18Min 11Hrs 54Min 24 Hrs 58Min
Web References	https://www.geeksforgeeks.org/computer-networks/computer-network-tutorials/ https://www.geeksforgeeks.org/computer-networks/basics-computer-networking/ https://www.geeksforgeeks.org/computer-networks/ccna-tutorial-for-beginners/	-

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.

Course Code: BEC0512	Course Name: Machine Learning	L	T	P	C
Course Offered in: B.Tech. ECE		3	0	0	3

Pre-requisite: Basics of mathematics and python programming

Course Objectives:

The course aims to provide a strong foundation in machine learning, neural networks, and intelligent data analysis. It enables students to understand data representation, dimensionality reduction, probabilistic learning, search and optimization techniques, and to implement and evaluate machine learning algorithms for solving real-world data-driven problems.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Describe the basic concepts of machine learning algorithms.	K2
CO2	Define and describe the Neurons, neural networks, and multilayer perceptron.	K2
CO3	Identify the dimensionality of data and reduces it using various mathematical concepts as well as describe the probabilistic learning.	K4
CO4	Describe and apply various search and optimization techniques to the raw data.	K3
CO5	Illustrate and apply various learning techniques.	K2

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	2	-	-	-	-	-	-	-	2	2	2	3
CO2	2	2	2	-	-	-	-	-	-	-	2	2	2	3
CO3	2	2	2	-	-	-	-	-	-	-	2	2	2	3
CO4	2	2	2	-	-	-	-	-	-	-	2	2	2	3
CO5	2	2	2	-	-	-	-	-	-	-	2	2	2	3

Course Contents / Syllabus

Unit 1	**Introduction to Machine Learning**	**09 hours**

Introduction, types of learning, History of ML, Introduction of Machine Learning Approaches, Introduction to Model Building, Sensitivity Analysis, Underfitting and Overfitting, Bias and Variance, Concept Learning Task, Find – S Algorithms, Version Space and Candidate Elimination Algorithm, Inductive Bias, Issues in Machine Learning and Data Science Vs Machine Learning

Unit 2	**Neural Networks**	**09 hours**

Hebb's Rule, McCulloch and Pitts Neurons, Limitation of McCulloch and Pitts Neurons, The Perceptron, Linear separability, Linear Regression, Back propagation algorithm. The Multi-Layer Perceptron (MLP): MLP algorithm, Sequential and Batch training, Amount of training data, number of hidden layers, when to stop training. The network output and errors, Requirements of activation function.

Unit 3	**Dimensionality Reduction**	**09 hours**

Linear discriminant analysis, Principal Component analysis, Factor analysis, Independent Component analysis, locally linear embedding, ISOMAP Models: Gaussian Matrix Models, Nearest Neighbour methods. Support Vector Machine (SVM): Optimal separation, Kernels, SVM algorithm, Extensions of SVM.

Unit 4	**Optimization and Search**	**09 hours**

Gradient Descent, Batch GD, Mini-batch GD, SGD, Going Downhill, least square optimization, conjugate gradients, Exhaustive search, Greedy search, hill climbing. Evolutionary Learning: The genetic algorithm, Genetic operators, punctuated equilibrium, The Knapsack Problems.

Unit 5	**Reinforcement Learning**	**09 hours**

State and action spaces, the reward function, Markov chain decision process, Uses of Reinforcement Learning. Learning with tree: Decision Tree, Classification and regression tree, Random Forest. Unsupervised Learning: The k-means algorithm, Vector quantization, The self-organization feature map, Simulated annealing.

	Total Lecture Hours	**45 hours**

Textbook:

	Authors
1. Machine Learning- An Algorithm Perspective	Stephen Marsland
2. Introduction to Machine Learning (Adaptive Computation and Machine Learning	Ethem Alpaydin
3. Neural Networks	Siman Haykin
4. Genetic Algorithms: Search, Optimization and Machine Learning	Addison Wesley, D.E. Goldberg
Reference Books:	
1. Neural Networks	Kumar Satish
2. Fuzzy Logic with Engineering Applications	Timothy J. Ross
3. Pattern Recognition and Machine Learning	Verlag. Bishop, C
4. An Introduction to Genetic Algorithms	Melanie Mitchell

Self-Study Content Links:		Duration (in Hrs)
MOOCs		
Video Lectures	**Unit 1** https://youtu.be/2oGsCHlfBUg?si=oBc5-EMGInbx0N7F **Unit 2** https://youtu.be/6XhSJbfT1pk?si=1Su3WN4f_I9EMI5F **Unit 3** https://youtu.be/JpLjNJGNDqk?si=EqwXbk7-CiVh-K3H **Unit 4** https://youtu.be/_U8p3wNRXpE?si=092L_H5pqBr9BP3- **Unit 5** https://youtu.be/faNdiZFKtxQ?si=U5NLP2oG3SrvXp_c	07Hrs05Min 04Hrs0Min 02Hrs05Min 01Hrs11Min 0017Hrs
Web References		

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.

Course Code: BEC515N	Course Name: VLSI Testing and Testability	L	T	P	C
Course Offered in: B.Tech. ECE		3	0	0	3

Pre-requisite: Fundamental knowledge of VLSI circuits.

Course Objectives:

To provide students with the fundamental concepts of VLSI testing, fault modeling, and test generation techniques for enhancing the quality, reliability, and yield of integrated circuits. The course also aims to develop proficiency in Design for Testability (DFT), memory testing, Built-In Self-Test (BIST), and UVM-based verification methodologies for modern VLSI systems.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Apply the concepts in testing which can help them design a better yield in IC design.	K3
CO2	Analyze the various test generation methods for combinational circuits.	K4
CO3	Analyze the various test generation methods for sequential circuits.	K4
CO4	Identify the design for testability methods for different memory circuits.	K2
CO5	Recognize BIST techniques for enhancing testability and explain the hierarchy and structure of UVM-based verification environments.	K2

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	3	–	2	–	–	–	–	–	2	2	3	2
CO2	3	3	2	–	2	–	–	–	–	–	2	2	3	2
CO3	3	3	2	–	2	–	–	–	–	–	2	2	3	2
CO4	3	2	3	–	2	–	–	–	–	–	2	2	3	2
CO5	3	2	3	–	2	–	-	–	–	–	2	2	3	2

Course Contents / Syllabus

Unit 1	**Introduction to VLSI Testing and Fault Modelling**	**09 hours**
Importance and Principle of testing, Challenges in VLSI testing, Levels of abstractions in VLSI testing, Functional vs. Structural approach to testing, Complexity of the testing problem, Types of Testing, DC and AC parametric tests Fault Modelling: Stuck at fault, fault equivalence, fault collapsing, fault dominance, fault simulation		
Unit 2	**Testing And Testability of Combinational Circuits**	**09 hours**
Test Generation Basics: Test generation algorithms, Random test generation, ATPG algorithms for combinational circuits, Boolean difference, Path sensitization, D –algorithm, PODEM, Testable combinational logic circuit design		
Unit 3	**Testing And Testability of Sequential Circuits**	**09 hours**
Testing of sequential circuits as iterative combinational circuits, state table verification, test generation based on circuit structure, Sequential ATPG, Ad Hoc design rules, Level Sensitive Scan Design, Scan path technique (scan design), partial scan, Boundary scan		
Unit 4	**Memory, Delay, Fault and IDDQ Testing**	**09 hours**
Testable memory design, RAM fault models, Test algorithms for RAM, Delay faults, Delay tests, IDDQ testing, Testing methods, Limitations of IDDQ testing.		
Unit 5	**Built In Self-Test (Bist) Techniques**	**09 hours**
Built-in self-test (BIST): Design rules, Exhaustive testing, Pseudo-random testing, Pseudo-exhaustive testing, Output response analysis, Logic BIST architectures, Introduction to Test compression, Introduction to Universal Verification Methodology (UVM), Hierarchy in UVM		
	Total Lecture Hours	**45 hours**

Textbook:

	Authors Name

1. An Introduction to Logic Circuit Testing	Parag K. Lala
2. Essentials of Electronic Testing for Digital, Memory and Mixed Signal VLSI Circuits	M. L. Bushnell and V. D. Agrawal
3. Digital System Testing and Testable Design	M. Abramovici, M.Breuer, and A. Friedman
Reference Books:	
	Authors Name
1. Introduction to Formal Hardware Verification	Thomas Kropf
2. Digital Systems and Testable Design	M. Abramovici, M.A. Breuer and A.D. Friedman
3. VLSI Test Principles and Architectures Design for Testability	W.W. Wen
4. Design Test for Digital IC's and Embedded Core Systems	A.L. Crouch

Self-Study Content Links:		Duration (in Hrs)
MOOCs		
Video Lectures	**Unit 1** https://youtu.be/otOSL1ZLnOo?si=_QEpaTc68DOVbs0j	02Hrs26Min
	Unit 2 https://youtu.be/ottMYN7yg8s?si=kMXFQhyfsIjZo3Ip	00Hrs29Min
	Unit 3 https://www.youtube.com/watch?v=MgCFUO2BrkQ	01Hrs25Min
	Unit 4 https://youtu.be/ottMYN7yg8s?si=Ki5KgxPZswrNsZPV	04Hrs09Min
	Unit 5 https://youtu.be/hXYAc8L2pR8?si=NmglQNWr0j3CvLUH	01Hrs27Min
Web References		

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.

Course Code: BEC0511	Course Name: Embedded Systems Design	L	T	P	C
Course Offered in: B.Tech. ECE		3	0	0	3

Pre-requisite: Knowledge of Microprocessor and Microcontroller

Course Objectives:

To provide students with the fundamental concepts of embedded systems, ARM Cortex-M4 architecture, and the STM32F401 microcontroller for designing modern embedded applications. The course also aims to develop proficiency in embedded software development, ARM programming, development tools, and embedded Linux for real-world system design.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Describe the design considerations of embedded systems.	K2
CO2	Apply the knowledge to use STM32F401 for various application.	K3
CO3	Analyze the Architecture of ARM CORTEX-M4 processor.	K4
CO4	Implement the programming techniques for ARM processor.	K3
CO5	Evaluate the concept of embedded Linux and kernel architecture.	K5

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	-	-	-	-	-	-	-	2	2	2	3
CO2	3	3	3	-	-	-	-	-	-	-	2	2	2	3
CO3	3	3	3	-	-	-	-	-	-	-	2	2	2	3
CO4	3	2	3	-	-	-	-	-	-	-	2	2	2	3
CO5	3	2	3	-	-	-	-	-	-	-	2	2	2	3

Course Contents / Syllabus

Unit 1	**Embedded System Concepts**	**9 hours**
Introduction to Embedded Systems: Definition of Embedded System, Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification, Major Application Areas, Purpose of Embedded Systems, Design Considerations of Embedded Systems		
Unit 2	**STM32F401 Board & Interfacing**	**9 hours**
STM32F401 Nucleo Board, Interfacing with Analog World, Output Devices, Sensors and Actuators, Interfacing with 7 segment LED and LCD Displays, Interfacing with Temperature Sensor and LDR Light Sensor, Speed Control of DC Motor		
Unit 3	**The ARM CORTEX-M4 Processor**	**9 hours**
Key features of Arm architectures and processors, Structure and purpose of specific registers in the Arm Cortex-M4 processor, Interrupts: Nested Vectored Interrupt Controller (NVIC), Wakeup Interrupt Controller (WIC), Memory Protection Unit (MPU), Bus Interconnect and Debug System and Low Power Features		
Unit 4	**ARM CORTEX-M4 Programming**	**9 hours**
Introduction to Arm Cortex-M4 Programming, Compare the C and Assembly programming languages, C as Implemented in Assembly Language, Benefits and drawbacks of high-level and low-level programming, Introduction to the Mbed Platform and CMSIS, Mbed platform and its importance		
Unit 5	**Embedded Linux & Drivers**	**9 hours**
History of Embedded Linux, Embedded Linux versus Desktop Linux, Embedded Linux Distributions, Architecture of Embedded Linux, Linux Kernel Architecture, Linux Start-Up Sequence, GNU Cross-p\Platform Tool chain, Linux Serial Driver, Ethernet Driver.		
	Total Lecture Hours	**45 hours**

Textbook:

	Authors
1. ARM System Developer's Guide	Andrew N. Sloss, Dominic Symes, Chris Wright
2. The Definitive Guide to the ARM Cortex-M3	Joseph Yiu

3. Embedded Linux System Design and Development		P. Raghavan, Amol Lad, Sriram Neelakandan
Reference Books:		
		Authors
1. Introduction to Embedded Systems		Shibu K. V
2. Embedded Systems: Architecture, Programming and Design		Raj Kamal
3. An Embedded Software Primer		David E. Simon
4. ARM System-on-Chip Architecture		Steve Furber

Self-Study Content Links:		Duration (in Hrs)
MOOCs		
Video Lectures	**Unit 1** https://www.youtube.com/watch?v=y9RAhEfLfJs	00Hrs55Min
	Unit 2 https://www.youtube.com/watch?v=C04ZthY8Yqk	00Hrs51Min
	Unit 3 https://nptel.ac.in/courses/106/105/106105193/	00Hrs55Min
	Unit 4 https://www.youtube.com/watch?v=csttt3VHxf8	00Hrs59Min
	Unit 5 https://www.youtube.com/watch?v=h-ZP98qhEM8	00Hrs48Min
Web References		

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.

Course Code: BEC0517	Course Name: Data Analytics	L	T	P	C
Course Offered in: B.Tech. ECE		**3**	**0**	**0**	**3**
Pre-requisite: Basic Programming, Basics of digital electronics					
Course Objectives:					
To provide students with the fundamental concepts of data analytics, including data representation, preprocessing, exploratory data analysis, and visualization techniques for extracting meaningful insights from diverse datasets. The course also aims to develop analytical and data-driven decision-making skills applicable to real-world domains.					

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Describe the fundamental concepts of data analytics in the areas that plays major role within the realm of data science	K2
CO2	Explain and exemplify the most common forms of data and its representations.	K2
CO3	Apply data pre-processing techniques on heterogeneous datasets.	K3
CO4	Analyze data using exploratory data analysis	K4
CO5	Apply visualization tool to analyze and draw inference from different types of data sets w.r.t different application scenarios.	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	-	3	-	-	-	-	-	2	2	2	2
CO2	3	2	2	-	3	-	-	-	-	-	2	2	3	2
CO3	3	3	2	-	3	-	-	-	-	-	2	3	3	2
CO4	3	3	3	-	3	-	-	-	-	-	2	2	3	2
CO5	3	2	3	-	3	-	-	-	-	-	2	2	2	2

Course Contents / Syllabus

Unit 1	Foundations of Data Science: Concepts, Tools and Applications	09 hours
Introduction to Data Science, Evolution of Data Science, Skillsets needed, Lifecycle, Need for Data Science, Datafication, Types of Data Analysis, Data Science Tools and technologies, Analysis Vs Analytics Vs Reporting, Applications of Data Science in various fields, Use cases of Data science-Facebook, Netflix, Amazon, Uber, Air BnB.		
Unit 2	**Data Types and Statistical Foundations**	**09 hours**
Types of Data: structured, semi-structured, unstructured data, Numeric, Categorical, Graphical, High Dimensional Data, Transactional Data, Spatial Data, Social Network Data, standard datasets, Sources of Data, Data manipulation in various formats, for example, CSV file, import and export data in R/Python. Measure of central tendency (Mean, Median, Mode), Central limit theorem, Skewness, Variance, SD, Covariance, Correlation, Normal distribution, Margin of Error.		
Unit 3	**Data Preprocessing and Visualization**	**09 hours**
Form of Data Pre-processing, data Attribute and its types, KDD process, Inconsistent Data, Data Cleaning: Missing Values, Noisy Data, Discretization and Concept hierarchy generation (Binning, Clustering, Histogram), Data Integration and Transformation. Data Reduction: Data Cube, Data Compression, Numerosity Reduction, R-Square, Adjusted R-Square, Significance of p-value.		
Unit 4	**Data Cleaning, Transformation, and Exploration**	**09 hours**
Variable Selection, Removing Redundant variables, identifying outliers, Removing Outliers, Time series Analysis, Data transformation and dimensionality reduction techniques such as Principal Component Analysis (PCA), Factor Analysis (FA) and Linear Discriminant Analysis (LDA), Univariate and Multivariate Exploratory Data Analysis. Data Wrangling using R/Python.		
Unit 5	**Data Visualization with Tableau**	**09 hours**

Introduction to Tableau, Installation and configuration of Tableau. Creating Your First visualization: Getting started with Tableau Software, Using Data file formats, connecting your Data to Tableau, creating basic charts using the Show me panel. Tableau Calculations: Overview of SUM, AVR, and Aggregate Features, creating custom calculations and fields, Manipulating Data in Tableau: Cleaning-up the data with the Data Interpreter, structuring your data, Sorting, and filtering Tableau data, Pivoting Tableau data. Advanced Visualization Tools: Using Filters, Using the Detail panel, Using the Size panels, customizing filters, Using and Customizing tooltips, formatting your data with colors, Creating Dashboards & Stories, Distributing & Publishing Your Visualization	
Total Lecture Hours	**45 hours**

Textbook:	
	Authors
1. Data Analysis and Data Mining,	Jiawei Han, Micheline Kamber, Jian Pei
2. Making sense of Data: A practical Guide to Exploratory Data Analysis and Data Mining	Glenn J. Myatt

Reference Books:	
	Authors
1. The Data Science Handbook	Field Cady
2. Data Mining Concepts and Techniques	Jiawei Han, Micheline Kamber, Jian Pei, Morgan Kaufmann

Self-Study Content Links:		**Duration (in Hrs)**
MOOCs		
Video Lectures	**Unit1** https://www.youtube.com/playlist?list=PLEiEAq2VkUUKgEFXH1tBbHwq38oWYDScU **Unit 2** https://www.youtube.com/watch?v=dcXqhMqhZUo **Unit 3** https://www.youtube.com/watch?v=VaSjiJMrq24 **Unit 4** https://www.youtube.com/watch?v=tDu_KIlXaB0 **Unit 5** https://www.youtube.com/watch?v=ZX8vmcSTCrc	05Hrs00Min 00Hrs06Min 29Hrs13Min 00Hrs05Min 01Hrs56Min
Web References		

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.

Course Code: BEC0518	Course Name: Low Power VLSI Design	L	T	P	C
Course Offered in: B.Tech. EE (VLSI)		3	0	0	3

Pre-requisite: Basic knowledge of Digital Electronics, CMOS circuits, MOSFET operation, and VLSI Design fundamentals.

Course Objectives:

This course introduces the principles of power dissipation and energy-efficient design in digital integrated circuits. It develops the ability to analyze and design low-power arithmetic and memory architectures using techniques that optimize power, performance, and area in VLSI systems.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Demonstrate the sources of power dissipation in digital IC systems & understand the impact of power on system performance and reliability.	K3
CO2	Illustrate the different low-power design approaches and optimization of switched capacitance.	K3
CO3	Discuss the different low-power high speed adders.	K2
CO4	Apply the concepts of low voltage and low power to different multipliers.	K3
CO5	Apply the concepts of low voltage and low power to different memories.	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	-	-	-	-	-	-	-	-	2	3	2
CO2	3	2	2	-	-	-	-	-	-	-	-	2	3	2
CO3	3	2	2	-	-	-	-	-	-	-	-	2	3	2
CO4	3	2	2	-	-	-	-	-	-	-	-	2	3	2
CO5	3	2	2	-	-	-	-	-	-	-	-	2	3	2

Course Contents / Syllabus

Unit 1	**Fundamentals of Low Power VLSI Design**	**9 hours**

Need for Low Power Circuit Design, Sources of Power Dissipation, Switching Power Dissipation, Short Circuit Power Dissipation, Leakage Power Dissipation-Reverse diode leakage current, Sub threshold leakage current, Glitching Power Dissipation.

Unit 2	**Low Voltage Process Technology**	**9 hours**

Low-Power Design through Voltage Scaling: VTCMOS circuits, MTCMOS circuits, Architectural Level Approach —Pipelining and Parallel Processing Approaches.

Estimation and Optimization of Switching Activity: The Concept of Switching Activity, Reduction of Switching Activity, Reduction of Switched Capacitance-System Level Measures, Circuit Level Measures, and Mask level Measures**.**

Unit 3	**Low-Voltage Low-Power Adders**	**9 hours**

Introduction, Standard Adder Cells, CMOS Adder's Architectures for Ripple Carry Adders, Carry Look-Ahead Adders, Carry Select Adders, Carry Save Adders, Carry Skip Adders.

Unit 4	**Low-Voltage Low-Power Multipliers**	**9 hours**

Overview of Multiplication, Booth Multiplier-Booth's algorithm, modified Booth algorithm, Introduction to Tree Multiplier (Wallace and Dada multipliers) and 4:2 Compressors.

Unit 5	**Low Power Random Access Memory Circuits**	**9 hours**

Sources of power dissipation in SRAMs, Low power SRAM circuit techniques, Sources of power dissipation in DRAMs, Low power DRAM circuit techniques.

	Total Lecture Hours	**45 hours**

Textbook:
1. CMOS Digital Integrated Circuits -Analysis and Design, TMH, 2011. Sung-Mo Kang, Yusuf Leblebici
2. Low-Voltage, Low-Power VLSI Subsystems, TMH Professional Engineering., 7th Edition, 2004. Kiat-Seng Yeo, Kaushik Roy

Reference Books:

1. Principles of CMOS VLSI Design, 2nd Edition, Addison Wesley (Indian reprint). Neil H. E. Weste and K. Eshraghian.
2. Low Power VLSI CMOS Circuit Design, Kluwer Academic Press, 1995. Bellamour, and M. I. Elmasri.
3. Low Power Digital CMOS Design, Kluwer Academic Publishers, 1995. Anantha P. Chandrakasan and Robert W. Brodersen.
4. Low-Power CMOS VLSI Design, Wiley-Interscience, 2000. Kaushik Roy and Sharat C. Prasad.

Self-Study Content Links:		**Duration (in Hrs)**
MOOCs		
Video Lectures	**Unit 1** https://www.youtube.com/watch?v=C8kiblD2riw&list=PL1wj50dotxPPsCrF16rHnkfID1TP2LJ5Z. **Unit 2** https://www.youtube.com/watch?v=0ykJeTGqv6M&list=PLB3F0FC99B5D89571&index=27 **Unit 3** https://www.youtube.com/watch?v=TFOO1JAll2Y&list=PLBU5hourursMXEMWAkoUPB5aqUPb3lKYqN6q **Unit 4** https://www.youtube.com/watch?v=HuwwBIS9yQs **Unit 5** https://www.youtube.com/watch?v=dmBc-E3EpgA	10 Hrs 0052 Hrs 0036 Hrs 1.02 Hrs 0028 Hrs
Web References		

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.

Course Code: BEC0516	Course Name: Control System and Automation	L	T	P	C
Course Offered in: B.Tech. ECE		3	0	0	3

Pre-requisite: Signal and System

Course Objectives:

To provide students with the fundamental concepts of control systems, including mathematical modeling, stability analysis, controller design, and discrete-time control techniques. The course also aims to develop an understanding of robotic, electro-pneumatic, hydraulic, and PLC-based control systems for industrial automation and modern engineering applications.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Describe the basics of control system with time domain specifications.	K2
CO2	Explain the concepts of absolute and relative stability for continuous data systems and designing of compensator.	K4
CO3	Analyze the control system design in state space & describe the discrete data control system.	K4
CO4	Explain the role control system in robotic.	K2
CO5	Analysis of electro pneumatics hydraulics & discrete control using PLC.	K4

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	1	-	-	-	-	-	-	-	-	2	2	2
CO2	3	3	2	-	-	-	-	-	-	-	-	2	2	2
CO3	3	3	3	-	-	-	-	-	-	-	-	2	2	2
CO4	3	3	3	-	-	-	-	-	-	-	-	2	2	2
CO5	3	3	2	-	-	-	-	-	-	-	-	2	2	2

Course Contents / Syllabus

Unit 1	**Basic of a Control System**	**09 hours**

Transfer function, Basic of a control system, Introduction: open-loop control system, close-loop control system, Block diagram, Signal flow graph, Modelling a control system: Electrical network, Mechanical system, Servo motor. Transient and steady state response, Input test signal, Time response of a first order control system, Time response of a second order control system, steady state Error, Design of controller.

Unit 2	**Concept of Stability**	**09 hours**

Stability in terms of characteristic equation, Routh Hurwitz criterion, Root-Locus Technique, Frequency domain analysis of control system, Nyquist stability criterion, stability analysis with the Bode plot, relative stability, Compensation of control system

Unit 3	**State Space Representation**	**09 hours**

State space representation, the concept of state, Block diagram for a state equation, Transfer function decomposition, Solution of state equation, Transfer matrix, Controllability, and Observability. Transfer function of discrete data system, State equations of linear discrete data system, Stability of discrete data system, Steady state error analysis of discrete data control system

Unit 4	**Introduction to Robot**	**09 hours**

Introduction to Robot: Classification of Robots, Advantages and Disadvantages of Robots, Robot Components, Robot Degrees of Freedom, Robot Joints, Robot Coordinates, Robot Reference Frames, Programming Modes, Robot Characteristics, Robot Workspace, Robot Languages. Introduction to RPA.

Unit 5	**Introduction to Automation**	**09 hours**

Introduction to Automation: Definition and fundamentals of automation, reasons for Automating, Electro pneumatics: Electro pneumatics, Design of Electro-Pneumatic Circuits, PLC- Architecture, PLC Programming Languages, ladder digs, Ladder Logic, Programming for different types of logic: Timers, Counter. Practical Examples of Ladder Programming.

Total Lecture Hours	**45 hours**

Textbook:	
	Authors
1. Automatic Control Systems	B.C. Kuo & Farid Gol Naraghi
2. Introduction to Robotics – Analysis, Systems and Application	Saeed B. Niku

Reference Books:	
	Authors
1. Automation, Production Systems and Computer Integrated Manufacturing	M.P. Grover
2. An Introduction to Automated Process Planning Systems	Tiess Chiu Chang & Richard A. Wysk

Self-Study Content Links:		Duration (in Hrs)
MOOCs		
Video Lectures	**Unit 1** https://youtu.be/RcuGxWc0HyQ?si=s6rL9gFYGoQUGfhV **Unit 2** https://youtu.be/p8bi5tcSVLg?si=lO3c1YnygFcT5GPe **Unit 3** https://youtu.be/86uzST3SM-0?si=prmI_i7EyVvpt0Q0 **Unit 4** https://youtu.be/CrXOMBlYFp0?si=Pw2yLGHjDNEyCBca **Unit 5** https://youtu.be/P_PP76flZfw?si=lvrjVyW4XmTzFG	00Hrs33Min 00Hrs30Min 00Hrs20Min 00Hrs31Min 00Hrs32Min
Web References		

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.

LAB Course Code: BEC0553	**LAB Course Name: Embedded System Design Lab (LCC)**	**L**	**T**	**P**	**C**
Course Offered in: B. Tech ECE		**0**	**0**	**2**	**1**

Pre-requisite: Knowledge of Microprocessor and Microcontroller

Course Objectives:

To provide hands-on experience in programming ARM-based microcontrollers using the Freedom KL25Z development board for embedded system design. The course also aims to develop practical skills in using commercial development tools, APIs, and software frameworks to implement and accelerate ARM-based embedded system applications.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Analyze Freedom KL25Z board to build a system.	K4
CO2	Build an Arm-based embedded system, and program to satisfy given user specifications.	K3
CO3	Use commercial tools to develop Arm-based embedded systems.	K3
CO4	Use commercial API and tools to accelerate the development cycle of Arm-based embedded systems.	K4
CO5	Analyze Freedom KL25Z board to build a system.	K4

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	2	-	-	-	-	-	-	1	2	1
CO2	3	3	2	2	2	-	-	-	-	-	-	1	3	1
CO3	3	3	3	2	3	-	-	-	-	-	-	1	3	1
CO4	2	2	3	1	3	-	-	-	-	-	-	2	3	1
CO5	2	2	3	1	3	-	-	-	-	-	-	2	3	1

List Of Practical's (Indicative & Not Limited To)

S. No.	**Name of Experiments/ Programs**	**CO**
1	Describe architecture and Pin diagram of Freedom KL25Z board	CO2
2	Write and compile the code to perform the arithmetic operations in ARM thumb instruction set.	CO1
3	Write and compile the code to perform logical operations in ARM thumb instruction set.	CO3
4	Write and compile code to perform Shift operations in ARM instruction set.	CO3
5	Write an assembly code subroutine to approximate the square root of an argument using the bisection method.	CO3
6	Write the Thumb code to multiply the two 32-bit in memory at addresses 0x1234_5678 and 0x7894_5612, storing the result in address 0x2000_0010.	CO2
7	To Write and compile assembly code and debug the program image on an embedded board (namely the Freedom KL25Z board) using the Keil MDK-ARM tool.	CO4
8	Write a program to configure a General-Purpose Input Output (GPIO) peripheral in a low-level (register-level) in practice.	CO3
9	Write and compile assembly code of I/O interfacing and debug the program image on a KL25Z board using the Keil MDKARM tool. Interface LEDs and Switches	CO5
10	Write and compile assembly code of Sensor interfacing and debug the program image on an KL25Z board using the Keil MDK-ARM tool. Interface PIR sensor-and DHT sensor.	CO5
		Total Hours: 15 hrs.

LAB Course Code: BCSE0552A	LAB Course Name: Computer Networks Lab	L	T	P	C
Course Offered in: CSE/CS/IT /CSE(AI)/CSE(AIML)/ CSE(DS)/ CSE(CYS)/MCT /ECE		0	0	4	2

Pre-requisite: Fundamental of Computers

Course Objectives:

Understand and configure basic networking concepts using CISCO Packet Tracer and device. Develop practical skills in IP addressing, Subnetting, V LAN, Routing, Switching and wireless networking. Learn to configure and manage network services such as DHCP, NAT, ACLs, and inter VLAN Routing. Perform network testing, Troubleshooting and connectivity verification using CISCO IOS CLI commands and diagnostic tools. Prepare students for industry-oriented networking rules and certification such CISCO CCNA by providing hands-on networking experience.

Course Outcome: After completion of the course, the student will be able to		Bloom's Level
CO1	Model computer network through cabling, assigning IP addresses along with subnetting using CISCO packet tracer.	K4
CO2	Analyse Layer 2 and Layer 3 networking features including switching, VLANs, trunking, inter-VLAN routing, STP, EtherChannel, static routing, and basic dynamic routing.	K4
CO3	Demonstrate core network services and security features such as wireless connectivity, DHCP, NAT/PAT, ACLs, transport/application layer protocols, and connectivity verification using network diagnostic tools.	K4

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	3	-	-	-	2	2	1	3	2	1
CO2	3	3	3	2	3	1	-	-	2	2	1	3	2	2
CO3	3	3	2	3	3	1	-	1	2	2	1	3	3	2

List Of Practical's (Indicative & Not Limited To)

S. N.	Name of Experiments/ Programs	CO
1	Explore the CISCO Packet Tracer.	CO1
2	Explore Network Devices and Cabling: Identify different network devices (router, switch, PC) and understand cable types (straight-through, crossover, fiber).	CO1
3	Basic Switch and End Device Configuration: Configure hostname, passwords, and basic security settings on switches and PCs.	CO1
4	Build a Simple Network Using Packet Tracer: Create a small network and verify connectivity using ping and traceroute.	CO1
5	Configure IPv4 Addressing: Assign IP addresses manually and test communication between devices.	CO1
6	Subnetting and Address Calculation: Apply subnetting techniques to divide networks efficiently.	CO1
7	Configure IPv6 Addressing: Assign IPv6 addresses and test connectivity.	CO1
8	Access Cisco IOS and CLI Navigation: Use CLI commands to configure and manage network devices.	CO1
9	MAC Address and ARP Analysis: Understand how MAC addresses and ARP work in local communication.	CO1
10	Basic Switch Configuration Configure switch settings, ports, and management IP.	CO1
11	VLAN Configuration: Create VLANs and assign ports to segment network traffic.	CO2
12	Inter-VLAN Routing: Enable communication between VLANs using router or Layer 3 switch.	CO2
13	Trunking Configuration (802.1Q): Configure trunk links to allow multiple VLAN traffic.	CO2
14	Spanning Tree Protocol (STP): Understand STP operation and prevent switching loops.	CO2

15	Static Routing Configuration: Configure static routes and verify packet forwarding.	**CO2**
16	Default and Dynamic Routing (RIP): Implement basic dynamic routing and default routes.	**CO2**
17	Wireless Network Configuration: Configure a wireless router and connect wireless clients.	**CO3**
18	NAT (Network Address Translation): Configure NAT/PAT for internet access.	**CO3**
19	Network Troubleshooting: Identify and resolve connectivity issues using commands like ping, traceroute, and show.	**CO3**
		Total Hours: 30 hrs.

LAB Course Code: BEC0512ZP	LAB Course Name: AI & ML Lab	L	T	P	C
Course Offered in: B. Tech		0	0	2	1

Pre-requisite: Basics of Python

Course Objectives:

To provide hands-on experience in implementing artificial intelligence and machine learning algorithms using Python and OpenCV. The course also aims to develop practical skills in problem-solving, inference techniques, and applying machine learning models to analyze datasets and solve real-world applications.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Implement the blind search algorithm.	K3
CO2	Implement the different AI based problem	K3
CO3	Apply various chaining algorithm in AI using python/Open CV	K4
CO4	Apply appropriate data sets to the Machine Learning algorithms.	K4
CO5	Identify and apply Machine Learning algorithms to solve real world problems.	K5

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	3	2	2	2	-	-	1	-	2	-	2	2	1
CO2	3	3	3	2	3	-	-	1	1	2	2	3	3	2
CO3	3	3	3	3	3	-	-	2	1	2	2	3	3	2
CO4	3	3	3	3	3	-	-	2	2	2	2	3	3	2
CO5	3	3	3	3	3	-	-	2	2	3	3	3	3	3

List of Practical's (Indicative & Not Limited To)

S. No	Name of Experiments/ Programs	COs
1	Implementation of Python basic Libraries such as Math, Numpy and Scipy.	CO1
2	Implementation of Python Libraries for ML application such as Pandas and Matplotlib.	CO1
3	Creation and loading different datasets in Python.	CO1
4	Familiarizing with Anaconda for importing modules and dependencies for ML.	CO1
5	Familiarizing with Jupyter for importing Modules and dependencies for ML.	CO1
6	Write a python program to compute Mean, Median.	CO1
7	Write a python program to compute Mode, Variance and Standard Deviation using Datasets.	CO1
8	Write a Program to Implement Breadth First Search using Python.	CO1
9	Write a Program to Implement Depth First Search using Python.	CO1
10	Write a program to implement Hill Climbing Algorithm using Python.	CO2
11	Write a program to implement Tic-Tac-Toe Game using Python.	CO2
12	Write a Program to implement Game Playing Algorithms: Minimax.	CO2
13	Write a Program to Implement A* Algorithm using Python.	CO2
14	Write a Program to implement Game Playing Algorithms: Alpha Beta Pruning.	CO2
15	Write a Program to implement Chatbot in Python.	CO2
16	Write a Program to Implement Missionaries Cannibals Problems using Python.	CO2
17	Write a Program to Implement 8-Puzzle Problem using Python.	CO2

18	Write a program to solve water jug problem using Python.	**CO2**
19	Write a program to solve Monkey banana problem using Python.	**CO2**
20	Write a program to Implement N-Queens Problem Using Python.	**CO2**
21	Write a program to Implement of Traveling Salesman using Python.	**CO2**
22	Write a Program to Implement Tower of Hanoi using Python.	**CO2**
23	Write a Program to Implement Forward Chaining.	**CO3**
24	Write a Program to Implement Backward Chaining	**CO3**
25	Implement the S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .csv file.	**CO4**
26	For a given set of training data examples stored in a .csv file, implement and demonstrate the CandidateElimination algorithm to output a description of the set of all hypotheses consistent with the training examples.	**CO4**
27	Build an Artificial Neural Network by implementing the Back propagation algorithm and test the same using appropriate data sets.	**CO4**
28	Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs.	**CO4**
29	Implement the S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .csv file.	**CO4**
30	Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .csv file. Compute the accuracy of the classifier, considering few test data sets.	**CO5**
31	Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set. You can use Java/Python ML library classes/API.	**CO5**
32	Apply EM algorithm to cluster a set of data stored in a .csv file. Use the same data set for clustering using kMeans algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Java/Python ML library classes/API in the program.	**CO5**
33	Write a program to implement k-Nearest Neighbor algorithm to classify the iris data set. Print both correct and wrong predictions. Java/Python ML library classes can be used for this problem.	**CO5**
34	Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.	**CO5**
		Total Hours: 15 hrs.

LAB Course Code: BEC0518P	**LAB Course Name: Low Power VLSI Design Lab**	**L**	**T**	**P**	**C**
Course Offered in: B. Tech ECE		**0**	**0**	**2**	**1**

Pre-requisite: CMOS circuit operation and power dissipations

Course Objectives:

Understand power dissipation mechanisms in CMOS circuits. Design low-power combinational and sequential logic circuits. Apply leakage power reduction techniques in VLSI designs. Develop and optimize low-power RTL architectures using energy-efficient design methods

Course Outcome: After completion of the course, the student will be able to

Course Outcomes		**Bloom's Level**
CO1	Analyze and measure static, dynamic, and short-circuit power dissipation components in CMOS logic circuits using electronic simulation tools.	K4
CO2	Design and optimize combinational and sequential logic blocks for minimal Power-Delay Product (PDP) using alternative logic styles.	K4
CO3	Implement and evaluate leakage reduction methodologies including MTCMOS, power gating, and transistor stacking configurations.	K4
CO4	Synthesize and validate low-power RTL-level architectures using clock-gating, multi-voltage domains, and energy-efficient multiplier algorithms.	K4

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2	3	-	-	-	-	-	2	2	3	2
CO2	3	3	2	2	3	-	-	-	-	-	2	2	3	2
CO3	3	3	2	2	3	-	-	-	-	-	2	2	3	2
CO4	3	3	2	2	3	-	-	-	-	-	2	2	3	2

List Of Practical's (Indicative & Not Limited To)

S. No.	**Name of Experiments/ Programs**	**CO**
1	Analyze CMOS inverter power characteristics using Voltage Transfer Characteristics (VTC) and evaluate short-circuit, static, and dynamic power dissipation mechanisms.	**CO1**
2	Design 2-input NAND and NOR gates using Static CMOS and Pass Transistor Logic (PTL), and compute and compare their Power Delay Product (PDP) performance.	**CO1**
3	Implement a 1-bit Full Adder using Conventional CMOS, Transmission Gate (TG), and compare total power consumption.	**CO1**
4	Design D Flip-Flop and JK Flip-Flop circuits and analyze energy consumption under varying clock frequencies	**CO2**
5	Simulate a 6T SRAM bit cell and implement techniques for reducing write-driver power consumption.	**CO2**
6	To design an adiabatic logic inverter circuit.	**CO2**
7	To design CMOS logic circuits using Low-Vt and High-Vt transistors	**CO3**
8	Implement PMOS header or NMOS footer sleep transistors and measure leakage reduction during sleep mode.	**CO3**
9	To apply forward and reverse body bias voltages to MOS transistors and study their effects on threshold voltage variation and leakage current reduction in CMOS circuits.	**CO3**
10	To design and implement clock gating logic in a synchronous register circuit and evaluate the reduction in dynamic power consumption using simulation and power analysis tools.	**CO4**

11	To design a conventional array multiplier. And to implement bypass or row-switching techniques for low-power operation.	**CO4**
12	To implement Dynamic Voltage Scaling (DVS) techniques in CMOS circuits and study the effect of supply voltage variation on circuit delay, power consumption, and overall energy efficiency	**CO4**
		Total Hours: 15 hrs.

LAB Course Code: BEC0516P	LAB Course Name: Control System and Automation Lab	L	T	P	C
Course Offered in: B. Tech ECE		0	0	2	1

Pre-requisite: Basics of MATLAB and Control System

Course Objectives:

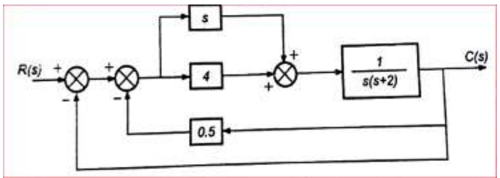
This course introduces MATLAB and the Control System Toolbox for modeling, simulation, and analysis of control systems. It develops an understanding of transfer functions, time-domain performance, and stability analysis techniques such as Root Locus, Bode, and Nyquist methods, while also covering state-space modeling and discrete-time control systems for modern control applications.

	Course Outcome: After completion of the course, the student will be able to	**Bloom's Level**
CO1	Apply MATLAB and the Control System Toolbox for basic control system modelling, simulation, and performance analysis.	K3
CO2	Evaluate the poles and zeros on s-plane along with transfer function of a given system.	K4
CO3	Evaluate the various specifications of time domain response of a given system.	K4
CO4	Examine the stability of a given transfer function using various methods such as Bode plot, Nyquist plot and root locus.	K4
CO5	Examine the concept of state variable analysis and discrete control system.	K4

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	-	3	-	-	-	-	-	-	2	2	2
CO2	3	3	2	-	3	-	-	-	-	-	-	2	2	2
CO3	3	3	2	-	3	-	-	-	-	-	-	2	2	2
CO4	3	3	2	-	3	-	-	-	-	-	-	3	2	2
CO5	3	3	3	-	3	-	-	-	-	-	-	3	2	2

List Of Practical's (Indicative & Not Limited To)

S. No.	Name of Experiments/ Programs	CO
1	Introduction to MATLAB and Control System Toolbox.	CO1
2	Plot the pole-zero configuration in s-plane for the given transfer function $$H(s) = \frac{2s+1}{s^2+5s+5}$$	CO1
3	Determine the transfer function for given closed loop system in block diagram representation. 	CO2
4	A unity feedback control system has forward path transfer function is given below, determine time response for unit step input, rise ti $G(s) = \frac{s+2}{s(s+1)}$ vershoot	CO2
5	The open loop transfer function of unity feedback control system is given below find the position error coefficient, velocity error coefficient and acceleration error coefficient. $$G(s) = \frac{10}{(s^2+6s+10)}$$	CO3

6	Draw the Nyquist plot for open loop transfer function given below and comment on its closed loop stability $$G(s)H(s) = \frac{2.2}{s(s+1)(s^2+2s+2)}$$	CO3
7	Plot the root locus plot for the system when the open loop transfer function is given by $$G(s) = \frac{K}{s(s+4)(s^2+4s+13)}$$	CO4
8	Obtain the state model for the transfer function given below $$\frac{C(s)}{R(s)} = \frac{s+2}{(s+3)(s+1)}$$	CO4
9	Plot the root locus plot for the system when the open loop transfer function is given by $$G(s) = \frac{K}{s(s+4)(s^2+4s+13)}$$	CO5
10	Obtain the state model for the transfer function given below $$\frac{C(s)}{R(s)} = \frac{s+2}{(s+3)(s+1)}$$	CO5
		Total Hours: 15 hrs.

Course Code: BEC0551X	Course Name: Wireless Communication Networks (Workshop-III)	L	T	P	C
Course Offered in: B.Tech. ECE		**0**	**0**	**6**	**3**

Pre-requisite: Analog and Digital Communication

Course Objectives:

This course provides an understanding of the evolution and fundamentals of modern wireless communication systems, including LTE, WiMAX, and 5G technologies. It covers wireless channel characteristics, MIMO systems, multiple access techniques, wireless network architectures, and advanced communication methods such as OFDM and beamforming, along with major wireless communication standards and their applications.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Explain the evolution of wireless communication systems from 1G to 5G, including LTE, LTE-A, and WiMAX technologies.	K2
CO2	Analyze radio wave propagation mechanisms, wireless channel models, fading characteristics, and MIMO communication channels.	K4
CO3	Compare and evaluate multiple access techniques, wireless network architectures, and challenges in MANET and WSN systems.	K4
CO4	Apply OFDM principles, multicarrier modulation techniques, beamforming, and spectrum sharing concepts in modern wireless systems.	K3
CO5	Explain LTE/LTE-A, IEEE 802.11 WLAN, and IEEE 802.16 standards and their roles in broadband wireless communication systems.	K2

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	-	-	-	-	-	-	-	-	2	3	2
CO2	3	3	2	-	-	-	-	-	-	-	-	2	3	2
CO3	3	3	2	-	-	-	-	-	-	-	-	2	3	2
CO4	3	3	3	-	-	-	-	-	-	-	-	3	3	2
CO5	3	3	2	-	-	-	-	-	-	-	-	2	3	2

Course Contents / Syllabus

Unit 1	**Introduction to Wireless Communication Systems**	**09 hours**

Introduction to 1G/2G/3G/4G/5G Terminology. Evolution of cellular systems requirements, goals, and vision of the next-generation wireless communication systems, Requirements and Targets for Long Term Evolution (LTE) - Technologies for LTE- 4G Advanced Features and Roadmap Evolutions from LTE to LTEA. WiMAX.

Unit 2	**Wireless Propagation and Channel Characteristics**	**09 hours**

Introduction to Radio Wave Propagation, Free Space Propagation Model, wireless channel models- path loss and shadowing models; statistical fading models; narrowband and wideband fading models; MIMO channels, Narrowband fading, Wideband fading models, Delay spread and Coherence bandwidth, Doppler spread and Coherence time, Flat fading versus frequency selective fading, Slow fading versus fast fading, Discrete-time model. AWGN

Unit 3	**Wireless Access Technique and Networks**	**09 hours**

Contention-free multiple access schemes (FDMA TDMA, CDMA, SDMA, and Hybrid), contention- based multiple access schemes (ALOHA and CSMA), Waveforms, Variable subcarrier spacing, supported transmission numerologies. Design Challenges in Ad-hoc wireless networks, the concept of cross-layer design, security in wireless networks, energy-constrained networks, MANET and WSN.

Unit 4	Advanced Wireless Communication Techniques	09 hours
Small cells: Past, present, and future trends of cellular networks coverage and capacity of small cell networks, Data transmission using multicarrier modulation for frequency-selective fading channels. Overlapping sub channels, Mitigation of Subcarrier Fading, Discrete Implementation of multicarrier – OFDM. Cyclic prefix, Peak-to average-power-ratio. Multicarrier modulation, OFDM, diversity multiplexing trade off, OFDM system, smart-antenna: beam forming, cognitive radio, software-defined radio, communication relays, spectrum sharing.		
Unit 5	**Introduction to LTE and Wireless Standards**	**09 hours**
Introduction to LTE, LTE-A Standards and Technology, WLAN Standard IEEE 802.11, IEEE 802.11 Medium Access Control, Comparison of IEEE 802.11 a,b,g and n standards, IEEE 802.16 and its enhancements.		
	Total Lecture Hours	**45 hours**

Textbook:	
	Authors Name
1. Millimeter Wave Wireless Communication	T. S. Rappaport, R. W. Heath Jr., R. C. Daniels, and J. M. Murdock,
2. Wireless Communications	Andrea Goldsmith
Reference Books:	
	Authors
1. Wireless Communications and Networks	Vijay K Garg,

Self-Study Content Links:		**Duration (in Hrs)**
MOOCs		
Video Lectures	**Unit 1** https://youtube.com/playlist?list=PLbRMhDVUMngGDlSMc5ibSqp2yAtbKo7d&si=m7gVcVO8ZN6f1ziI	06Hrs28Min
	Unit 2 https://www.youtube.com/watch?v=9ujT1upyWVg	03Hrs56Min
	Unit 3 https://www.youtube.com/watch?v=AKXFwwcww_E	02Hrs59Min
	Unit 4 https://www.youtube.com/watch?v=ew0lx9buuXc	02Hrs49Min
	Unit 5 https://www.youtube.com/watch?v=pnunzdvezto	01Hrs59Min
Web References		

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.

List Of Practical's (Indicative & Not Limited To)		
S. No.	**Name of Experiments/ Programs**	**CO**
1	Understand Measures of Network Performance: Throughput and Delay.	**CO1**
2	Simulate and study 5G Handover procedure.	**CO1**
3	Simulate and analyze the relation between beamforming gain and antenna count.	**CO4**
4	Investigate how throughput varies with antenna count.	**CO5**
5	Investigate how a packet is transmitted over OFDM physical layer.	**CO4**

6	Analytically estimate (per 3GPP standards) the application throughput for asimple use-case.	**CO2**
7	Simulate and analyze throughput as different PHY parameters are varied.	**CO2**
8	Analytically estimate (per 3GPP standards) the application throughput for a simple use-case.	**CO3**
9	Simulate path loss variation with the distance between the UE and the gNB.	**CO3**
10	Investigate path loss variation with gNB height. What is the optimal height of a gNB?	**CO4**
11	To calculate no of channel in FDMA.	**CO5**
12	To calculate allocated bandwidth for given specification.	**CO3**
13	To calculate efficiency in TDMA system.	**CO3**
14	To calculate channel capacity of SISO.	**CO3**
15	To calculate channel capacity of single input multiple output.	**CO4**
16	To calculate channel capacity of SIMO with N=40.	**CO4**
17	To calculate channel capacity of multiple input and single output (MISO) system.	**CO4**
18	To calculate the channel capacity of MISO of receiver.	**CO4**
19	To calculate channel capacity of MIMO system.	**CO4**
20	To calculate the channel capacity of MIMO with different no of receiver and transmitter.	**CO4**
21	To calculate the channel capacity of SISO system if bandwidth of channel is 1MHZ and SNR is 24db.	**CO4**
22	To calculate no of channel in FDMA system.	**CO4**
23	To calculate Allocated BW "Bt" given N, Bc and Bg for a wireless system.	**CO3**
24	To calculate time in transmitting 1bit of data.	**CO2**
25	To calculate rate of transmission of data if no of bit and time is given.	**CO2**
26	To compute total frame efficiency in TDMA system.	**CO2**
27	To compute the total no of overhead bits of TDMA system if eff is given.	**CO3**
28	To calculate vulnerable time for pure aloha.	**CO3**
29	To calculate the vulnerable time for slotted aloha.	**CO3**
30	To calculate the throughput in KBPS for pure aloha.	**CO3**
31	To calculate no of station given other parameters of pure aloha.	**CO3**
32	To calculate the no of frame per second by each station.	**CO3**
33	To calculate the coherent time in Doppler shift.	**CO3**
34	To calculate the no of channel in pure aloha.	**CO2**
35	To calculate the maximum throughput of pure aloha given BW.	**CO3**
36	To calculate the throughput of each station of if probability of each is given.	**CO3**
37	To find AMPS communication level.	**CO3**
38	To find comparison of capacity.	**CO1**
39	To find Capacity of GSM.	**CO5**
40	To find frame duration.	**CO5**
		Total Hours: 35 hrs.

Course Code: BEC0602	Course Name: Digital Signal Processing	L	T	P	C
Course Offered in: B.Tech. ECE		3	1	0	4

Pre-requisite: Basic Vector Algebra

Course Objectives:

This course introduces the fundamental concepts of Discrete Fourier Transform (DFT), circular convolution, and digital filtering techniques used in discrete-time signal processing. It develops the ability to design, analyze, and evaluate IIR and FIR digital filters using various analog-to-digital transformation methods and filter design approaches. The course also provides knowledge of digital system realization structures, multirate signal processing, and adaptive filtering techniques, enabling students to address advanced signal processing and communication system applications.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Perform the linear filtering through circular convolution using Discrete Fourier Transform.	K3
CO2	Design the Infinite Impulse Response digital filters from Analog filter using various transformation techniques.	K4
CO3	Design and analyse the Finite Impulse Response Filters.	K4
CO4	Realize the digital system through different methods of realization structures and their utilities.	K4
CO5	Explain the concept of Multirate and adaptive signal processing.	K2

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	-	-	-	-	-	-	-	3	2	3	3
CO2	3	3	3	-	-	-	-	-	-	-	3	2	3	3
CO3	3	3	3	-	-	-	-	-	-	-	3	2	3	3
CO4	3	3	2	-	-	-	-	-	-	-	3	2	3	3
CO5	3	3	2	-	-	-	-	-	-	-	3	2	3	3

Course Contents / Syllabus

Unit 1	**Discrete Fourier Transform**	**9 hours**

Basics of signal processing: Classification of signal processing, Applications of Digital Signal Processing in the real world. Frequency Analysis of Discrete-Time Systems: Discrete Time Fourier Transform (DTFT), Discrete Fourier Transform (DFT), Properties of the DFT, Relationship of DFT with DTFT & Z- transform. Linear Filtering using Circular Convolution and Linear Convolution. Fast Fourier Transform: Radix-2 DIT-FFT & DIF-FFT algorithm, inverse DFT using FFT algorithm.

Unit 2	**Design of IIR Digital Filters**	**9 hours**

Introduction to Filters: Classification of filters, Characteristic of digital filters, Filter Design Specifications. Filter Transformation Techniques: Impulse Invariant Transformation, Bi-Linear Transformation. All- Pole Analog Filters: Design of Butterworth and Chebyshev filters, Analog and Digital frequency transformation.

Unit 3	**Design of FIR Digital Filters**	**9 hours**

FIR filter: Condition for linear phase, Frequency response of linear phase FIR filter. FIR filter Design: Fourier series method, Gibb's Phenomenon, Windowing methods, Comparison of FIR & IIR digital filters. Finite Word length effects in digital filters: Coefficient quantization error, Quantization noise – truncation and rounding, Limit cycle oscillations-dead band effects.

Unit 4	**Realization of Digital Systems**	**9 hours**

Introduction: basic building blocks to represent a digital system, recursive and non-recursive systems, basic structures of a digital system: Canonical and Non-Canonical structures. IIR Filter Realization: Direct form, Cascade, Parallel form realization, continued fraction expansion, Ladder structures. FIR Filter Realization: Direct form, Cascade, Linear Phase Realization.		
Unit 5	**Multirate Signal Processing**	**9 hours**
Introduction to Multirate signal processing: Decimation, Interpolation, Sampling rate conversion: Single and Multistage, applications of MDSP- Sub-Band Coding of Speech signals, Quadrature mirror filters, Advantages of MDSP. Adaptive Filter: Introduction & Example of adaptive Filter, The window LMS Algorithm, Recursive Least Square Algorithm. The Forward-Backward Lattice and Gradient Adaptive Lattice Method. Basics of bio-medical signal processing.		
	Total Lecture Hours	**45 hours**

Textbook:	
	Authors Name
1. Digital signal processing Principles Algorithms & Applications	John G Prokias, Dimitris G Manolakis
2. Digital signal processing	S. Salivahanan, A Vallavaraj, C Gnanapriya

Reference Books:	
	Authors Name
1. Digital Signal Processing	Johnny R. Johnson
2. Discrete Time Signal Processing	Oppenheim & Schafer

Self-Study Content Links:		Duration (in Hrs)
MOOCs		
Video Lectures	Unit 1 https://youtu.be/Q8wuqYsdnSs?si=gcOSHbgyoMRkbe3S Unit 2 https://youtu.be/OX69YU-zEGY?si=GRu-T4QR1qc2KGyr Unit 3 https://youtu.be/c6o3fscTEtc?si=ZnoWkH-59fVERXue Unit 4 https://youtu.be/4Q-R1E5B40Q?si=e3Th7qV_KmajfojM Unit 5 https://youtu.be/__uF9WlEpPo?si=Yq85IpRIbi6GEKZ-	02Hrs57Mins 01Hrs01Mins 03Hrs49Mins 01Hrs01Mins 01Hrs01Mins
Web References		

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.

Course Code: BEC0603	Course Name: IoT Architecture and Protocols	L	T	P	C
Course Offered in: B.Tech. ECE		3	1	0	4

Pre-requisite: Basic knowledge of programming, networking (like the OSI Model), and basic electronics.

Course Objectives:

To provide students with the fundamental concepts of Internet of Things (IoT), including system architecture, communication protocols, sensor interfacing, and cloud connectivity. The course also aims to develop the skills required to design, implement, and deploy IoT-based communication and control systems for real-world applications.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Describe the components, layers, and architecture of IoT systems including device, network, and application layers.	K2
CO2	Develop the ability to interface sensors with microcontrollers and transmit sensor data to the cloud using platforms like ThingSpeak and Blynk.	K2
CO3	Explore various communication protocols and standards in IoT such as UART, Bluetooth, LoRaWAN, NB IoT, and M2M.	K2
CO4	Evaluate differences and capabilities of IoT architectures and middleware platforms including OIC, IoTivity, and WoT.	K4
CO5	Simulate and design data communication and control in IoT systems using dashboards, cloud integration, and lightweight data formats	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	-	-	-	-	-	-	-	-	1	2	3
CO2	2	3	2	-	-	-	-	-	-	-	-	1	2	3
CO3	2	2	2	-	-	-	-	-	-	-	-	1	2	3
CO4	2	2	2	-	-	-	-	-	-	-	-	1	2	3
CO5	3	2	2	-	-	-	-	-	-	-	-	1	2	2

Course Contents / Syllabus

Unit 1	**Reference Architecture**	**9 hours**
IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, IoT Reference Architecture Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. Real-World Design Constraints- Introduction, Technical Design constraints, Data representation and visualization, Interaction and remote control, Wireless Sensor Network.		
Unit 2	**IoT Device Architecture**	**9 hours**
IoT Open-source architecture (OIC)- OIC Architecture & Design principles- IoT Devices and deployment models- IoTivity: An Open source IoT stack - Overview- IoTivity stack architecture- Resource model and Abstraction. LoRaWAN architecture, Channel access mechanism specific to NB IoT.		
Unit 3	**IoT Connectivity Protocol**	**9 hours**
IoT Connectivity Overview, Wireless Long Range (WAN) Protocols, LAN Protocols, Serial Protocols, IoT transmission Protocols, Wired LAN Protocols, Features and security in Bluetooth.		
Unit 4	IoT Layered Protocol	**9 hours**
Protocol Standardization for IoT, Efforts, M2M and WSN Protocols, SCADA and RFID Protocols, Issues with IoT Standardization, Unified Data Standards Protocols IEEE802.15.4, IEEE 802.11, BAC Net Protocol Modbus, KNX, architecture and Protocol stack used in Zig bee, Network layer, APS layer.		

Unit 5	Web of Things	9 hours
Web of Things versus Internet of Things, Two Pillars of the Web, Architecture Standardization for WoT, Platform Middleware for WoT, Unified Multitier WoT Architecture, WoT Portals and Business Intelligence.		
	Total Lecture Hours	**45**

Textbook:	
	Authors Name
1. Internet of Things (A Hands-on-Approach)	Vijay Madisetti, Arshdeep Bahga
2. Rethinking the Internet of Things: A Scalable Approach to Connecting Everything	Francis DaCosta
Reference Books:	
	Authors Name
1. Getting Started with the Internet of Things	Cuno Pfister
2. Digital Electronics- An introduction to theory and practice	W.H Gothmann
3. Theory and Logic Design	A. Anand Kumar

Self-Study Content Links:		**Duration (in Hrs)**
MOOCs		
Video Lectures	**Unit 1** https://www.youtube.com/live/-RHYCpsn8TA?si=_W9-dCLt6cfpfMMK	01Hrs11Min
	Unit 2 https://youtu.be/UETJWf-lQeE?si=KmSa9DgzjlcI7FG0	01Hrs28Min
	Unit 3 https://youtube.com/playlist?list=PLgwJf8NK-2e6AVNI0dpIFsrNjsGGf-qLu&si=gZYN_oi6ZfAwUMno	02Hrs27Min
	Unit 4 https://youtu.be/-7dAFWRjCoA?si=olbTb8ZxfE-DvyDq	02Hrs27Min
	Unit 5 https://youtu.be/qbQVKRZoOcQ?si=KDxJ88MVBpK8mBQB	00Hrs07Min
Web References		

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.

Course Code: BEC0612	Course Name: Image Processing and Pattern Recognition	L	T	P	C
Course Offered in: B.Tech. ECE		3	0	0	3

Pre-requisite: Basic knowledge of programming, networking (like the OSI Model), and basic electronics.

Course Objectives:

To provide students with the fundamental concepts of digital image processing, including image representation, enhancement, restoration, and segmentation techniques. The course also aims to develop the ability to analyze, interpret, and extract meaningful information from images for diverse real-world applications.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Describe the fundamental concepts of digital image processing and image formation	K2
CO2	Apply image enhancement techniques in spatial and frequency domains.	K3
CO3	Recognize various noises in images and apply restoration methods	K2
CO4	Apply different segmentation techniques on image.	K3
CO5	Apply knowledge of mathematics for image understanding and analysis.	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	-	-	-	-	-	-	-	-	2	2	3
CO2	3	2	2	-	-	-	-	-	-	-	-	2	2	3
CO3	3	2	2	-	-	-	-	-	-	-	-	2	2	3
CO4	3	2	2	-	-	-	-	-	-	-	-	2	2	3
CO5	3	2	2	-	-	-	-	-	-	-	-	2	2	3

Course Contents / Syllabus

Unit 1	**Digital Image Processing**	**09 hours**

Digital Image Processing: Definition, Basic image file formats, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Image Sensing and Acquisition, Image Sampling and Quantization, Basic Relationship between Pixels, Applications of DIP.

Unit 2	**Image Enhancement**	**09 hours**

Spatial Domain: Basic Gray Level Transformations, Histogram based Processing, Enhancement using Arithmetic/Logic Operations, Spatial Filtering: Smoothing and Sharpening Filter. Frequency Domain: Image Smoothing and Image Sharpening Using Frequency Domain Filters, Homomorphic Filtering.

Unit 3	**Image Restoration**	**09 hours**

Image Degradation/Restoration process model, Noise Models, Restoration in the presence of noise only spatial filtering, Periodic noise reduction by frequency domain filtering. Compression: Lossless compression: Variable length coding, LZW coding, Bit plane coding, Predictive coding-DPCM, Lossy Compression: Transform coding, Wavelet coding, Basics of Image compression standards: JPEG, MPEG, HEIF/HEIC and WebP

Unit 4	**Image Segmentation and Image/Object Feature Extraction**	**09 hours**

Fundamentals of different color models - RGB, CMY, HSI, YCbCr, Lab; False color; Pseudo color; Enhancement; Segmentation, Dilation and Erosion Operators, Top Hat Filters.

Unit 5	**Color Image Processing & Morphological Filtering Basis**	**09 hours**

Point, Line and Edge Detection, Thresholding: Otsu and Adaptive, Region-Based Segmentation, Morphological Watershed, K-means and Fuzzy C-means, Wavelet Transform, Discrete Wavelet Transform, Hough Transform

	Total Lecture Hours	**45 hours**

Textbook:

	Authors Name
1. Digital Image Processing Pearson	Rafael C. Gonzalez

2. Fundamentals of Digital Image Processing	Anil K. Jain
Reference Books:	
	Authors Name
1. Image Processing, Analysis and Machine Vision	Milan Sonka Vaclav Hlavav, Roger Boyle
2. Digital Image Processing	Rafael C Gonzalez and Richard E Woods
3. Digital Image Processing	John Wiley & Sons

Self-Study Content Links:		**Duration (in Hrs)**
MOOCs		
Video Lectures	**Unit 1** https://youtube.com/playlist?list=PL1F076D1A98071E24&si=2cIpmH8Tgpjldqtr **Unit 2** https://youtu.be/994ZNi7rSXo?si=DetcbGIr0NiCjKrc **Unit 3** https://youtu.be/5qxrzD6ODHc?si=cHzxu_vKZIpHWiwP **Unit 4** https://youtu.be/3qJej6wgezA?si=IsYvtfoeFT8MqAFp **Unit 5** https://youtu.be/eVugfKb91ZY?si=jihIZzWGbmbfFePX	00Hrs54Min 00Hrs58Min 00Hrs59Min 00Hrs57Min 00Hrs54Min
Web References		

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.

Course Code: BEC0618	Course Name: Semiconductor Memories	L	T	P	C
Course Offered in: B.Tech. ECE		3	0	0	3

Pre-requisite: Basic knowledge of Digital Electronics, Semiconductor Devices, and Computer Organization

Course Objectives:

To provide students with the fundamental concepts of semiconductor memory systems, including memory hierarchy, organization, and performance characteristics. The course also aims to develop an understanding of RAM, ROM, advanced and emerging memory technologies, and their applications in modern computing systems.

Course Outcome: After completion of the course, the student will be able to

Course Outcome		Bloom's Level
CO1	Explain the basic concepts and hierarchy of semiconductor memories.	K2
CO2	Analyze different types of RAM and ROM and their working principles.	K4
CO3	Design and evaluate memory organization and addressing techniques.	K4
CO4	Compare advanced memory technologies and their applications.	K2
CO5	Describe the timing and power optimization of memory systems.	K2

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	-	-	-	-	-	-	-	-	1	3	2
CO2	3	3	2	-	-	-	-	-	-	-	-	1	3	2
CO3	3	3	3	-	-	-	-	-	-	-	-	1	3	2
CO4	3	3	2	-	-	-	-	-	-	-	-	1	3	2
CO5	3	2	2	-	-	-	-	-	-	-	-	1	3	2

Course Contents / Syllabus

Unit 1	Introduction to Semiconductor Memories	09 hours

Memory hierarchy, Overview of memory types and their applications, Importance of memory design in integrated circuits, Basic principles of memory operation: Basic memory cell, memory organization, addressing and decoding, performance parameters (access time, cycle time, bandwidth).

Unit 2	Read Only Memory (ROM)	09 hours

Mask ROM, PROM, EPROM, EEPROM, Flash memory, memory cell design, programming and erasing mechanisms, applications of ROM.

Unit 3	Random Access Memory (RAM)	09 hours

Static RAM (SRAM): SRAM cell design and optimization, Memory bit-cell stability and read/write operations, SRAM array architecture and peripheral circuitry

Dynamic RAM (DRAM): DRAM cell design and refresh mechanisms, Memory array organization and addressing, Timing considerations in DRAM design, Comparison between SRAM and DRAM, memory expansion and organization.

Unit 4	Advanced Memory Technologies	09 hours

Flash memory architecture, NAND and NOR Flash, Programming and erasing mechanisms, Wear levelling and error correction in Flash memory, cache memory, associative memory, content addressable memory (CAM), virtual memory concepts.

Unit 5	Emerging Memory Technologies/Timing and Power optimization	09 hours

Magneto resistive RAM (MRAM), Phase Change Memory (PCM), Ferroelectric RAM (FeRAM), Resistive RAM (ReRAM), 3D memory architectures, future trends in memory design.

Timing and Signal Integrity: Setup and hold time analysis, Clock-to-q delay considerations, Signal integrity challenges in memory circuits. **Power Optimization in Memory Systems:** Active and standby power consumption in memory, Power-gating and clock gating techniques, Low-power design strategies for memory circuits.	
Total Lecture Hours	**45 hours**
Textbook:	
	Authors Name
1. VLSI Memory Chip Design	Itoh, Kiyoo
2. Memory Systems: Cache, DRAM, Disk	Morgan Kaufmann, Bruce Jacob, Spencer Ng, David Wang
3. Semiconductor Memories: Technology, Testing and Reliability	Ashok K. Sharma
Reference Books:	
	Authors Name
1. Computer Organization and Design	Morgan Kaufmann, Patterson & Hennessy
2. Designing Memory	Tanović, Sabina.
3. VLSI-Design of Non-Volatile Memories	Campardo, Giovanni.

Self-Study Content Links:		**Duration (in Hrs)**
MOOCs		
Video Lectures	**Unit 1** https://youtube.com/playlist?list=PLS5wcuo7uiTdG3UAxkTWh2MT1mzWaKh8p&si=mT-zgu1XGcoyV10R	00Hrs22Min
	Unit 2 https://youtu.be/Cd19ohX0770?si=1Do_Wplu3TqNjEbq	00Hrs10Min
	Unit 3 https://youtu.be/p4R0Ej6FCn0?si=2F360aDXGvC8K1zm	00Hrs13Min
	Unit 4 https://youtu.be/dDpYha_4NYI?si=IuHOgb7OfwoPQeQu	00Hrs15Min
	Unit 5 https://youtu.be/aDzUu0L-rdg?si=BEPJ1NlXJDYqEYa_	00Hrs45Min
Web References		

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.

Course Code: BEC0616	Course Name: Real Time Operating System	L	T	P	C
Course Offered in: B.Tech. ECE		3	0	0	3

Pre-requisite: Basic fundamental of microprocessor, microcontroller & Embedded System

Course Objectives:

To provide students with the fundamental concepts of embedded operating systems and real-time operating systems (RTOS), including process management, task scheduling, and resource management. The course also aims to develop the skills required to interface memory and I/O devices and implement embedded applications using CMSIS-RTOS and RTX.

Course Outcome: After completion of the course, the student will be able to

Course Outcome		Bloom's Level
CO1	Explain the basics Embedded Operating System internals.	K2
CO2	Describe the basic concepts of RTOS.	K2
CO3	Apply the concepts of Process and Task Scheduling	K3
CO4	Implement strategies to interface memory and I/O with RTOS kernel	K3
CO5	Analyze the architecture of CMSIS-RTOS & process of RTX task management.	K4

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	2	-	-	-	-	-	-	-	-	2	2	3
CO2	2	2	2	-	-	-	-	-	-	-	-	2	2	3
CO3	2	2	2	-	-	-	-	-	-	-	-	2	2	3
CO4	2	2	2	-	-	-	-	-	-	-	-	2	2	3
CO5	2	2	2	-	-	-	-	-	-	-	-	2	2	3

Course Contents / Syllabus

Unit 1	**Linux Internals**	**09 hours**

Linux internals: Process Management, File Management, Memory Management, I/O Management. Overview of POSIX APIs, Threads – Creation, Cancellation, POSIX Threads Inter Process Communication – Semaphore, Pipes, FIFO, Shared Memory Kernel: Structure, Kernel Module Programming, Interfacing: Serial, Parallel Interrupt Handling Linux Device Drivers: Character, USB, Block & Network.

Unit 2	**OS Overview**	**09 hours**

OS overview: OS components, OS structure, Types of Operating Systems, Basics of RTOS: Real-time concepts, Characteristics of RTOS, Architecture of RTOS, Classification of RTOS: Hard Real time and Soft Real-time, Firm real time system, Advantage and disadvantage of RTOS

Unit 3	**Process Management**	**09 hours**

Process: Introduction, Memory lay out of an executing program, Process types, Schedulers and Types of scheduling, Scheduling Process control block, Process creation, Process Termination, Context Switching and States.

Unit 4	**Concurrency & Memory Management**	**09 hours**

Concurrency: Concurrency Scheduling, Multiprocessing environment, Read-write by multiple CPUs and consistency problem, Solutions with Mutual Exclusion, Hardware Mutex, Software Mutex, Example: Dekker's algorithm, Semaphore, Deadlock, Bankers algorithm. Memory Management: Processes Need Memory, Address Binding & its types, Memory Hierarchy, Virtual Memory, Memory Partitioning, Paging, Segmentation with Paging, File System, File Structure, Directory Structure, Disk, Interrupt & DMA.

Unit 5	**Introduction to RTX**	**09 hours**

RTX: RTX structure, RTX files, RTX task and time management, Simple Time Management APIs, Task Priority Scheme in RTX, Inter-Task Communication, Event, Interrupt, Mutex, Semaphore, Mailboxes and Messages in RTX, RTX control functions, Architecture of CMSIS-RTOS.		
	Total Lecture Hours	**45 hours**

Textbook:

	Authors Name
1. Real-Time Operating Systems for ARM Cortex-M Microcontrollers	Jonathan W. Valvano
2. Real-Time Concepts for Embedded Systems	Qing Li and Carolyn Yao
3. The Real-Time Kernel	Jean J. Labrosse

Reference Books:

	Authors Name
1. Embedded Systems: Architecture Programming and Design	Raj Kamal
2. Building Embedded Linux Systems	Karim Yaghmour

Self-Study Content Links:		**Duration (in Hrs)**
MOOCs		
Video Lectures	**Unit 1** https://youtu.be/jENkpxUOoXM?si=OQB-DiRgojwraWi- **Unit 2** https://youtu.be/vJ10L102xb0?si=ZZm5gySoMcYqwC9J **Unit 3** https://youtu.be/2h3eWaPx8SA?si=plNynA4Z3UNttfFE **Unit 4** https://youtu.be/RhNWpUrO5MQ?si=dfDa4KNBNlMO4yXU **Unit 5** https://youtu.be/5ASguXEl_VE?si=9dT4rZpxQB7GxNul	00Hrs17Min 01Hrs06Min 02Hrs06Min 02Hrs12Min 01Hrs07Min
Web References		

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.

Course Code: BEC0615	Course Name: ANN & Deep Learning	L	T	P	C
Course Offered in: B.Tech. ECE		3	0	0	3

Pre-requisite: Basic knowledge of Linear Algebra, Probability Theory. It would be beneficial if the participants have done a course on Machine Learning

Course Objectives:

This course introduces the fundamentals of neural networks and deep learning, including optimization techniques, PCA, and model regularization methods. It enables students to design, train, and apply deep learning models using CNNs, RNNs, LSTMs, and GRUs for solving complex real-world problems.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Describe the fundamental concepts, history, and architecture of neural networks and deep learning.	K2
CO2	Implement and analyze gradient-based optimization algorithms and dimensionality reduction techniques like PCA.	K3
CO3	Apply regularization methods and optimization strategies to train efficient deep learning models.	K3
CO4	Compare and contrast popular deep learning architectures such as CNNs (LeNet, AlexNet, VGG, ResNet, etc.).	K2
CO5	Design and implement RNN, LSTM, and GRU-based models for sequential data analysis.	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	-	-	-	-	-	-	-	2	2	2	3
CO2	3	3	2	-	-	-	-	-	-	-	2	2	2	3
CO3	3	3	2	-	-	-	-	-	-	-	2	2	2	3
CO4	3	3	2	-	-	-	-	-	-	-	2	2	2	3
CO5	3	3	2	-	-	-	-	-	-	-	2	2	2	3

Course Contents / Syllabus

Unit 1	**Introduction**	**9 hours**

Introduction: History of Deep Learning, Deep Learning Success Stories, McCulloch Pitts Neuron, ANN and its types, Multilayer Perceptron's (MLPs), Representation Power of MLPs, Sigmoid Neurons, RELU activation, Gradient Descent, Activation Functions, Loss Functions, Feed Forward Neural Networks, Back propagation.

Unit 2	**Optimization & Dimensionality Reduction**	**9 hours**

Gradient Descent (GD), Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, Principal Component Analysis and its interpretations, Singular Value Decomposition, Auto encoders and relation to PCA, Regularization in auto encoders, De-noising auto encoders, Sparse auto encoders.

Unit 3	**Design of FIR Digital Filters**	**9 hours**

Regularization: Bias Variance Trade-off, L1 and L2 regularization, Drop-outs, Early stopping, Dataset augmentation, Greedy Layer-wise Pretraining, Soft-max layer, Weight initialization methods, Batch Normalization, Learning Vectorial Representations of Words.

Unit 4	**Deep learning architectures**	**9 hours**

Convolutional Neural Networks: Convolution, Padding, Stride, Pooling, LeNet, AlexNet, ZF-Net, VGGNet, ResNet, DenseNet.

Unit 5	**RNN and LSTM models**	**9 hours**

<table>
<tr><td colspan="4">Recurrent Neural Networks, Back propagation through time (BPTT), Vanishing and Exploding Gradients, Truncated BPTT, GRU, LSTMs, Encoder Decoder Models.</td></tr>
<tr><td colspan="3" align="right">Total Lecture Hours</td><td>45 hours</td></tr>
<tr><td colspan="4">Textbook:</td></tr>
<tr><td colspan="2"></td><td colspan="2">Authors Name</td></tr>
<tr><td colspan="2">1. Deep learning</td><td colspan="2">Ian Goodfellow and Yoshua Bengio and Aaron Courville</td></tr>
<tr><td colspan="2">2. Artificial neural network</td><td colspan="2">B. Yegnanarayana</td></tr>
<tr><td colspan="4">Reference Books:</td></tr>
<tr><td colspan="2"></td><td colspan="2">Authors Name</td></tr>
<tr><td colspan="2">1. Neural Networks and Deep Learning</td><td colspan="2">Nielsen, Michael A.</td></tr>
<tr><td colspan="2">2. Machine Intelligence: Demystifying Machine Learning, Neural Networks and Deep Learning</td><td colspan="2">Suresh Samudrala</td></tr>
<tr><td colspan="2">3. Neural Networks</td><td colspan="2">Kumar Satish</td></tr>
<tr><td colspan="3">Self-Study Content Links:</td><td>Duration (in Hrs)</td></tr>
<tr><td>MOOCs</td><td colspan="2"></td><td></td></tr>
<tr><td>Video Lectures</td><td colspan="2">Unit 1
https://www.youtube.com/watch?v=QK7GJZ94qPw
Unit 2
https://www.youtube.com/watch?v=IHZwWFHWa-w
Unit 3
https://www.youtube.com/playlist?list=PLVHz9YUo4rRd5ZmGg8Kq0S1tIi7hthm4V
Unit 4
https://www.youtube.com/playlist?list=PLEAYkSg4uSQ1r-2XrJ_GBzzS6I-f8yfRU
https://www.youtube.com/playlist?list=PLVHz9YUo4rRd5ZmGg8Kq0S1tIi7hthm4V
Unit 5
https://www.youtube.com/watch?v=AsNTP8Kwu80
https://www.youtube.com/playlist?list=PLEAYkSg4uSQ1r-2XrJ_GBzzS6I-f8yfRU</td><td></td></tr>
<tr><td>Web References</td><td colspan="2"></td><td></td></tr>
</table>

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.

Course Code: BEC0614	Course Name: Robotics Design Mechanism	L	T	P	C
Course Offered in: B.Tech. ECE		3	0	0	3

Pre-requisite: Basics of mathematics and python programming

Course Objectives:

To provide students with the fundamental concepts of industrial robotics, including robot configurations, workspaces, drive systems, sensors, material handling, and end-effectors. The course also aims to develop an understanding of robot dynamics, feeding mechanisms, and the design and application of robotic systems in industrial automation.

Course Outcome: After completion of the course, the student will be able to

Course Outcome		Bloom's Level
CO1	Explain industrial robots and their operational workspace characteristics & Manipulators.	K2
CO2	Analyze drives & its control.	K4
CO3	Describe the use of sensors & solve kinematics of robot manipulators.	K2
CO4	Apply feed material & orientation.	K3
CO5	Create application-based prototypes of robots.	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	-	-	-	-	-	-	-	2	1	2	3
CO2	3	3	3	-	-	-	-	-	-	-	2	1	2	3
CO3	3	3	2	-	-	-	-	-	-	-	2	1	2	3
CO4	3	3	2	-	-	-	-	-	-	-	2	1	2	3
CO5	3	3	3	-	-	-	-	-	-	-	2	1	2	3

Course Contents / Syllabus

Unit 1	Review and Definitions	09 hours

Robots & its Kinds, Definition of Levels, Manipulators, Structure of Automatic Industrial Systems, Non-industrial Representatives of the Robot Family, Relationship between the Level of Robot "Intelligence" and the Product. Concepts and Layouts: Processing Layout, Concept of an Automatic Manufacturing Process, Productivity of a Manufacturing Process, Then Kinematic Layout, Rapid Prototyping.

Unit 2	Kinematics and Control of Automatic Machines	09 hours

Electromagnetic Drive, Electric Drives, Hydraulic Drive, Pneumo-drive, Brakes, Drive with a Variable Moment of Inertia. Kinematics and Control of Automatic Machines: Position Function, Camshafts, Master Controller, Amplifiers, Dynamic Accuracy, Damping of Harmful Vibrations, Automatic Vibration Damping, Electrically Controlled Vibration Dampers.

Unit 3	Transporting Device	09 hours

Linear and Angular Displacement Sensors, Speed and Flow-Rate Sensors, Force Sensors Temperature Sensors, Item Presence Sensors. Transporting Devices: General Considerations, Linear Transportation, Rotational Transportation, Vibrational Transportation.

Unit 4	Types of Orientation	09 hours

Introduction, Feeding of Liquid and Granular Materials, Feeding of Strips, Rods, Wires, Ribbons, Feeding of Oriented Parts from Magazines, Feeding of Parts from Bins, General Discussion of Orientation of Parts, Passive Orientation, Active Orientation, Logical Orientation, Orientation by Non-mechanical Means.

Unit 5	Manipulators	09 hours

General Concepts, Automatic Assembling, Special Means of Assembly, Inspection Systems, Miscellaneous Mechanisms. Manipulators: Dynamics of Manipulators, Grippers & Guides.			
		Total Lecture Hours	**45 hours**
Textbook:			
	Authors Name		
1. Robotics designing the mechanisms for automated machinery	Ben-Zion Sandler		
2. Industrial Automation	John Wiley & Sons		
Reference Books:			
	Authors Name		
1. Introduction to Manufacturing Processes	Schey, John A		
2. Introduction to Robotics	Londo. Critchlow, ArthurJ		

Self-Study Content Links:		**Duration (in Hrs)**
MOOCs		
Video Lectures	**Unit 1** https://nptel.ac.in/courses/107106090 **Unit 2** https://nptel.ac.in/courses/112107289 **Unit 3** https://nptel.ac.in/courses/112105319 **Unit 4** https://nptel.ac.in/courses/108108147 **Unit 5** https://nptel.ac.in/courses/112103174	02Hrs04Min 01Hrs02Min 02Hrs07Min 04Hrs10Min 04Hrs02Min
Web References		

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.

LAB Course Code: BEC0653	LAB Course Name: IoT Architecture and Protocols Lab	L	T	P	C
Course Offered in: B. Tech ECE		0	0	4	2

Pre-requisite: Basic knowledge of programming, networking (like the OSI Model), and basic electronics.

Course Objectives:

To provide students with the fundamental concepts of Internet of Things (IoT), including system architecture, communication protocols, cloud integration, and middleware platforms. The course also aims to develop the skills required to design, implement, and analyze IoT-based monitoring and control systems for real-world applications.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Explain the layered architecture and functional components of IoT systems and apply them to real world applications	K2
CO2	Implement cloud-based data transmission and remote-control using platforms such as ThingSpeak, Blynk, and IoT dashboards.	K3
CO3	Analyze communication protocols and technologies including LoRa, NB-IoT, Bluetooth, and serial communication for IoT systems.	K4
CO4	Evaluate and compare open-source IoT architectures (OIC, IoTivity, WoT) based on scalability, interoperability, and middleware capabilities.	K5

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	2	-	-	-	-	-	-	1	2	1
CO2	3	3	2	2	2	-	-	-	-	-	-	1	3	1
CO3	3	3	3	2	3	-	-	-	-	-	-	1	3	1
CO4	2	2	3	1	3	-	-	-	-	-	-	2	3	1

List Of Practical's (Indicative & Not Limited To)

S. No.	**Name of Experiments/ Programs**	**CO**
1	Understand the layers and components of a basic IoT system.	CO1
2	Transmitting Sensor Data to Cloud (Thing Speak). Send live data from a sensor to a cloud server.	CO1
3	Building a Simple IoT Dashboard to understand data visualization in IoT.	CO2
4	Remote Device Control using Blynk App to enable remote control in an IoT system.	CO2
5	Create JSON strings from sensor data to Explore data formats used in IoT communication.	CO2
6	Analyze a real-life IoT application using reference architecture views. Select a use case (e.g., smart parking).	CO2
7	To implement the RFID-based authentication using a Raspberry Pi.	CO3
8	To Transfer Data Between Arduino and NodeMCU Using Zigbee Modules.	CO3
9	To send sensor data to the Thingspeak cloud with a Raspberry Pi	CO3
10	Smart Lighting System using ThingSpeak IoT Cloud and Raspberry Pi	CO4
11	Simple Serial communication from Arduino to Raspberry Pi	CO4
12	To implement the communication between Android and Raspberry Pi using Bluetooth.	CO4
13	IoT Controlled LED with Blynk App using Raspberry Pi	CO4

Total Hours: 30 hrs.

LAB Course Code: BEC0652N	LAB Course Name: Digital Signal Processing Lab	L	T	P	C
Course Offered in: B. Tech ECE		0	0	4	2

Pre-requisite: Basic knowledge signal and systems concepts

Course Objectives:

To provide students with the fundamental concepts of digital signal processing, including frequency-domain analysis, DFT, FFT, and digital filter design. The course also aims to develop the skills required to design, analyze, and implement IIR and FIR filters, and apply multirate signal processing techniques in practical DSP applications.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Perform frequency domain analysis of discrete-time system using N point DFT & FFT. different types of signals and its properties used in signal processing.	K3
CO2	Design and evaluate the performance of IIR filters using various techniques and implement in Butterworth and Chebyshev approximation respectively.	K4
CO3	Design and evaluate the performance of FIR filters using various window techniques.	K4
CO4	Realize the IIR and FIR filters using various techniques.	K3
CO5	Analysis the decimation and interpolation processes for multi-rate signal processing system.	K4

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	-	3	-	-	-	-	-	-	3	2	2
CO2	3	3	3	-	3	-	-	-	-	-	-	3	2	2
CO3	3	2	3	-	3	-	-	-	-	-	-	3	2	2
CO4	3	2	2	-	3	-	-	-	-	-	-	3	2	2
CO5	3	2	2	-	3	-	-	-	-	-	-	3	2	2

List Of Practical's (Indicative & Not Limited To)

S. No.	Name of Experiments/ Programs	CO
1	Evaluate the DFT of a given sequences and plot the magnitude and phase response of the output sequence and also find its IDFT using MATLAB.	**CO1**
2	Write a MATLAB program to perform the various matrix operations such as addition, subtraction, multiplication, inverse etc on Twiddle factor with its Conjugate Twiddle factor.	**CO1**
3	Evaluate and verify the linear convolution of the given sequences and impulse response using MATLAB for linear filtering applications.	**CO1**
4	Evaluate and verify the circular convolution of the given sequences and impulse response using MATLAB for linear filtering applications.	**CO1**
5	Analysis of DIT-FFT algorithm for a given sequence x(n)= {2n} for n= 0, 1, 2, 3 and draw the frequency spectrum of given signals.	**CO1**
6	Write a MATLAB code for a given sequence using DIF-FFT algorithm and draw the frequency spectrum of given signals.	**CO1**
7	Write a MATLAB code for the IDFT of a given sequence using DIF algorithm. (Include signal graph calculation).	**CO1**
8	Write a MATLAB program to plot a given continuous time signal and its sampled version, given that fs=10 Hz.	**CO2**

9	Design and analysis of a 2nd order analog Low Pass and High Pass Butterworth IIR filter for a cut off frequency of 4 KHz also draw the pole-zero diagram, magnitude and phase response using Filter Designer tool.	**CO2**
10	Design and analysis of a Band Pass and Band Stop Butterworth IIR filter also draw the pole-zero diagram, magnitude and phase response using Filter Designer tool.	**CO2**
11	Design and analysis of a 2nd order analog Low Pass and High Pass Chebyshev IIR filter for a cut off frequency of 4 KHz also draw the pole-zero diagram, magnitude and phase response using Filter Designer tool.	**CO2**
12	Design and analysis of a Band Stop and Band Pass Chebyshev IIR filter also draw the pole-zero diagram, magnitude and phase response using Filter Designer tool.	**CO2**
13	Write a MATLAB program to design a digital low pass Butterworth filter to satisfy the following: As=16 dB, Ap=7dBΩp=0.2π , Ωs= 0.3π. Use the Invariant Transform method. Assume T= 1 sec	**CO2**
14	Write a MATLAB program to design a digital low pass Butterworth filter to satisfy the following: As=16 dB, Ap=7dBΩp=0.2π , Ωs= 0.3π. Use the bilinear transformation method. Assume T= 1 sec	**CO2**
15	Design and implement a Low Pass FIR filter using rectangular window and Hamming window technique in MATLAB.	**CO3**
16	Design and implement a Low Pass FIR filter using Hanning window and Bartlett window technique in MATLAB.	**CO3**
17	Write a MATLAB program to design an FIR filter to meet the following specifications: pass band edge= 2 KHz, stopband edge= 5 KHz, passband attenuation=2 dB, stopband attenuation= 42 dB and sampling frequency= 20 KHz.	**CO3**
18	Write a MATLAB program to design a LPF with passband gain of unity, cut off frequency of 100 Hz and working sampling frequency of 5 KHz using rectangular window. Take the length of the impulse responses M=7.	**CO3**
19	Design and implement a Low Pass FIR filter using Gibbs window technique and verify its linear phase characteristics in MATLAB.	**CO3**
20	Realization of IIR digital systems of transfer function in Direct Form I and Direct Form II using MATLAB.	**CO4**
21	Realization of IIR digital systems of transfer function in Cascade Form and Parallel Form using MATLAB.	**CO4**
22	Realization of IIR digital systems from difference equations using Ladder structure Form in MATLAB.	**CO4**
23	Realization of FIR digital systems of transfer function using Direct Form in MATLAB.	**CO4**
24	Realization of FIR digital systems of transfer function in Linear Phase structure form using MATLAB	**CO4**
25	Realization of FIR digital systems of given transfer function in Linear Phase-Cascade Form using MATLAB	**CO4**
26	Design and analysis of decimation and interpolation of a given sequence x(n) = {1, 2, 2, 3, 2, 2, 2, 2, 1} for decimation factor D=4 and interpolation factor I=3.	**CO5**
27	Write a MATLAB program to observe the effect of down sampling and up sampling in frequency domain.	**CO5**
28	Design FIR low-pass and high-pass mirror filters using MATLAB and plot its magnitude and phase responses and analyze cutoff frequency and transition bandwidth.	**CO5**

29	Design and implement a Least Mean Square (LMS) and Recursive Least Squares (RLS) adaptive filter adaptive filter and evaluate noise reduction performance using SNR	**CO5**
30	Design FIR low-pass, high-pass, and band-pass filters for ECG/EEG processing and perform spectral analysis using FFT	**CO5**
Total Hours: 30 hrs.		

LAB Course Code: BEC0612P	**LAB Course Name: Image Processing and Pattern Recognition Lab**	**L**	**T**	**P**	**C**
Course Offered in: B. Tech ECE		**0**	**0**	**2**	**1**

Pre-requisite: Python/MATLAB, Probability, Image Processing Fundamentals.

Course Objectives:

To provide students with the fundamental concepts of digital image processing, including image enhancement, sharpening, restoration, compression, and segmentation techniques. The course also aims to develop the skills required to analyze image features and apply image processing methods for computer vision and image analysis applications.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Implement image sharpening and image enhancement algorithm.	K3
CO2	Analyze the power of various image restoration and compression techniques.	K3
CO3	Learn basic skills for image segmentation and image analysis.	K2
CO4	Analyze the spatial/ texture features of image.	K4
CO5	Implement and evaluate different enhancement and segmentation techniques for developing computer vision applications.	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	2	-	3	-	-	-	-	3	2	2	2	2
CO2	2	2	2	-	3	-	-	-	-	3	2	2	2	3
CO3	2	2	2	-	3	-	-	-	-	3	2	2	2	3
CO4	2	2	2	-	3	-	-	-	-	3	2	2	2	3
CO5	2	2	2	-	3	-	-	-	-	3	2	2	2	3

List Of Practical's (Indicative & Not Limited To)

S. No.	**Name of Experiments/ Programs**	**CO**
1	To Write a program using MATLAB/Python to display grey scale/color images.	**CO1**
2	Write a program using MATLAB/Python to extract different attributes (i.e., Geometrical and texture) of an Image.	**CO4**
3	Write a program using MATLAB/Python for Image Negation.	**CO2**
4	Write a program using MATLAB/Python for Power Law Transformation.	**CO1**
5	Write a program using MATLAB/Python for Histogram Mapping and Equalization.	**CO3**
6	Write a program using MATLAB/Python for Image Smoothening and Sharpening.	**CO1**
7	Write a program using MATLAB/Python for Edge Detection using Sobel, Prewitt and Roberts Operators.	**CO3**
8	Write a program using MATLAB/Python for Morphological Operations on Binary Images	**CO3CO4**
9	Write a program using MATLAB/Python for Pseudo Coloring.	**CO5**
10	Write a program using MATLAB/Python for the segmentation using watershed transform.	**CO3CO5**
11	Write a program to eliminate the high frequency components of an image. Write a MATLAB program for DCT based image compression	**CO2**
12	Write a program using MATLAB/Python to extract the image features for image segmentation using DWT Computation	**CO4CO5**
		Total Hours: 15 hrs.

LAB Course Code: BEC0616P	LAB Course Name: Real Time Operating System Lab	L	T	P	C
Course Offered in: B. Tech ECE		0	0	2	1

Pre-requisite: Microcontroller architecture, GPIO, timers, serial communication protocols.

Course Objectives:

To provide hands-on experience in real-time operating systems (RTOS), including task creation, scheduling, inter-task communication, and synchronization techniques. The course also aims to develop practical skills in designing and implementing real-time embedded applications using CMSIS-RTOS, FreeRTOS/RTX on ARM Cortex-M and STM32 platforms.

Course Outcome: After completion of the course, the student will be able to

Course Outcomes		Bloom's Level
CO1	Develop and execute RTOS-based programs involving task creation, scheduling, and inter-task communication using appropriate development tools.	K3
CO2	Implement synchronization and resource-sharing mechanisms such as semaphores, mutexes, message queues, and event flags in real-time applications.	K3
CO3	Implement real-time applications using an RTOS like CMSIS-RTOS, Free RTOS, or RTX.	K3
CO4	Perform hands-on experimentation on real or simulated embedded hardware (e.g., STM32, ARM Cortex-M).	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	2	-	3	-	-	-	-	-	2	2	2	2
CO2	2	2	2	-	3	-	-	-	-	-	2	2	2	2
CO3	2	2	2	-	3	-	-	-	-	-	2	2	2	2
CO4	2	2	2	-	3	-	-	-	-	-	2	2	2	2

List Of Practical's (Indicative & Not Limited To)

S. No.	Name of Experiments/ Programs	CO
1	Setup of toolchain (e.g., Keil uVision, STM32CubeIDE), Introduction to CMSIS-RTOS or Free RTOS. Blinking LED without RTOS vs. with RTOS.	CO1
2	Create multiple tasks with different priorities; demonstrate task switching and preemption	CO1
3	Use osDelay, vTaskDelay, and timers. Measure task execution time.	CO2
4	Change task priorities dynamically and observe scheduling behavior.	CO2
5	Use binary and counting semaphores for task synchronization	CO3
6	Implement inter-task communication using message queues	CO3
7	Use mailboxes or event flags for signaling between tasks	CO4
8	Use software timers for delayed and periodic task execution	CO4
9	Explore static and dynamic memory allocation APIs in RTOS.	CO4
10	Implement Round Robin, Rate Monotonic (RM), or Earliest Deadline First (EDF) scheduling.	CO4

Total Hours: 15 hrs.

LAB Course Code: BEC0614P	LAB Course Name: Robotics Lab	L	T	P	C
Course Offered in: B. Tech ECE		**0**	**0**	**2**	**1**

Pre-requisite: Mechanics, kinematics, dynamics, basic electrical circuits

Course Objectives:

To provide hands-on experience in robotic simulation using KUKA. Sim Pro software and the KUKA KR10 robotic arm. The course also aims to develop practical skills in programming, simulating, and validating robotic operations for industrial automation applications.

Course Outcome: After completion of the course, the student will be able to		Bloom's Level
CO1	Explain the basic features of KUKA sim pro software/Robot Studio ABB Software.	K2
CO2	Develop and simulate the various programs on KUKA sim pro software/Robot Studio ABB Software.	K5
CO3	Summarize about the KUKA KR10 robotics arm.	K2
CO4	Simulate various programs on KUKA KR10 robotics arm.	K5

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	2	-	-	-	-	-	-	3	2	2	1
CO2	3	2	1	2	-	-	-	-	-	-	3	2	2	1
CO3	3	2	1	2	-	-	-	-	-	-	3	2	2	1
CO4	3	2	1	2	-	-	-	-	-	-	3	2	2	1

List Of Practical's (Indicative & Not Limited To)

S. No.	Name of Experiments/ Programs	CO
1	Study of KUKA sim pro/ABB Robot Studio software and its features.	CO1
2	Create target, create path, create work object move along the path-linear movement in KUKA sim pro/ABB Robot Studio software.	CO1
3	Write a simulation program for welding task by using KUKA sim pro/ABB Robot Studio software. Geometrical path generation Automated circular path creation	CO2
4	To write a simulation program for pick & place task on using KUKA sim pro/ABB Robot Studio software.	CO2
5	Study Teach pandent of KUKA /ABB Robotics Arm.	CO2
6	Study Rapid Programming/ KRL programming and write a program of pick and place using programming.	CO3
7	Simulation of finger gripper in KUKA sim pro with the help of a "move tower" project.	CO3
8	To study about robotics arm KR 10 and its features.	CO4
9	To verify the simulation program for task of pick & place on robotic arm KR-10.	CO4
10	To verify the simulation program for welding task on robotic arm KR-10.	CO4

Total Hours: 15 hrs.

Course Code: BEC0655	Course Name: 5G Technology (Workshop)	L	T	P	C
Course Offered in: B.Tech. ECE		0	0	6	3

Pre-requisite: Basics understanding of wireless communication, 4G LTE technology, and networking concepts.

Course Objectives:

To provide students with the fundamental concepts of 5G communication systems, including architecture, protocol stack, physical layer, and wireless channel characteristics. The course also aims to develop an understanding of advanced 5G technologies such as Massive MIMO, beamforming, and millimeter-wave communication for next-generation wireless networks.

Course Outcome: After completion of the course, the student will be able to		**Bloom's Level**
CO1	Explain 5G architecture, protocol stack, and physical layer operations.	K2
CO2	Analyze propagation models and channel characteristics in 5G systems.	K4
CO3	Apply Massive MIMO, beamforming, and mmWave concepts in 5G design.	K3
CO4	Evaluate mobility management, QoS mechanisms, and routing in 5G networks.	K4
CO5	Explain network slicing, NFV, and their role in modern 5G networks.	K2

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	-	3	-	-	-	-	-	-	2	3	3
CO2	3	3	2	-	3	-	-	-	-	-	-	2	3	3
CO3	3	3	3	-	3	-	-	-	-	-	-	3	3	3
CO4	3	3	2	-	3	-	-	-	-	-	-	2	3	3
CO5	3	2	2	-	3	-	-	-	-	-	-	3	3	3

Course Contents / Syllabus

Unit 1	**Introduction to 5G Architecture and Protocols**	**09 hours**

Introduction to 5G RAN (Radio Access Networks), 5G NR Logical architectures, 5G NR Protocol stack (Layer 2 and Layer 3) Introduction to Physical Layer: Physical layer techniques, 5G NR MAC layer Architecture, functions, Channel Mapping, Procedures, Headers and Sub-headers.

Unit 2	**Propagation Scenarios and Channel Modelling**	**09 hours**

Channel modelling requirements, propagation scenarios and challenges in the 5G modelling, Channel Models for mm Wave MIMO Systems. 5G Requirements, Key Capabilities of 5G versus 4G, 5G operating scenario, mm wave technology, Propagation modelling of 5G. The architecture and function of core network nodes in 5G. Components and protocols involved in the 5G core.

Unit 3	**Massive MIMO Techniques**	**09 hours**

Massive MIMO propagation channel models, Channel Estimation in Massive MIMO, Massive MIMO with Imperfect CSI, Multi-Cell Massive MIMO. Compare legacy (4G LTE) and modern (5G) core architectures. Configuration of 5G CN elements. Beamforming.

Unit 4	**Mobility and Handoff Management**	**09 hours**

Interference and mobility management in 5G, Handoff management in 5G, QoS improvement with 5G, QoS mechanisms offered by 5G, 5G QoS Flow Descriptions and Characteristics. IP Routing: Types of routing protocols, IPv6 addressing.

Unit 5	**Network Slicing and Function Virtualization**	**09 hours**

Network Slicing: Concept, architecture, the status of network slicing in 5G standards, network slicing in core networks, network slicing challenges for 5G Networks. Network Functions Virtualization (NFV): Functionality, architecture, advantages for 5G network

			Total Lecture Hours	45 hours
Textbook:				
		Authors Name		
1. 5G Mobile and Wireless Communications Technology		Afif Osseiran, Jose F. Monserrat, Patrick Marsch		
2. Fundamentals of 5G Mobile Networks		Jonathan Rodriguez		
Reference Books:				
		Authors Name		
1. Millimetre Wave Wireless Communications		Theodore S. Rappaport		
2. Network Slicing for 5G and Beyond Networks		S. M. Ahsan Kazmi, Latif U. Khan, Nguyen H. Tran, Choong Seon Hong		
Self-Study Content Links:			**Duration (in Hrs)**	
MOOCs				
Video Lectures	**Unit 1** https://www.youtube.com/watch?v=SbYltPawklg **Unit 2** https://www.youtube.com/watch?v=FwtVorAfEss **Unit 3** https://www.youtube.com/watch?v=9ujT1upyWVg **Unit 4** https://www.youtube.com/watch?v=0MvAflrjIq0 **Unit 5** https://www.youtube.com/watch?v=MdPY0UCQe2o		01Hrs26Min 01Hrs28Min 03Hrs56Min 02Hrs14Min 01Hrs31Min	
Web References				

Note: Self-study material may include assignments, seminars, micro projects, industrial visits, any other student activities, etc.