NEW HORIZON COLLEGE OF ENGINEERING

Autonomous College Permanently Affiliated to VTU, Approved by AICTE & UGC
Accredited by NAAC with 'A' Grade, Accredited by NBA

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

Scheme & Syllabus

(Fourth) Final Year BE

Academic Year 2022-23

New Horizon College of Engineering

Department of Electronics and Communication Engineering

VISION

To create high quality engineering professionals who can serve the society and earn global recognition.

MISSION

- To build strong foundation in Electronics and Communication Engineering aspects by exposing students to state of the art technology and research.
- To strengthen the curriculum through interaction with industry experts to equip the students with the required competency.
- To mould students to share technical knowledge and to practice professional and moral values.

Program Education objectives (PEOs)

PEO1	To produce graduates with understanding of fundamentals and applications of Electronics and Communication Engineering.
PEO2	To hone graduates with ability to apply, analyze, design and develop electronic systems.
PEO3	To enhance graduates with latest technologies to enable them to engineer products for real world problems in Electronics and Communication.
PEO4	To build leadership qualities, management skills, communication skills, moral values, team spirit and lifelong learning ability for the graduates.

PEO to Mission Statement Mapping

Mission Statements	**PEO1**	**PEO2**	**PEO3**	**PEO4**
To build strong foundation in Electronics and Communication Engineering aspects by exposing students to state of the art technology and research.	3	3	3	2
To strengthen the curriculum through interaction with industry experts to equip the students with the required competency.	2	3	3	2
To mould students to share technical knowledge and to practice professional and moral values.	1	2	2	3

Correlation: 3- High, 2-Medium, 1-Low

Program Outcomes (PO) with Graduate Attributes

	Graduate Attributes	Program Outcomes (POs)
1	**Engineering knowledge**	**PO1:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems in Electronics and Communication Engineering.
2	**Problem analysis**	**PO2:** Identify, formulate, review research literature, and analyze complex engineering problems in Electronics and Communication Engineering reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3	**Design/development of solutions**	**PO3:** Design solutions for complex engineering problems and design system components or processes of Electronics and Communication Engineering that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4	**Conduct investigations of complex problems**	**PO4:** Use research-based knowledge and research methods including design of experiments in Electronics and Communication Engineering, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5	**Modern tool usage**	**PO5:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities in Electronics and Communication Engineering with an understanding of the limitations.
6	**The engineer and society**	**PO6:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice in Electronics and Communication Engineering.
7	**Environment and sustainability**	**PO7:** Understand the impact of the professional engineering solutions of Electronics and Communication Engineering in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8	**Ethics**	**PO8:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9	**Individual and team work**	**PO9:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10	**Communication**	**PO10:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11	**Project management and finance**	**PO11:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12	**Life-long learning**	**PO12:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes

PSO1	To demonstrate the ability to design and develop complex systems in the areas of next generation Communication Systems, IoT based Embedded Systems, Advanced Signal and Image Processing, latest Semiconductor technologies, RF and Power Systems.
PSO2	To demonstrate the ability to solve complex Electronics and Communication Engineering problems using latest hardware and software tools along with analytical skills to contribute to useful, frugal and eco-friendly solutions.

Mapping of PEOs to POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
PEO1	3	3	2	2	2	1	1	1	1	1	1	1	1	1
PEO2	3	3	3	3	3	2	2	2	2	2	2	2	3	2
PEO3	3	3	3	3	3	3	3	2	2	2	2	2	3	3
PEO4	1	1	1	1	1	2	2	3	3	3	3	3	1	1

Correlation: 3-High, 2-Medium, 1-Low

New Horizon College of Engineering
Department of Electronics and Communication Engineering
Scheme of Seventh Semester (Autonomous)
B.E Program – Batch: 2019-2023
Academic Year 2022-2023 (ODD)

Semester VII

Sl. No.	Course Code	Course	BoS	Credit Distribution				Overall Credits	Contact hours	Marks		
				L	T	P	S			CIE	SEE	Total
1	20ECE71A	Wireless Communication	ECE	3	0	0	0	3	3	50	50	100
2	20ECE72A	Antennas and Wave Propagation	ECE	3	0	0	0	3	3	50	50	100
3	20ECE73A	Fiber Optic Communication	ECE	3	0	0	0	3	3	50	50	100
4	**20ECE74XA**	**Professional Elective-IV**	ECE	3	0	0	0	3	3	50	50	100
	20ECE741A	Embedded Computing	ECE									
	20ECE742A	Advanced Semiconductors	ECE									
	20ECE743A	Satellite Communications	ECE									
	20ECE744A	Biomedical Signal Processing	ECE									
	20ECE745A	Artificial Intelligence and Cognitive Computing	ECE									
	20ECE746A	Software Defined Radio	ECE									
5	**20ECE75XA**	**Professional Elective-V**	ECE	3	0	0	0	3	3	50	50	100
	20ECE751A	Robotics	ECE									
	20ECE752A	Low Power VLSI Design	ECE									
	20ECE753A	Wireless Ad-hoc Sensor Networks	ECE									
	20ECE754A	VLSI Signal Processing	ECE									
	20ECE755A	Neural Networks	ECE									
	20ECE756A	Renewable Energy	ECE									
6	20ECL76A	Advanced Communication Lab	ECE	0	0	1.5	0	1.5	3	25	25	50
7	20ECL77A	EDA Software Workshop Lab	ECE	0	0	1.5	0	1.5	3	25	25	50
8	20ECL78A	**Project Phase-1**	ECE	0	0	2	0	2	4	25	25	50
9	**20NHOPXXX**	**Open Elective-II**	ECE	3	0	0	0	3	3	50	50	100
	20NHOP709	CISCO - Routing and Switching-1	ECE									
	20NHOP712	CISCO- Routing and Switching-2	ECE									
	20NHOP718A	Physical Design	ECE									
	20NHOP722A	Programming of Industrial Robot	ECE									
	20NHOP723A	5G Mobile Communication	ECE									
Total								**23**	**28**	**375**	**375**	**750**

New Horizon College of Engineering
Department of Electronics and Communication Engineering
Scheme of Eighth Semester (Autonomous)
B.E Program – Batch: 2019-2023
Academic Year 2022-2023 (EVEN)

Semester VIII

Sl. No.	Course Code	Course	BoS	Credit Distribution				Overall Credits	Contact hours	Marks		
				L	T	P	S			CIE	SEE	TOTAL
1	**20ECE81XA**	**Professional Elective-VI**	ECE	3	0	0	0	3	3	50	50	100
	20ECE811A	Internet of Things	ECE									
	20ECE812A	VLSI Design Manufacturing	ECE									
	20ECE813A	Cellular Mobile Communication	ECE									
	20ECE814A	Industrial Automation	ECE									
	20ECE815A	Python and R Programming	ECE									
	20ECE816A	Optical Networks	ECE									
2	**20ECE82XA**	**Professional Elective-VII**	ECE	3	0	0	0	3	3	50	50	100
	20ECE821A	Switching & Finite Automata Theory	ECE									
	20ECE822A	Digital Neurocomputing	ECE									
	20ECE823A	Pattern Recognition and Application	ECE									
	20ECE824A	Radar Networks	ECE									
	20ECE825A	Wireless and High speed ICs and Systems	ECE									
	20ECE826A	Block Chain Technology	ECE									
3	20ECL83A	**Internship**	ECE	0	0	0	0	4	0	50	50	100
4	20ECL84A	**Project Phase-2**	ECE	0	0	10	0	10	20	150	150	300
							Total	**20**	**26**	**300**	**300**	**600**

SEVENTH SEMESTER

(SYLLABUS)

Wireless Communication

Course Code : 20ECE71A | **Credits : 3**
L: T:P:S : 3:0:0:0 | **CIE Marks : 50**
Exam Hours : 3 Hrs | **SEE Marks : 50**

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Understand the basics of wireless communication and evolution of wireless communication standards with time
CO2	Choose appropriate radio signal propagation model for different communication systems
CO3	Recognize GSM and CDMA basic operations and call setup processes
CO4	Appraise the significance of multi carrier modulation techniques in current communication scenario
CO5	Identify the application areas of modern communication techniques
CO6	Apply the concept of smart multi antenna systems for advanced wireless communication

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	3	-	-	1	1	-	-	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-
CO4	3	3	3	3	-	1	1	-	-	-	-	2
CO5	3	3	3	3	-	1	1	-	-	-	-	2
CO6	3	3	-	-	-	1	1	-	-	-	-	2

SYLLABUS			
Module No	**Module Contents**	**Hours**	**COs**
1	**Introduction to wireless communication systems** Evolution of wireless communication systems, Examples of wireless communication systems. Cellular concept - Frequency reuse - channel assignment strategies - hand off strategies -interference & system capacity – trunking & grade of service – Improving coverage and capacity in cellular system. Text Book 1: 1.1,1.4, 3.1,3.2,3.3,3.4, 3.5, 3.6, 3.7	**9**	**CO1**
2	**Free Space Propagation Model** Three Basic Propagation mechanism – Reflection (Ground Reflection -Two Ray model), Diffraction(knife-edge diffraction model)and Scattering ,model - Link Budget design using Path Loss model(log normal shadowing) Outdoor and Indoor Propagation models –Okumura model, Hata model, log	**9**	**CO1,CO2**

	distance path loss model Small scale multipath propagation – Parameters of mobile multipath channels – Types of small scale fading –Fading effects due to Multipath time delay spread and Fading effects due to Doppler spread - Rayleigh and Rician distribution. Text Book 1:4.1, 4.2, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9,4.10,4.11,5.4,5.5,5.5.1,5.5.2, 5.6		
3	**Wireless standards** Introduction to wireless standards – 1G-AMPS, 2G. GSM services and features, System architecture, Radio subsystem, channel types, Frame structure for GSM CDMA (IS-95) – CDMA frequency bands, Forward and Reverse CDMA Channel. Text Book 1: 11.1, 11.3, 11.4	**9**	**CO1,CO3**
4	**OFDM for Wireless Communication** Basic principles of orthogonality, single Vs Multi-carrier systems, ODFM Block diagram, OFDM signal mathematical representation, pilot insertion and channel estimation Text Book 2: 9.1, 9.2, 9.3, 9.4, 9.9	**9**	**CO4,CO5,**
5	**Multipath Mitigation Techniques** Diversity – Types of Diversity – Diversity combining techniques: Selection, Feedback, Maximal Ratio Combining and Equal Gain Combining Introduction to MIMO, MIMO based system architecture, MIMO channel modeling, Advantages and applications of MIMO Text Book 2: 15.1, 15.2, 15.3,15.8, 15.13	**9**	**CO4, CO5,CO6**

Text Books:

1. Rappaport T.S., "Wireless communications", Pearson Education, 2014.
2. Wireless Communication — UpenDalal, Oxford Univ. Press,2009

Reference books:

1. Lee, W.C.Y., Mobile Communication Engineering, McGraw Hill, 2017.
2. David Tse and Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press, 2005.
3. Andreas.F. Molisch, "Wireless Communications", John Wiley India, 2006.
4. Wireless Communications-Andrea Goldsmith, 2005 Cambridge University Press.

Mapping of CO v/s PSO:

-	PSO1	PSO2
20ECE71A	**Wireless Communication**	
CO1	-	-
CO2	-	-
CO3	-	-
CO4	3	3
CO5	3	3
CO6	3	3

Assessment Pattern

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Category	Tests	Assignments	Quizzes
Marks (out of 50)	25	15	10
Remember	-		
Understand	10		
Apply	10	10	5
Analyze	5	5	5
Evaluate			
Create			

SEE- Semester End Examination (50 Marks)

Bloom's Taxonomy	SEE Marks
Remember	-
Understand	20
Apply	20
Analyze	10
Evaluate	-
Create	-

Antennas and Wave Propagation

Course Code: 20ECE72A **Credits : 3**
L: T:P:S : 3:0:0:0 **CIE Marks :50**
Exam Hours: 3 Hrs **SEE Marks : 50**

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Understand basic antenna parameters and mathematical representations
CO2	Interpret the radiation pattern of antenna arrays for complex engineering problems
CO3	Analyze radiation integrals and auxiliary potential for antennas
CO4	Make use of mathematical analysis of electric short dipole and linear wire antennas in describing the characteristics of antennas
CO5	Design antenna systems for Multidisciplinary domain with appropriate consideration for public health and safety
CO6	Choose proper atmospheric layer for wave propagation with respect to environmental consideration

Mapping of Course Outcomes to Program Outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	3	1	-	-	-	-	-	-	-	-
CO3	3	3	3	-	-	-	-	-	-	-	-	-
CO4	3	3	3	1	-	-	-	-	-	-	-	-
CO5	3	3	3	1	-	1	1	1	-	-	-	1
CO6	3	-	-	-	-	-	-	-	-	-	-	-

SYLLABUS			
Module No	**Module Contents**	**Hours**	**COs**
1	**UNIT 1: FUNDAMENTELS OF ANTENNA:** Introduction, Radiation patterns, Radiation Power Density and intensity, Beam-width, Directivity, Antenna Efficiency, Gain, Beam Efficiency, Bandwidth, Polarization, Input Impedance, Antenna Radiation Efficiency, Vector Effective Length and Equivalent Areas, Maximum Effective Area, Antenna temperature, Friis Equation. Antenna field zones. **Text1:** **2.2,2.3,2.4,2.5,2.6,2.8.2.9,2.10,2.11,2.12,2.13,2.14,2.15,2.16, 2.17.,2.18.** **Text2 : 2.1,2.2,2.3,2.4,2.5,2.6,2.7,7.1,7.2,7.3,7.4,7.5**	9	CO1, CO2
2	**UNIT 2: RADIATION INTEGRALS AND AUXILIARY POTENTIAL:** Introduction, The Vector Potential for an Electric Current Source and Magnetic Current Source**,** Fields for Electric and Magnetic Current Sources. Solution of Wave Equation. Far-Field Radiation, Duality, Reciprocity and Reaction Theorems **Text1 : 3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8** **Text 2 : 1.1, 1.2**	9	CO3
3	**UNIT 3: LINEAR WIRE ANTENNAS:** Introduction, Infinitesimal Dipole, Small Dipole, Region Separation, Finite Length Dipole, Half-Wavelength Dipole, Linear Elements Near or on Infinite Perfect Conductors, Ground Effects. **Types of Antennas and their characteristics- Yagi Uda, Micro-strip and Horn antennas.** **Text 1: 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 13.1, 13.2, 14.1, 14.2.** **Text2 : 6.3,6.9**	9	CO4
4	**UNIT 4: ANTENNA ARRAYS: LINEAR, PLANAR, AND CIRCULAR:** Introduction, Two-Element Array, N-Element Linear Array: Uniform Amplitude and Spacing, Directivity, N-Element Linear Array: N-Element Uniform Spacing, Non-uniform Amplitude, Planar Array, Circular Array. **Text1: 6.1, 6.2, 6.3, 6.4, 6.5, 6.10, 6.11, 6.12.** **Text2 :5.1,5.2,5.3,5.4**	9	CO5
5	**UNIT 5: WAVES PROPAGATION:** Introduction, Ground wave propagation, free space propagation, ground reflection, surface wave, diffraction. Tropospheric scatter, Ionosphere propagation, electrical properties of the ionosphere, effects of earth's magnetic field. **Text1 :16.4** **Text2:8.1,8.2.**	9	CO6

Text Books:

1. "Antenna Theory, Analysis, and, Deign" – C. A. Balanis, 3rd Edition, John Wiley India Pvt. Ltd., 2008.
2. "Antennas and Wave Propagation" - Harish and Sachidananda: Oxford Press 2007.

Reference Books:

1. "Antennas and Wave Propagation," John D. Krauss, 4th En, McGraw-Hill International edition, 2010.
2. "Antennas and Propagation for Wireless Communication Systems" – S. R. Saunders, John Wiley, 2003.
3. "Antennas and Wave Propagation", - G S N Raju, Pearson Education, 2005.

Mapping of CO v/s PSO:

-	PSO1	PSO2
20ECE72A	**Antennas and Wave propagation**	
CO1	-	-
CO2	3	3
CO3	-	-
CO4	3	3
CO5	3	3
CO6	3	3

Assessment Pattern

CIE – Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	5	---	---
Understand	5	---	5
Apply	10	---	---
Analyze	5	15	5
Evaluate	---	---	---
Create	---	---	---

SEE – Semester End Examination (50 Marks)

Bloom's Taxonomy	SEE Marks
Marks	**50**
Remember	10
Understand	10
Apply	20
Analyze	10
Evaluate	---
Create	---

Fiber Optic Communication

Course Code : 20ECE73A | **Credits : 3**
L: T:P:S : 3:0:0 :0 | **CIE Marks : 50**
Exam Hours : 3 Hrs | **SEE Marks : 50**

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Apply the fundamentals of optical fiber communication in modern communication systems
CO2	Identify suitable Optical fiber structure for a specific application
CO3	Analyze the effect of channel impairments in Optical Fiber communication systems
CO4	Assess the performance of optical receivers
CO5	Utilize the theory of optical multiplexers for networking applications
CO6	Illustrate different concepts for creating optical amplification

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	3	-	-	-	-	-	-	-	-	-
CO3	3	3	3	3	-	-	-	-	-	-	-	-
CO4	3	3	3	3	2	1	-	-	-	-	-	-
CO5	3	3	-	-	-	-	-	-	-	-	-	-
CO6	3	3	3	3	-	1	1	-	-	-	-	-

SYLLABUS			
Module No	**Module Contents**	**Hours**	**COs**
1	**OVERVIEW OF OPTICAL FIBER COMMUNICATION:** Historical development, The General System, advantages, disadvantages, and applications of optical fiber communication, Raytheory, Electromagnetic mode theory, cylindrical fiber (no derivations in section 2.4.4), single mode fiber, cutoff wave length, mode filed diameter. Text Book 1: 1.1, 1.2, 1.3, 2.1, 2.2, 2.3.1,2.3.2,2.3.3,2.4, 2.5.1, 2.5.2	**9**	**CO1**
2	**OPTICAL SOURCES AND TRANSMISSION CHARACTERISTICS OF OPTICAL FIBERS:** Optical sources: LED, power and efficiency, LED structures, LED characteristics, LASER basic concepts, The Semiconductor Injection LASER Attenuation, absorption, scattering losses, bending loss, dispersion, Chromatic dispersion, Inter model dispersion.	**9**	**CO2, CO3**

	Text Book 1: 7.2,7.3.1,7.3.2,7.3.3,7.3.4, 7.4,6.2,6.4,3.1, 3.2 3.3, 3.4, 3.6, 3.8, 3.9, 3.10		
3	**OPTICAL RECEIVER:** Physical Principles of Photo diodes, PIN and APD, Photo detector noise. Optical Receiver Operation, receiver sensitivity, quantum limit, eye diagrams, coherent detection Text Book2: 6.1.1,6.1.2, 6.2, 7.1, 7.2.2, 7.2.3,7.3, 7.4	**9**	**CO4, CO6**
4	**OPTICAL AMPLIFIERS:** Basic Applications and types of Optical amplifiers, semiconductor optical amplifiers, EDFA, Amplifier Noise, Optical SNR Text Book2: 11.1,11.2,11.3,11.4,11.5	**9**	**CO4, CO6**
5	**WDM CONCEPTS AND OPTICAL NETWORKS:** Overview of WDM- operation principles, WDM standards, Mach-Zehender interferometer multiplexer, Isolators and circulators, Optical network concepts, network topologies, SONET/SDH, Optical Add/Drop Multiplexing Text Book2:10.1.1, 10.1.2,10.2.5,10.3,13.1,13.2,13.3,13.5	**9**	**CO5**

TEXT BOOKS:

1. **"Optical Fiber Communications"**, John M. Senior, Pearson Education, Second Edition,7th Impression, 2010.

2. **"Optical Fiber Communication"**, Gerd Keiser, 4th Ed., MGH, 2008.

REFERENCE BOOK:

1. **Fiber Optic Communication** - Joseph C Palais: 4th Edition, Pearson Education.

Mapping of CO v/s PSO:

-	PSO1	PSO2
20ECE73A	**Fiber Optic Communication**	
CO1	-	-
CO2	-	-
CO3	3	3
CO4	3	3
CO5	-	-
CO6	3	3

Assessment Pattern

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Category	**Tests**	**Assignments**	**Quizzes**
Marks (out of 50)	25	15	10
Remember	-	-	-
Understand	10	-	5
Apply	10	10	5
Analyze	5	5	-
Evaluate	-	-	-
Create	-	-	-

SEE- Semester End Examination (50 Marks)

Bloom's Category	**SEE Marks**
Remember	-
Understand	20
Apply	20
Analyze	10
Evaluate	-
Create	-

Embedded Computing

Course Code : 20ECE741A | **Credits : 3**

L: T:P:S : 3:0:0:0 | **CIE Marks : 50**

Exam Hours : 3 | **SEE Marks : 50**

Course Outcomes: At the end of the Course, the student will be able to:

CO1	Understand the characteristics of embedded computer systems
CO2	Analyze the mechanism of Interrupts in embedded computing systems
CO3	Make use of Interrupt Service Mechanism for programming I/O Devices
CO4	Identify the design and development approaches
CO5	Evaluate the testing and debugging environment for embedded computing systems
CO6	Model the real time computing applications

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	2	2	-	-	-	-	2	-	3
CO3	3	3	3	-	-	-	-	-	-	-	-	3
CO4	3	3	3	2	2	-	-	-	2	2	2	3
CO5	3	3	3	-	2	-	-	-	2	-	2	-
CO6	3	-	3	-	-	2	2	-	2	2	-	3

Module No	Module Contents	Hours	Cos
1	Introduction to embedded systems: Embedded systems, Processor embedded into a system, Embedded hardware units and device in a system, Embedded software in a system, Examples of embedded systems. Devices and communication buses for devices network: IO types and example, Serial communication devices, Parallel device ports, Sophisticated interfacing features in device ports, Wireless devices, Timer and counting devices, Watchdog timer, Real time clock, Networked embedded systems **Text1:1.1-1.5,3.1-3.9**	9	**CO1**

2	Device drivers and interrupts and service mechanism: Programming-I/O busy-wait approach without interrupt service mechanism, ISR concept, Interrupt sources, Interrupt servicing (Handling) Mechanism, Multiple interrupts, Context and the periods for context switching, interrupt latency and deadline, Classification of processors interrupt service mechanism from Context-saving angle, Direct memory access, Device driver programming **Text1:4.1-4.9**	9	**CO2**
3	Inter process communication and synchronization of processes, Threads and tasks: Multiple process in an application, Multiple threads in an application, Tasks, Task states, Task and Data, Clear-cut distinction between functions. ISRS and tasks by their characteristics, concept and semaphores, Shared data, Inter process communication, Signal function, Semaphore functions, Message Queue functions, Mailbox functions, Pipe functions, Socket functions, RPC functions. **Text1: 7.1-7.16**	9	**CO3**
4	Design process in embedded system, Formalization of system design, Design process and design examples Embedded Firmware Design Approaches, Embedded Firmware Development Languages, Programming in Embedded C **Text1:1.8-1.10 ,Text2: 9.1-9.3**	9	**CO4**
5	Embedded Software Development Process and tools**:** Introduction to Embedded Software Development Process and tools, Host and target machines, Linking and locating software, Getting Embedded software into the target system, Issues in Hardware-Software Design and co-design, Testing on Host machine, Simulators, Case studies and application of embedded computing systems **Text1:13.1-13.5,14.1,14.2,11.1,11.2,12.1,12.2**	9	**CO5,CO6**

TEXT BOOKS:

1. Raj Kamal, "Embedded Systems: Architecture, Programming, and Design" 2nd / 3rd edition , Tata McGraw hill-2013
2. Shibu K.V, "Introduction to Embedded Systems"2nd, Tata McGraw hill
3. Stuart Bennett, "Real –Time Computer Control" second edition ,2010

REFERENCE BOOKS:

1. Marilyn Wolf, "Computer as Components, Principles of Embedded Computing System Design" 3rd edition, Elsevier-2014.

2. Embedded Systems Architecture – A Comprehensive Guide for Engineers and Programmers, Tammy Noergaard, Elsevier Publication, 2005.

3. Embedded Systems – A contemporary Design Tool, James K. Peckol, John Weily India Pvt. Ltd, 2008

Mapping of CO v/s PSO:

-	PSO1	PSO2
20ECE741A	**Embedded Computing**	
CO1	-	-
CO2	3	2
CO3	3	2
CO4	3	2
CO5	3	2
CO6	3	2

Assessment Pattern

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	-	-	5
Understand	10	-	5
Apply	10	5	-
Analyze	5	5	-
Evaluate	-	5	-
Create	-	-	-

SEE- Semester End Examination (50 Marks)

Bloom's Taxonomy	Tests
Remember	10
Understand	10
Apply	20
Analyze	10
Evaluate	-
Create	-

Advanced Semiconductors

Course Code : 20ECE742A | **Credits : 3**
L: T:P:S : 3:0:0:0 | **CIE Marks : 50**
Exam Hours : 3 Hrs | **SEE Marks : 50**

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Understand the principles and fundamentals of semiconductor devices
CO2	Apply the basics of Quantum mechanics for the formulation of atomic structure
CO3	Estimate the energy levels of semiconductors
CO4	Analyze the device structures in 1-D as well as in 3-D
CO5	Interpret the carrier concentration distribution for the formulation of intrinsic and extrinsic semiconductors
CO6	Model the formulation of the continuity equation, with reference to different types of carrier movements in semiconductors

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO100	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	2	-	-	-	-	-	-	-	-	-
CO3	3	3	-	3	-	-	-	-	-	-	-	-
CO4	3	3	-	3	-	-	-	-	-	-	-	2
CO5	3	3	2	3	-	-	-	-	-	-	-	-
CO6	3	3	-	3	-	-	-	-	-	-	-	2

SYLLABUS

Module No	Module Contents	Hours	COs
1	**Basic Semiconductor Properties**: General Material Properties, Crystal Structure, The Unit Cell Concepts, Simple 3-D Unit Cells, Bravais Lattices and Crystal Systems, Specific Semiconductor Lattice, Miller Indices, Use of Miller Indices, Wafer Surface Orientation, Wafer Flats and Notches, Pattern Alignment. Exercises.	**9**	**CO1**
2	**Elements of Quantum Mechanics**: The Quantum Concept, Blackbody Radiation, The Bohr Atom, Wave-Particle Duality, Basic Formalism - General Formulation, Time-Independent Formulation, The Free Particle, Particle in a 1-D Box, Exercises.	**9**	**CO2**
3	**Energy Band Theory**: Preliminary Considerations, Approximate One-Dimensional Analysis, Extrapolation of Concepts to Three Dimensions, Band Gap Energy, Exercises.	**9**	**CO3, CO4**

4	**Equilibrium Carrier Statistics**: Density of States - General Derivation, Specific Materials, Fermi Function, Supplemental Information, Equilibrium Distribution of Carriers, The Energy Band Diagram, Equilibrium Concentration Relationships, Concentration and EF Calculations, General Information, Equilibrium Carrier Concentration, Freeze-Out/Extrinsic and Intrinsic, Exercises	**9**	**CO5**
5	**Carrier Transport**: Drift and Diffusion Visualization, Diffusion Current, Einstein Relationship, Equations of State, Current Equations, Carrier Currents, Dielectric Displacement Current, Quasi Fermi Levels, Continuity Equations, Minority Carrier Diffusion Equations, Exercises.	**9**	**CO6**

TEXT BOOKS:

1. Advanced Semiconductor Fundamentals, Robert F Pierret, Pearson Prentice Hall, Second edition, 2002.

REFERENCE BOOKS:

1. Solid State Electronic Devices, Ben G. Streetman and Sanjay Kumar Banerjee, Pearson Seventh edition, 2015.

Mapping of CO v/s PSO:

-	**PSO1**	**PSO2**
20ECE742A	**Advanced Semiconductors**	
CO1	-	-
CO2	2	2
CO3	-	-
CO4	2	2
CO5	-	-
CO6	2	2

Assessment Pattern

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Category	Tests	Assignments	Quizzes
Marks (out of 50)	25	15	10
Remember	10	-	5
Understand	10	5	-
Apply	5	5	-
Analyze	-	5	5
Evaluate	-	-	-
Create	-	-	-

SEE- Semester End Examination (50 Marks)

Bloom's Category	SEE Marks
Remember	15
Understand	15
Apply	15
Analyze	5
Evaluate	-
Create	-

Satellite Communications

Course Code : 20ECE743A | **Credits : 3**
L: T:P:S : 3:0:0:0 | **CIE Marks : 50**
Exam Hours : 3 Hrs | **SEE Marks : 50**

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Distinguish signal loss factors in satellite communication for categorized noises/perturbations
CO2	Apply Kepler laws and understanding satellite orbits
CO3	Examine process involved in communication between transmitters and receivers with respect to satellite communication
CO4	Identify the working of earth segment and space segment of satellite communication.
CO5	Examine satellite services &Satellite Access Techniques at different uplink and downlink frequencies
CO6	Construct satellites through student satellite programs

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-
CO3	3	3	3	-	-	-	-	-	-	-	-	-
CO4	3	3	3	3	-	-	-	-	-	-	-	-
CO5	3	3	3	3	-	1	-	-	1	-	-	1
CO6	3	3	3	3	1	1	-	-	1	1	-	1

SYLLABUS			
Module No	**Module Contents**	**Hrs**	**Cos**
1	**FUNDAMENTALS OF SATELLITE AND PROPAGATION IMPAIRMENTS** Introduction, frequency allocation, INTELSAT, Indian Satellite systems. **PROPAGATION IMPAIRMENTS**: Introduction, atmospheric loss, ionospheric effects, rain attenuation, other propagation impairments. (T1, 1.1 – 1.3; 4.1 -4.5)	9	CO1
2	**ORBITS** Introduction, Kepler laws, definitions, orbital element, apogee and perigee heights, orbit perturbations, inclined orbits, calendars, universal time, sidereal time, orbital plane and sun synchronous orbits. Geostationary orbit: Introduction, antenna look angles, polar mount antenna, limits of visibility, earth eclipse of satellite, sun transit outage. (T1, 2.1 – 2.8 ; 2.9.1, 2.9.2 , 2.9.4 , 2.9.5 , 3.1 -3.4 , 3.6 , 3.7)	9	CO1, CO2

3	**SPACE SEGMENT AND SPACE LINK:** Introduction, power supply units, altitude control, station keeping, thermal control, TT&C Subsystem, transponders, antenna subsystem. **SPACE LINK:** Introduction, EIRP, transmission losses, link power budget Equation, system noise, CNR, uplink and downlink, combined CNR. . (T1, 7.1 – 7.8; 12.1 -12.8 & 12.10)	9	CO4, CO5, CO6
4	**EARTH SEGEMENT & SATELLITE ACCESS TECHNIQUES:** Introduction, receive only home TV system, outdoor unit, indoor unit, MATV, CATV, Tx–Rx earth station. (T1, 8.1 – 8.3; 8.4 & 8.5) Satellite Access Techniques – Bandwidth-Limited and Power-Limited, TDMA Downlink analysis for digital transmission, Comparison of uplink power requirements for FDMA and TDMA, On-Board Signal Processing for FDMA/TDM Operation, Satellite switched TDMA. (T1: 14.6, 14.7.11-12,14.8, 14.9)	9	CO4, CO5, CO6
5	**DBS, SATELLITE MOBILE AND SPECIALIZED SERVICES:** Introduction, orbital spacing, power ratio, frequency and polarization, transponder capacity, bit rates for digital TV, satellite mobile services, VSAT, Radar Sat. GPS: Introduction, GPS position and location principles, GPS receiver and codes, Orbcomm. (T1, 16.1 -16.6 , 17.2 -17.6)	9	CO3, CO5, CO6

Text Books:

1. Dennis Roddy, “Satellite Communications”, 4th Edition, McGraw-Hill International edition, 2006.

Reference Books:

1. Timothy Pratt, Charles Bostian and Jeremy Allnutt, “Satellite Communications”, 2nd Edition, John Wiley Pvt. Ltd & Sons, 2008.
2. W. L. Pitchand, H. L. Suyderhoud, R. A. Nelson, “Satellite Communication Systems Engineering”, 2nd Ed., Pearson Education., 2007.
3. W. L. Pritchart, H. G. Suyderhoud and R. A. Nelson, “Satellite Communication Systems Engineering,” 2nd Edition, Pearson Education, 2012.

Mapping of CO v/s PSO:

-	PSO1	PSO2
20ECE743A	**Satellite Communications**	
CO1	-	-
CO2	-	-
CO3	3	3
CO4	-	-
CO5	3	3
CO6	3	3

Assessment Pattern

CIE – Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	5	---	---
Understand	5	---	---
Apply	10	---	5
Analyze	5	15	5
Evaluate	---	---	---
Create	---	---	---

SEE – Semester End Examination (50 Marks)

Bloom's Taxonomy	SEE Marks
Marks	**50**
Remember	15
Understand	10
Apply	15
Analyze	10
Evaluate	---
Create	---

Biomedical Signal Processing

Course Code : 20ECE744A | **Credits : 3**
L: T:P:S : 3:0:0:0 | **CIE Marks : 50**
Exam Hours : 3 Hrs | **SEE Marks : 50**

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Describe the origin, properties and suitable models of biomedical signals such as ECG and EEG
CO2	Apply signal processing methods to extract relevant information from biomedical signal measurements
CO3	Develop the relevant mathematical and computational skills relevant in compression of biomedical signals
CO4	Analyze the ECG Signal behavior using signal processing methods
CO5	Analyze the rhythms and detection process in neurological signal processing
CO6	Examine the quality of biomedical images acquired from Computed Tomographic Imaging and Ultrasound Imaging modalities

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-
CO3	3	3	2	-	-	-	-	-	-	-	-	-
CO4	3	3	-	3	-	3	-	-	-	-	-	-
CO5	3	3	-	3	-	3	-	-	-	-	-	-
CO6	3	-	2	3	1	3	-	-	-	-	-	-

SYLLABUS			
Module No	**Module Contents**	**Hrs**	**COs**
1	**Introduction to Biomedical Signals:** The nature of Biomedical Signals, Examples of Biomedical Signals, Objectives and difficulties in Biomedical analysis. **Signal Conversion:** Simple signal conversion systems, Conversion requirements for biomedical signals, Signal conversion circuits. **Signal Averaging:** Basics of signal averaging, signal averaging as a digital filter, a typical averager, software for signal averaging, limitations of signal averaging. Text Book no : 1 Sections :1.1,2.1-2.3,3.2-3.4; 9.1-9.5.	9	CO1, CO2

2	**Adaptive Noise Cancelling:** Principal noise canceller model, 60-Hz adaptive cancelling using a sine wave model, other applications of adaptive filtering. **Data Compression Techniques:** Turning point algorithm, AZTEC algorithm, Fan algorithm, Huffman coding, data reduction algorithms, usage of Fourier transform, Correlation, Convolution, Power spectrum estimation for analysis of ECG signal time and frequency domains. Text Book no : 1 Sections : 8.1-8.3,10.1-10.4,11.1-11.4	9	CO2,CO3
3	**Electrocardiography:** Basic Electrocardiography, ECG data acquisition, ECG lead system, ECG signal characteristics (parameters and their estimation), Analog filters, ECG amplifier, and QRS detector, Power spectrum of the ECG, Bandpass filtering techniques, Differentiation techniques, Template matching techniques, A QRS detection algorithm, Real-time ECG processing algorithm, ECG interpretation, ST segment analyzer, Portable arrhythmia monitor. Text Book no: 2 Sections: 7.1-7.4 Text Book no: 1 Sections :12.1-12.6,13.1-13.3	9	CO4
4	**Neurological signal processing:** The brain and its potentials, The electrophysiological origin of brain waves, The EEG signal and its characteristics (EEG rhythms, waves, and transients), Correlation. **Analysis of EEG channels:** Detection of EEG rhythms, Template matching for EEG, spike and wave detection. Text Book no: 2 Sections :4.1-4.4	9	CO5
5	**Biomedical Image Processing using CT:** Introduction, CT Instrumentation, Image Formation, Image Quality in CT. **Biomedical Image Processing using Ultrasound:** Introduction, Instrumentation, Pulse-Echo Imaging, Transducer Motion, Ultrasound Imaging Modes, Steering and Focusing, 3-D Ultrasound Imaging, Image Quality. Text Book no: 3 Sections :6.1-6.4, 11.1-11.8	9	CO6

Textbooks:

1. W. J. Tompkins, “Biomedical Digital Signal Processing,” PHI Learning Private Limited, New Delhi, India, 2015.
2. D. C. Reddy, “Biomedical Signal Processing: Principles and techniques,” Tata McGraw-Hill, New Delhi, India, 2015.
3. J. L. Prince, and J. M. Links, “Medical Imaging Signals and Systems,” Pearson Education, Inc., New Delhi, India, 2015.

References:

1. R. Rangayyan, "Biomedical Signal Analysis," Wiley India Private Limited, New Delhi, India, 2015.
2. Bruce, "Biomedical Signal Processing & Signal Modeling," John Wiley and Sons, Singapore, 2001.
3. Sörnmo, "Bioelectrical Signal Processing in Cardiac & Neurological Applications," Reed Elsevier Private Limited, New York, U.S.A., 2009.
4. Semmlow, "Biosignal and Biomedical Image Processing," Marcel Dekker, London, U.K., 2004
5. Enderle, "Introduction to Biomedical Engineering," 2nd Edition, Reed Elsevier Private Limited, New York, U.S.A., 2005.

Mapping of CO v/s PSO:

-	PSO1	PSO2
20ECE744A	**Biomedical Signal Processing**	
CO1	-	-
CO2	3	3
CO3	3	3
CO4	3	3
CO5	3	3
CO6	3	3

Assessment Pattern

CIE – Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	5	---	---
Understand	5	---	---
Apply	10	---	5
Analyze	5	15	5
Evaluate	---	---	---
Create	---	---	---

SEE – Semester End Examination (50 Marks)

Bloom's Taxonomy	SEE Marks
Marks	**50**
Remember	15
Understand	10
Apply	15
Analyze	10
Evaluate	---
Create	---

Artificial Intelligence and Cognitive Computing

Course Code : 20ECE745A | **Credits : 3**
L:T:P:S : 3:0:0 :0 | **CIE Marks : 50**
Exam Hours : 3 Hrs | **SEE Marks : 50**

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Apply the searching methods in Artificial Intelligence
CO2	Use the rules of Artificial Intelligence for knowledge representation
CO3	Examine the different reasoning and learning techniques
CO4	Distinguish the week and strong, slot and filler structures
CO5	Analyze the architecture of Cognitive computing system
CO6	Engage in self learning by performing cognitive analytics

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	-	3	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-
CO3	3	3	3	-	3	-	-	-	-	-	-	-
CO4	3	3	3	-	3	-	-	-	-	-	-	-
CO5	3	3	3	2	3	2	-	-	2	-	-	2
CO6	3	3	3	2	3	2	-	-	2	-	-	2

SYLLABUS			
Module No	**Module Contents**	**Hrs.**	**Cos**
1	**Introduction:** Definition of artificial intelligence, Problems, Problem Spaces and search, Heuristic search technique. **(Text1: 1.1 to 1.7, 2.1 to 2.6, 3.1 to 3.6)**	**9**	**CO1**
2	**Knowledge Representation:** Its issues, Using Predicate Logic, representing knowledge using Rules. **(Text1: 4.1 to 4.4, 5.1 to 5.5)**	**9**	**CO2**
3	**Statistical reasoning and Slot-Filler structures:** Symbolic Reasoning under Uncertainty, Statistical reasoning, Weak Slot and Filler Structures, Strong slot-and-filler structure. **(Text1: 8.1 to 8.5, 9.1, 9.2, 10.1, 10.2)**	**9**	**CO3 CO4**
4	**Cognitive Computing:** Concepts, Architecture, System and Application**:** Introduction, Cognitive Computing Architecture and approaches, Cognitive computing System and Applications. **(Text2: Chapter 1)**	**9**	**CO5**
5	**Cognitive Analytics:** Introduction, Evolution of Analytics and Core theme, Types of Learning, Cognitive Analytics applications. **(Text2: Chapter 5)**	**9**	**CO6**

Text Books:

1. Artificial Intelligence, E. Rich, K. Knight & S. B. Nair, 3rd edition, 2009, McGraw Hill.
2. Cognitive Computing: Theory and Applications, Vijay V. Raghavan, Venkat N. Gudivada, Venu Govindaraju, C.R. Rao, 2016, Elsevier.

Reference books:

1. Artificial Intelligence: A Modern Approach, Stuart Russell, Peter Norving, 2nd Edition, 2010, Pearson Education.
2. Introduction to Artificial Intelligence and Expert Systems, Dan W. Patterson, 1990, PHI.
3. Artificial Intelligence: Structures and Strategies for complex problem Solving, G. Luger, 4th Edition, 2002, Pearson Education.
4. Artificial Intelligence and Expert Systems Development, D. W. Rolston, 2002, McGraw hill.
5. Artificial Intelligence and Intelligent Systems, N. P. Padhy, 2015, Oxford University Press

Mapping of CO v/s PSO:

-	PSO1	PSO2
20ECE745A	**Artificial Intelligence and Cognitive Computing**	
CO1	3	2
CO2	-	-
CO3	3	2
CO4	-	-
CO5	-	-
CO6	3	2

Assessment Pattern

CIE- Continuous Internal Evaluation (50Marks)

Bloom's Category	Tests	Assignments	Quizzes
Marks (out of 50)	**25**	**15**	**10**
Remember	5	-	5
Understand	10	5	
Apply	5	5	5
Analyze	5	5	-
Evaluate	-	-	-
Create	-	-	-

SEE- Semester End Examination (50Marks)

Bloom's Category	SEE Marks
Remember	10
Understand	20
Apply	10
Analyze	10
Evaluate	-
Create	-

Software Defined Radio

Course Code : 20ECE746A | **Credits : 3**
L: T:P:S : 3:0:0:0 | **CIE Marks : 50**
Exam Hours : 3 Hrs | **SEE Marks : 50**

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Understand the concepts of software defined radio and its implementation issues
CO2	Apply the Multi rate signaling technique for sample rate conversion
CO3	Illustrate the various digital synthesis approaches
CO4	Examine the various data converter architectures and their performance
CO5	Analyze the basics of designing smart antenna systems to accommodate the needs of software defined radio
CO6	Make system level decisions for software defined radio technology and products

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	2
CO3	3	3	3	-	-	-	-	-	-	-	-	-
CO4	3	3	3	2	-	-	-	-	-	-	-	-
CO5	3	3	3	2	-	1	1	-	-	-	-	2
CO6	3	3	2	2	1	1	1	1	-	-	2	2

SYLLABUS			
Module No	**Module Contents**	**Hrs**	**Cos**
1	**Introduction to SDR:** What is a Software Radio? The need for Software Radios, Characteristics and benefits of a Software Radio, Design principles of Software Radio. Text 1: 1.1,1.2,1.3,1.4 **Radio frequency implementation issues**. The purpose of the RF Front-End, Dynamic range: The principal challenge of receiver design. RF receiver front-end topologies, Enhanced flexibility of the RF Chain with Software Radios. Text 1: 2.1,2.2, 2.3, 2.4	**9**	**CO1 CO6**
2	Importance of the components to Overall performance, Transmitter architectures and their Issues, noise and distortion in the RF Chain, ADC and DAC distortion. Text 1: 2.5,2.6, 2.7, 2.8 **Multirate signal processing-** Introduction to sample rate conversion principles, poly phase filters, digital filter banks, Text 1: 3.1, 3.2,3.3,3.4.	**9**	**CO2 CO6**

3	**Digital generation of signals**. Comparison of direct digital synthesis with analog signal synthesis, Approaches to direct digital synthesis, Analysis of spurious signals, Spurious components due to periodic jitter, Bandpass signal generation, Performance of direct digital synthesis systems, Hybrid DDS-PLL Systems, Applications of direct digital synthesis, Generation of random sequences, ROM compression technique. Text 1: 4.1 To 4.11	**9**	**CO3** **CO6**
4	Analog to digital and digital to analog conversion, Parameters of ideal data converters, Parameters of practical data converters, Techniques to improve data converter performance, Common ADC and DAC Architectures. Text 1: 5.1,5.2,5.3,5.4,5.5	**9**	**CO4** **CO6**
5	Smart antennas designing issues, Vector channel modelling, Benefits of smart antennas, Structures for beamforming systems, Smart antenna algorithms, Diversity and space-time adaptive signal processing, Algorithms for transmit STAP, Hardware Implementation of smart antennas. Text 1: 6.1,6.2,.6.3,6.4,6.5,6.6,6.7,6.8	**9**	**CO5** **CO6**

Text Books:

1. Jeffrey H Reed, Software Radio- A modern approach to radio engineering Prentice Hall PTR, 2002.

Reference books:

1.Telecommunication Breakdown by C. Richard Johnson Jr., William A. Sethares, 2003, Prentice Hall.

2. Multi-carrier and Spread Spectrum Systems, K. Fazel, S. Kaiser, John Wiley and Sons, Ltd. Publication, 2010.

3. N.J. Fliege, “Multirate Signal Processing” John Wiley and Sons, 1994.

Mapping of CO v/s PSO:

-	PSO1	PSO2
20ECE746A	**Software Defined Radio**	
CO1	3	-
CO2	-	-
CO3	3	2
CO4	3	2
CO5	3	2
CO6	3	2

Assessment Pattern

CIE- Continuous Internal Evaluation (50Marks)

Bloom's Category	Tests	Assignments	Quizzes
Marks (out of 50)	**25**	**15**	**10**
Remember	5	-	-
Understand	10	5	5
Apply	5	5	5
Analyze	5	5	-
Evaluate	-	-	-
Create	-	-	-

SEE- Semester End Examination (50Marks)

Bloom's Category	SEE Marks
Remember	10
Understand	20
Apply	10
Analyze	10
Evaluate	-
Create	-

Robotics

Course Code : 20ECE751A | **Credits : 3**
L: T:P:S : 3:0:0:0 | **CIE Marks : 50**
Exam Hours : 3 Hrs | **SEE Marks : 50**

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Model the mathematical representation of robots' workspace
CO2	Simplify the kinematics of robot manipulators
CO3	Design of trajectory(s) for robot motion using joint space and cartesian space
CO4	Analyze the control mechanism in the design of a robot
CO5	Make use of actuators, and controllers for robotic applications
CO6	Identify the sensors for interfaces in industrial robots

Mapping of Course Outcomes to Graduate Attributes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	-	-	-	-	-	-
CO2	3	3	3	-	-	-	-	-	-	-	-	-
CO3	3	3	3	2	-	-	1	-	-	-	-	-
CO4	3	3	3	2	1	-	-	-	-	-	-	-
CO5	3	3	3	-	-	-	-	-	-	-	-	-
CO6	3	3	3	-	-	-	-	-	-	-	-	-

SYLLABUS			
Module no	**Module Contents**	**Hrs**	**COs**
1	**Introduction:** History of robotics, Applications, Spatial descriptions and Transformations: Description of position and orientation**:** position vector, Rotation matrix; Mapping: translation and rotation, homogeneous transform; transformation arithmetic, transform equations, other forms of representation of orientation: Euler angles, 2 –vector representation, angle – axis representation, Euler parameters Text 01; Chapters: 1,2	**9**	**CO1**
2	**Forward Kinematics:** Introduction, Link description, link connection description, Denavit Hartenberg parameters, Derivation of link transformations, concatenating link transformations, actuator space, joint space and Cartesian space **Inverse Kinematics:** Introduction, Solvability: existence of solution, multiple solutions and method of solution; algebraic vs. geometric approach, algebraic solution by reduction topolynomial, workspace, Repeatability and accuracy Text 01; Chapters: 3,4	**9**	**CO2**
3	**Trajectory Generation**: Introduction, general considerations in path description and generation, Joint space schemes: cubic	**9**	**CO3**

	polynomial, cubic polynomial for a path with via points, linear function with parabolic blends, linear function with parabolic blends for a path with via points, Cartesian space schemes: Cartesian straight-line motion, geometric problems with Cartesian paths, path generation at run time Text 01; Chapters: 7		
4	**Linear Control**: Feedback control, second order linear systems, control law portioning, trajectory following control, disturbance rejection and steady state error, continuous vs. discrete time control, modeling and control of a single joint, architecture of PUMA 560 robot controller Text 01; Chapters: 9 **Actuators:** Power conversion unit, Types of Actuators Text 02; Chapters: 7	**9**	**CO4 , CO5**
5	**Sensors**: Sensor characteristics, Position sensors-potentiometers, Encoders, LVDT, Resolvers, Displacement sensor, Velocity sensor-encoders, tachometers, Acceleration sensors, Force and Pressure sensors piezoelectric, force sensing resistor, Torque sensors, Touch and tactile sensor, Proximity sensors-magnetic, optical, ultrasonic, inductive, capacitive, eddy-current proximity sensors Text 02; Chapters: 8	**9**	**CO6**

Case study:

Mandatory case study on a Robotic system specifying its block diagram and operation to be submitted as an assignment.

Text Books:

1. Introduction to robotics: mechanics and control, Craig J J, 3/E,Pearson Education India,2008.
2. Introduction to robotics: Analysis, systems, applications, Niku S B, Pearson Education,2008.

Reference Books:

1. Robotics: Fundamental concepts & analysis, Ghosal A, Oxford University Press, 2006
2. Craig. J. J. “Introduction to Robotics- mechanics and control”, Addison- Wesley, 1999

Mapping of CO v/s PSO:

-	PSO1	PSO2
20ECE751A	**Robotics**	
CO1	3	2
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-
CO6	3	2

Assessment Pattern

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Category	Tests	Assignments	Quizzes
Marks (out of 50)	25	15	10
Remember	5	-	5
Understand	10	5	-
Apply	5	5	-
Analyze	5	5	5
Evaluate	-	-	-
Create	-	-	-

Note: *Any particular Robotic system can be considered as case-study for a team of students, and the teams are required to present the system's basic working principles to the class. This work can be considered as one of the assignments, which can be evaluated for 5 marks*.

SEE- Semester End Examination (50 Marks)

Bloom's Category	SEE Marks
Remember	15
Understand	15
Apply	10
Analyse	10
Evaluate	-
Create	-

Low Power VLSI Design

Course Code : 20ECE752A | **Credits : 3**
L: T:P:S : 3:0:0:0 | **CIE Marks : 50**
Exam Hours : 3 Hrs | **SEE Marks : 50**

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Examine the sources of power dissipation in CMOS circuits
CO2	Investigate the Impact of device and technology scaling on Low Power Electronics
CO3	Inspect different low power circuit techniques to design digital circuits
CO4	Distinguish various architectural techniques for minimizing power in SRAM
CO5	Analyze various energy recovery techniques in low power VLSI Design
CO6	Survey research articles on low power design methodologies in VLSI Design

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	-	-	-	-	-	1
CO2	3	3	3	3	-	2	-	-	-	-	-	1
CO3	3	3	3	3	-	2	2	-	-	-	-	1
CO4	3	3	3	3	-	-	-	-	-	-	-	1
CO5	3	3	3	3	-	-	2	-	-	-	-	1
CO6	3	3	3	3	-	2	2	-	-	-	-	1

SYLLABUS			
Module No	**Module Contents**	**Hrs**	**Cos**
1	**Introduction to Low Power CMOS VLSI Design**: Motivation, Needs for Low Power VLSI Chips, Sources of Dissipation in digital integrated circuits, Degrees of freedom, Recurring themes in Low Power, Emerging Low power approaches-an overview. TEXT1:(1.1, 1.2, 1.3, 1.4, 1.5)	**9**	CO1
2	**Device and Technology Impact on Low Power Electronics: in**troduction, dynamic dissipation in CMOS, Effects of and on Speed, Constraints on reduction, Transistor sizing and Optimal Gate oxide thickness, impact of technology scaling, Technology and device innovations. TEXT1:(2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7)	**9**	CO2

3	**Low Power Circuit Techniques:** Introduction, Power Consumption in Circuits, Flip Flops and latches, Logic, High Capacitance Nodes. TEXT1:(3.1, 3.2, 3.3, 3.4, 3.5)	**9**	CO3
4	**Low-Power Static RAM Architectures:** Introduction, Organization of a static RAM, MOS static RAM memory cell, Banked Organization of SRAMs, Reducing Voltage swings on Bit Lines, Reducing Power in the write driver circuits, Reducing Power in Sense Amplifier Circuits, Method for Achieving Low Core Voltages from a single supply. TEXT2:(6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 6.8)	**9**	CO4
5	**Low- Energy Computing Using Energy Recovery techniques:** Energy Dissipation in Transistor Channel Using an RC Model, Energy Recovery Circuit Design, Designs with Partially Reversible Logic, Supply Clock Generation. TEXT2:(7.1, 7.2, 7.3, 7.4)	**9**	CO5 CO6

TEXT BOOKS:

1. Low Power Design Methodologies, Jan M. Rabaey, Massoud Pedram, 2nd edition 2014, Springer Science + Business Media, LLC.
2. Low Power CMOS VLSI Circuit Design, Kaushik Roy, Sharat C. Prasad, 2015, Wiley India Pvt.Ltd
3. Practical Low Power Digital Low Power VLSI Design, Gary Yeap, 4th edition, 2014, Springer International Edition.

REFERENCE BOOKS:

1. CMOS VLSI Design: A circuits and systems perspective, Neil H.E. Weste, David Harris, 4th Edition, 2015, Pearson.

Mapping of CO v/s PSO:

-	**PSO1**	**PSO2**
20ECE752A	**Low Power VLSI Design**	
CO1	-	-
CO2	2	2
CO3	2	2
CO4	2	2
CO5	2	2
CO6	2	2

Assessment Pattern

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Category	Tests	Assignments	Quizzes
Marks (out of 50)	25	15	10
Remember	5	-	5
Understand	10	5	-
Apply	5	5	-
Analyze	5	5	5
Evaluate	-	-	-
Create	-	-	-

SEE- Semester End Examination (50 Marks)

Bloom's Category	SEE Marks
Remember	15
Understand	15
Apply	10
Analyse	10
Evaluate	-
Create	-

Wireless Ad-Hoc Sensor Networks

Course Code: 20ECE753A **Credits : 3**
L: T:P:S : 3:0:0:0 **CIE Marks : 50**
Exam Hours : 3 Hrs **SEE Marks : 50**

Course Outcomes: At the end of the Course, the student will be able to:

CO1	Understand the architecture and application of ad-hoc and wireless sensor networks
CO2	Classify MAC protocols of Ad Hoc Networks
CO3	Evaluate various routing protocols of Ad Hoc Networks and WSN
CO4	Discuss the design principles and services of WSN
CO5	Examine the packet delivery process in WSN over transport layer
CO6	Comprehend the issues and challenges in Ad Hoc Networks and WSN design

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-
CO3	3	3	3	2	-	-	-	-	-	-	-	-
CO4	3	3	-	-	-	-	-	-	-	-	-	-
CO5	3	3	3	2	-	-	-	-	-	-	-	-
CO6	3	3	3	-	-	-	-	-	-	-	-	-

SYLLABUS			
Module No	**Module Contents**	**Hours**	**COs**
1	**Introduction to AD Hoc Networks** Ad Hoc Networks, Differences between Cellular and Ad Hoc Wireless Networks, Applications of Ad Hoc Wireless Networks, Technical and Research Challenges, Issues in Ad Hoc Wireless Networks. Text Book 1: 1.3.1, 1.3.2, 1.3.3, 1.3.4	9	CO1
2	**MAC Layer Protocols for Ad Hoc Wireless Networks** Important Issues and the Need for Medium Access Control (MAC) Protocols, Classification of MAC Protocols- Contention-Based MAC Protocols, Contention-Based MAC Protocols with Reservation Mechanisms, Multiple-Channel MAC Protocols. Text Book 1: 2.2, 2.3.1, 2.3.2, 2.3.4	9	CO2
3	**Routing Protocols and Network Security Ad Hoc Wireless Networks** Design Issues of Routing Protocols for Ad Hoc Networks, Proactive Routing Protocols- Wireless Routing Protocol (WRP), Reactive Routing Protocols- Dynamic Source Routing (DSR)	9	CO3

	Protocol, Hybrid Routing Protocols- Zone Routing Protocol (ZRP) Text Book 1: 3.2, 3.4.1, 3.5.2, 3.6.1		
4	**Architecture and Design Principles of WSN** Challenges for WSNs, Difference between WSN and MANET, Single-node architecture- Hardware components, Energy consumption of sensor nodes, Sensor network scenarios, Optimization goals and figures of merit, Design principles for WSNs, Service interfaces of WSNs Text Book 2 : 1.4, 1.5, 2.1, 2.2, 3.1, 3.2 3.3, 3.4	9	CO1, CO4
5	**Routing protocols and Transport layer in WSN** Gossiping and agent-based unicast forwarding, Energy-efficient unicast, Broadcast and multicast, Geographic routing, The transport layer and QoS in wireless sensor networks, Single packet delivery, Block delivery Text Book 2 : 11.2, 11.3, 11.4, 11.5, 13.1, 13.4, 13.5	9	CO3, CO5

TEXT BOOKS:

1. Subir Kumar Sarkar, T G Basavaraju," Ad Hoc Mobile Wireless Networks, Principles, Protocols and Applications", Auerbach Publications, Taylor and Francis, London, 2008
2. Holger Karl and Andreas Willig "Protocols and Architectures for Wireless Sensor Networks", Wiley, 2005

REFERENCE BOOKS:

1. W Dargie and C Poellabauer, "Wireless Sensor Networks: Theory and Practice", 1st Edition, Wiley India Pvt. Ltd., New Delhi, India, 2012.
2. Kazem Sohraby, Daniel Minoli, &TaiebZnati, "Wireless Sensor Networks- Technology, Protocols, and Applications", John Wiley, 2007.
3. Anna Hac, "Wireless Sensor Network Designs", John Wiley, 2003.
4. Feng Zhao and Leonides Guibas, "Wireless Sensor Networks", Elsevier Publication - 2002.

Mapping of CO v/s PSO:

-	PSO1	PSO2
20ECE753A	**Wireless Ad-Hoc Sensor Networks**	
CO1	-	-
CO2	-	-
CO3	2	2
CO4	2	2
CO5	-	-
CO6	2	2

Assessment Pattern

CIE- Continuous Internal Evaluation Theory (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	5	-	5
Understand	10	5	-
Apply	5	5	5
Analyze	5	5	-
Evaluate	-	-	-
Create	-	-	-

SEE- Semester End Examination Theory (50 Marks)

Bloom's Taxonomy	SEE Marks
Remember	10
Understand	20
Apply	10
Analyze	10
Evaluate	-
Create	-

VLSI Signal Processing

Course Code : 20ECE754A | **Credits : 3**
L: T:P:S : 3:0:0:0 | **CIE Marks : 50**
Exam Hours : 3 Hrs | **SEE Marks : 50**

Course Outcomes: At the end of the Course, the student will be able to:

CO1	Understand the concepts of DSP and Low power VLSI signal Processing
CO2	Use of transformation technique like retiming to improve system efficiency and optimization
CO3	Illustrate the use of various DSP algorithms for VLSI processing
CO4	Use pipelining and parallel processing in design of high-speed /low-power applications
CO5	Apply the Arithmetic Architecture and its applications to improve overall System efficiency.
CO6	Evaluate the use of look-ahead techniques in parallel and pipelined IIR Digital filters

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-
CO3	3	3	3	-	1	-	-	-	-	-	-	2
CO4	3	3	-	-	1	-	-	-	-	-	-	-
CO5	3	-	-	-	-	-	-	-	-	-	-	-
CO6	3	3	3	-	1	-	-	-	-	-	-	2

SYLLABUS			
Module No	**Module Contents**	**Hours**	**COs**
1	**Introduction to DSP Systems& Low power Design** Introduction to DSP Systems -Typical DSP algorithms; Iteration Bound – data flow graph representations, loop bound and iteration bound, Low power Design – needs for low power VLSI chips, charging and discharging capacitance, short-circuit current of an inverter, CMOS leakage current, Static Current, basic principles of low power design & Low Power Figure of Merits Text-1: 1.1,1.2, 2.1,2.2,2.3 Text 2: 1.1,1.2,1.3,1.4,1.5,1.6, 1.7	**9**	**CO1**
2	**Retiming:** Retiming - definitions and properties; Unfolding – algorithm for Unfolding, properties of unfolding, DCT algorithm architecture transformation, parallel architectures for rank-order filters, Odd- Even Merge- Sort architecture, parallel	**9**	**CO2**

	rank-order filters. **Data Correlation Analysis in DSP Systems** Text-1: 4.1, 4.2, 4.3, 5.1,5.2,5.3, 9.1, 9.2, 9.3, 9.4, 9.5 **Text 2: 2.5**		
3	**Fast Convolution & Advanced Techniques in Low power designs:** Fast convolution – Cook-Toom algorithm, modified Cook-Took algorithm; Pipelined and parallel recursive and adaptive filters – inefficient/efficient single channel interleaving, Look A head pipelining in first- order IIR filters, Look-Ahead pipelining with power-of-two decomposition, Clustered Look-Ahead pipelining, parallel processing of IIR filters, combined pipelining and parallel processing of IIR filters, pipelined adaptive digital filters, relaxed look-ahead, pipelined LMS adaptive filter. **Adiabatic Computation, Pass Transistor Logic Synthesis, Asynchronous Circuits** Text-1: 8.1,8.2,10.1,10.2,10.3,10.4,10.5,10.6,10.8 **Text2: 8.1 – 8.3**	**9**	**CO3, CO4**
4	**Bit-Level Arithmetic Architectures& System** Scaling and Round Off Noise, State Variable Description of Digital Filters, Scaling and Round off Noise Computation, Round Off Noise in Pipelined IIR Filter. Bit Level Arithmetic Architecture Power and Performance Management, Switching Activity Reduction, Parallel Architecture with Voltage Reduction, Flow Graph Transformation Text-1: 11.1,11.2,11.3,11.4,11.5,13.1,13.2,13.3,13.4,13.5,13.6,13.7 **Text 2: 7.1 - 7.4**	**9**	**CO4, CO5**
5	**Programming Digital Signal Processors:** Numerical Strength Reduction – sub expression elimination, multiple constant multiplications, iterative matching. Linear transformations; Synchronous, Wave and asynchronous pipelining synchronous pipelining and clocking styles, clock skew in edge-triggered single-phase clocking, two-phase clocking, wave pipelining, asynchronous pipelining bundled data versus dual rail protocol; Programming: Digital Signal Processors – general architecture with important features. Text1- 15.1,15.2,15.3,16.1,16.2,16.3,16.4,16.5,16.6,16.7,18.1,18.2,18.3	**9**	**CO6**

TEXT BOOKS:

1. VLSI Digital Signal Processing systems, Design and implementation, Keshab K.Parhi, Wiley, Inter Science, 2007
2. Practical Low Power Digital VLSI Design, Gary Yeap, Kluwer Academic Publishers, 1998.

REFERENCE BOOKS:

1. Analog VLSI Signal and Information Processing, Mohammed Ismail and Terri Fiez, Mc Graw-Hill, 1994.
2. VLSI and Modern Signal Processing, S.Y. Kung, H.J. White House, T. Kailath, Prentice Hall, 1985.
3. Design of Analog & Digital VLSI Circuits for Telecommunication and Signal Processing, Jose E. France, Yannis Tsividis, Prentice Hall, 1994.
4. CMOS Analog Circuit Design, Phillip E Allen, Douglas R Holberg, OUP USA , 3rd Edition , 2012

Mapping of CO v/s PSO:

-	PSO1	PSO2
20ECE754A	**VLSI Signal Processing**	
CO1	-	-
CO2	3	2
CO3	3	2
CO4	3	2
CO5	3	2
CO6	3	2

Assessment Pattern

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	-	-	5
Understand	10	-	5
Apply	10	5	-
Analyze	5	5	-
Evaluate	-	5	-
Create	-	-	-

SEE- Semester End Examination (50 Marks)

Bloom's Taxonomy	SEE Marks
Remember	10
Understand	10
Apply	20
Analyze	10
Evaluate	-
Create	-

Neural Networks

Course Code : 20ECE755A | **Credits : 3**
L: T:P:S : 3:0:0:0 | **CIE Marks : 50**
Exam Hours : 3 Hrs | **SEE Marks : 50**

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Understand the neural network and relate how to model equivalent neuron models
CO2	Examine different learning algorithms for single layer and multilayer perceptron's
CO3	Analyse different neural network models for feed forward and feedback networks
CO4	Explore the application of SVM and RBF in modelling neural networks
CO5	Investigate various competitive learning network architectures for complex pattern recognition tasks
CO6	Identify and execute engineering applications based on neural networks

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	3	-	-	-	-	-	-	-	-	-
CO3	3	3	3	2	-	-	-	-	-	-	-	-
CO4	3	3	3	2	2	-	-	-	-	-	-	1
CO5	3	3	3	-	2	-	-	-	-	-	-	1
CO6	3	3	3	2	2	-	-	-	-	-	-	1

SYLLABUS			
Module No.	**Module Contents**	**Hours**	**COs**
1	**Introduction:** What is a neural network? Human brain, Models of a Neuron, Neural Networks viewed as Directed Graphs, Characteristics of Neural Networks, Historical Development of Neural Networks, Principles, Network Architectures, Knowledge Representation, Hebbian learning, Competitive learning, Boltzmann learning, memory-based learning. Text 1: Chapter-1,8	9	CO1
2	**Single layer and multilayer perceptron's:** Introduction, adaptive filtering problem, linear least square filters, least mean square algorithm, perceptron convergence theorem, relation between perceptron and Bayes classifier for a Gaussian environment, back propagation algorithm, XOR problem, feature detection Text 1: Chapter- 3,4	9	CO2
3	**Feed forward Neural Networks:** Introduction, Analysis of pattern Association Networks, Analysis of Pattern Classification Networks, Analysis of Pattern Mapping Networks, Analysis of Linear Auto associative FF Networks.	9	CO3, CO6

	Feedback Neural Networks: Introduction, Analysis of Pattern Storage Networks, Boltzmann Machine Text 1: Chapter- 4,5,11 Text 2: Chapter- 4		
4	**Support Vector Machines and Radial Basis Function:** Introduction, how to build a support vector machine for pattern recognition, example, SVM for nonlinear regression, Radial Basis Function, Regularization theory, Generalized RBF Networks, approximation properties of RBF networks, comparison of RBF networks and multilayer perceptron's. Text 1: Chapter – 5,6	9	CO4, CO6
5	**Competitive Learning Neural Networks &architectures for Complex pattern Recognition tasks:** Introduction, components of competitive learning networks, Analysis of Pattern Clustering Networks, Analysis of Feature Mapping Networks, Associative Memory, pattern mapping, temporal patterns. Text 2: Chapter- 4,9	9	CO5, CO6

TEXT BOOKS:

1. Neural Networks: A comprehensive foundation, Simon Haykin 3rd edition, Pearson education, 2016.
2. Artificial Neural Networks: B. Yagna Narayana, PHI, 2004

REFERENCE BOOKS:

1. Neural networks: algorithms, applications and programming techniques, James A. Freeman, David M. Skapura, Pearson Education, 2002.
2. Introduction to artificial neural systems, Jacek M. Zurada, Jaico publishing house, 1994.
3. Deep Learning Essentials, Wei Di, Anurag Bhardwaj, Jianing Wei ,Packt publishing Ltd. 2018

Mapping of CO v/s PSO:

-	PSO1	PSO2
20ECE755A	**Neural Networks**	
CO1	-	-
CO2	3	2
CO3	3	2
CO4	3	2
CO5	3	2
CO6	3	2

Assessment Pattern

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Category	Tests	Assignments	Quizzes
Marks (out of 50)	25	15	10
Remember		-	5
Understand	5	5	-
Apply	10	5	5
Analyze	10	5	-
Evaluate	-	-	-
Create	-	-	-

SEE- Semester End Examination (50 Marks)

Bloom's Category	SEE Marks
Remember	
Understand	15
Apply	20
Analyze	15
Evaluate	-
Create	-

Renewable Energy

Course Code : 20ECE756A | **Credits : 3**
L: T:P:S : 3:0:0:0 | **CIE Marks : 50**
Exam Hours : 3 Hrs | **SEE Marks : 50**

Course Outcomes: On completion of the course, students should be able to:

CO1	Categorize the sources and features of energy and discuss its impact
CO2	Examine the traditional energy systems in present context
CO3	Analyze the technologies and applications associated with Solar Energy systems
CO4	Appraise the operating principle of sustainable renewable energy systems
CO5	Estimate the Life Cycle Costing of sustainable hybrid energy systems
CO6	Engage in independent study as a member of a team and make an effective oral presentation on the applications of renewable energy concepts

Mapping of Course Outcomes to Program Outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	3	3	-	-
CO3	3	3	3	3	-	3	3	-	3	3	-	3
CO4	3	3	3	3	-	3	3	-	-	3	-	3
CO5	3	3	3	-	-	3	3	-	3	-	3	3
CO6	3	3	3	3	-	3	3	-	3	3		3

SYLLABUS			
Module. No	**Module Contents**	**Hours**	**COs**
1	**Introduction:** Energy usage by Human-Estimate of Impact on atmosphere, Fossil fuel-based systems and its impact on society. **Renewable Energy:** Sources and features, Hybrid energy systems and Distributed energy systems. Current energy scenario of India and world. Reference: 1,2,3	9	CO1
2	**Traditional Energy Systems:** Sources, Features and Characteristics. **Applications:** Transport – bullock cart, horse carriage, camels; Agriculture – ox plough, water lifting devices; Human power – bicycle, cycle rickshaw etc.; House hold – cooking (bio mass), lighting etc. Reference:2, 3, 5	9	CO2, CO6
3	**Solar Thermal Systems:** Solar radiation spectrum. Radiation measurement, Technologies. Applications: Heating, Cooling, Drying, Distillation, Power generation. **Solar Photovoltaic Systems:** Operating principles and its concept, Cell, Module, Array, Series and parallel connections, Maximum power point tracking. Applications: Battery charging, Pumping, Lighting and Peltier cooling. **Case Study: "*Rural electrification programme*"** Text-1: 1.1, 1.2, 2.1-2.3,3.1-3.4,8.1-8.3,8.6; Reference-1	9	CO3,CO6
4	**Micro-hydel:** Operating principles, Components of a micro-hydel power plant, Types, characteristics of turbines and Turbine Selection. **Wind**: Operating principle, Site selection, Types of windmills, and characteristics of wind generators **Biomass:** Combustion, Biomass gasifier and Wood gasifier Applications: Biogas, Wood stoves and Bio diesel. **Wave Energy:** Operating principle, Power associated with sea waves, devices for harnessing wave energy. **Case study: *"Biomass gasifier for electrification"*** Text-1:9.1,9.2,9.3,9.4; Text2:6.1,6.2,6.5.2,6.7,6.8,6.11,12.1,12.2,12.3,12.5; Reference-1	9	CO4, CO6
5	**Hybrid Systems and Costing:** Need for Hybrid Systems. Range and type of Hybrid systems. Study of Diesel-PV, Wind-PV, Micro-hydel-PV, Biomass-Diesel systems, electric and hybrid electric vehicles **Costing:** Life cycle costing (LCC). Solar thermal system LCC. Solar PV system LCC. Micro-hydel LCC. Wind system LCC. Biomass system LCC. Reference 3, 4- chapter 7.4	9	CO5

Text Books

1. Solar Energy, S. P. Sukhatme and J. K. Nayak, Mc Graw Hill Education, Fourth edition, 2017
2. Non-conventional energy resources, Shobh Nath Singh, Pearson India, 2015.

Reference Books/Materials:

1. NPTEL Lecture material on Non-Conventional Energy Sources by Dr.Haridoss, IIT Madras.
2. "Energy Technologies and Economics" , Springer, Chapter Fossil Energy Systems, pp 51-120.
3. Learning Material - NCES-renewable energy by L.Umaanand, IISc, Bangalore.
4. Renewable Energy: Physics, Engineering, Environmental Impacts, Economics & Planning, Academic Press, 5th Edition 2017.
5. Rural Energy System(RDL 722)-Animal Energy and its application-IIT Bombay.

Mapping of CO v/s PSO:

-	PSO1	PSO2
20ECE756A	**Renewable Energy**	
CO1	-	-
CO2	-	-
CO3	3	2
CO4	3	2
CO5	3	2
CO6	3	2

Assessment Pattern

CIE – Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	---	---	---
Understand	5	---	5
Apply	5	5	5
Analyze	10	5	---
Evaluate	5	5	---
Create	---	---	---

SEE – Semester End Examination (50 Marks)

Bloom's Taxonomy	SEE Marks
Marks	**50**
Remember	---
Understand	10
Apply	15
Analyze	15
Evaluate	10
Create	---

Advanced Communication Lab

Course Code : 20ECL76A | **Credits : 1.5**
L: T: P:S : 0:0:1.5:0 | **CIE Marks : 25**
Exam Hours : 3 Hrs | **SEE Marks : 25**

Course Outcomes: At the end of the Course, the student will be able:

CO1	Analyze the functionality of different blocks in Communication Trainer boards
CO2	Model a satellite communication system based on link budget
CO3	Demonstrate the working of a spectrum analyzer
CO4	Implement the various models of radio signal propagation mechanisms
CO5	Simulate digital modulation schemes
CO6	Simulate modern communication techniques

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	-	-	3	-	2	-
CO2	3	3	3	3	3	2	2	-	3	-	2	3
CO3	3	3	-	-	-	-	-	-	-	-	-	-
CO4	3	3	3	3	3	2	2	-	3	-	2	-
CO5	3	3	3	3	3	2	2	-	3	-	2	3
CO6	3	3	3	3	3	2	2	-	3	-	2	3

Sl. No.	LIST OF EXPERIMENTS	COs
1	Study of basic operation of a spectrum analyzer.	**CO3**
2	Simulation of Okumura, HATA models using MATLAB.	**CO4**
3	Simulation of log-normal shadowing models using MATLAB.	**CO4**
4	Study of CDMA (DS-SS) technique using analog signal as an input signal (trainer kit based).	**CO1**
5	Study and identify different blocks of mobile phone unit and sketch the waveforms of different sections, measure voltages at various test points in Mobile Communication Trainer board.	**CO1, CO3**
6	Simulation of OFDM transmitter and receiver using MATLAB.	**CO5, CO6**
7	Simulation of MIMO system using MATLAB.	**CO5, CO6**
8	To write a MATLAB program to calculate the link budget for satellite communication.	**CO2**

9	To write a MATLAB program to calculate the Carrier to noise ratio for uplink and downlink and also the overall carrier to noise ratio.	**CO2**
10	To Generate & detect QPSK using MATLAB.	**CO5**
11	To Generate & detect BFSK using MATLAB.	**CO5**
12	To Generate & detect Delta Modulation using MATLAB.	**CO5**

Mapping of CO v/s PSO:

-	PSO1	PSO2
20ECL76A	**Advanced Communication Lab**	
CO1	3	2
CO2	3	2
CO3	3	2
CO4	3	2
CO5	3	2
CO6	3	2

Assessment Pattern

CIE- Continuous Internal Evaluation (25 Marks)

Bloom's Taxonomy	Performance (day to day)	Internal test
Marks	**15**	**10**
Remember	-	-
Understand	5	-
Apply	5	5
Analyze	5	5
Evaluate	-	-
Create	-	-

SEE- Semester End Examination (25 Marks)

Bloom's Taxonomy	SEE Marks
Remember	-
Understand	5
Apply	10
Analyze	10
Evaluate	-
Create	-

EDA Software Workshop Lab

Course Code : 20ECL77A | **Credits : 1.5**
L: T: P:S : 0:0:1.5:0 | **CIE Marks : 25**
Exam Hours : 3 Hrs | **SEE Marks : 25**

Course Outcomes: At the end of the Course, the student will be able to:

CO1	Use the different freeware for circuit simulation and analysis
CO2	Employ the available freeware for designing Printed Circuit Boards
CO3	Program the embedded system designs using the available freeware
CO4	Develop solutions to the industry needs, by using the embedded designs
CO5	Verify the functionality of various analog and digital VLSI circuits using the freeware
CO6	Perform the layout design for the simulated VLSI circuitry

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	-	-	-	3	2	-	3
CO2	3	3	3	-	-	-	-	-	3	2	-	3
CO3	3	3	3	-	-	-	-	-	3	2	-	3
CO4	3	3	3	-	-	-	-	-	3	2	-	3
CO5	3	3	3	2	2	-	-	-	3	-	-	3
CO6	3	3	3	2	2	-	-	-	3	-	-	3

Sl. No.	LIST OF EXPERIMENTS	COs
1	**Proteus :** Proteus combines powerful features with ease of use to help electronics engineers design, test, and lay out professional PCBs incredibly quickly and easily. Proteus is intuitive and includes a world-class shape-based autorouter, making it a complete software design tool for modern engineers. • Nearly 800 microcontroller variants ready for simulation right from the schematic • Professional PCB layout package • Combines schematic capture and ARES PCB layout programs to be a powerful, integrated suite of tools for professional PCB design	**CO1, CO2**
2	**Atmel Studio:** Studio includes Atmel Gallery, an online app store that allows you to extend your development environment with plug-ins developed by Microchip as well as third-party tool and embedded software vendors. Studio 7 can also seamlessly import your Arduino sketches as C++ projects, providing a simple transition path from Makerspace to Marketplace.	**CO3, CO4**

3	**Tanner:** T-Spice simulator, part of the Tanner Tool Suite, integrates easily with other design tools in the flow and is compatible with industry-leading standards. It improves simulation accuracy with advanced modeling, multi-threading support, device-state plotting, real-time waveform viewing, and analysis, and a command wizard for simple SPICE syntax creation.	**CO5, CO6**
4	**Ultiboard:** National Instruments accelerates engineering success with their open, software-centric platform that leverages modular hardware and an expansive ecosystem. • Seamless integration with Multisim • Saves electronics engineers hours of development time • Complete circuit schematics, SPICE simulation, and PCB layout in the same environment	**CO1, CO2**
5	**Uvision Keil:** Arm Keil MDK is the most comprehensive software development solution for Arm-based microcontrollers and includes all components that you need to create, build, and debug embedded applications.	**CO3, CO4**
6	**Electric:** It is one of the highly efficient options for VLSI simulation and layout. This very-large-scale-integration (VLSI) tool lets you draw schematics and create integrated circuit (IC) layouts digitally. Electric 9.07 is also compatible with hardware description languages like VHDL and Verilog.	**CO5, CO6**

Mapping of CO v/s PSO:

-	PSO1	PSO2
20ECL77A	**EDA Software Workshop Lab**	
CO1	3	2
CO2	3	2
CO3	3	2
CO4	3	2
CO5	3	2
CO6	3	2

Assessment Pattern

CIE- Continuous Internal Evaluation (25 Marks)

Bloom's Taxonomy	Performance (day to day)	Internal test
Marks	**15**	**10**
Remember	-	-
Understand	5	-
Apply	5	5
Analyze	5	5
Evaluate	-	-
Create	-	-

SEE- Semester End Examination (25 Marks)

Bloom's Taxonomy	SEE Marks
Remember	-
Understand	5
Apply	15
Analyze	5
Evaluate	-
Create	-

Project Phase- 1			
Course Code	**20ECL78A**	**Credits**	**02**
L: T: P: S	**0:0:2:0**	**CIE Marks**	**25**
Exam Hours	**03**	**SEE Marks**	**25**

	Course outcomes
CO1	Engage in independent study to review literature in identified domain
CO2	Ability to consolidate the literature search to identify and formulate the engineering problem
CO3	Identify the community that shall benefit through the solution and also create awareness for eco friendly environment through prescribed standards/safety norms
CO4	Ability to engage in independent study to arrive at an exhaustive list of available engineering tools that may be used for solving the identified engineering problem
CO5	Ability to prepare the Gantt Chart for scheduling the project work and designate responsibility of every member in the team
CO6	Engage in effective written and oral communication through project report/viva voce

Mapping of Course Outcomes to Program Outcomes:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**
CO2	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**
CO3	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO5	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**-**
CO6	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**-**

CIE - Continuous Internal Evaluation (25)

Bloom's Taxonomy	**Project Phase - 1**
Marks (Out of 25)	**-**
Remember	-
Understand	-
Apply	10
Analyze	10
Evaluate	5
Create	-

SEE – Semester End Examination (25)

Bloom's Taxonomy	**Project Phase - 1**
Remember	-
Understand	-
Apply	10
Analyze	10
Evaluate	5
Create	-

CISCO - ROUTING AND SWITCHING-I

Course Code : 20NHOP709 | **Credits : 3**
L:T:P:S : 3:0:0:0 | **CIE Marks : 50**
Exam Hours : 3 | **SEE Marks : 50**

Course Outcomes: At the end of the Course, the student will be able to:

CO1	Identify various network devices, topologies and protocols.
CO2	Construct IPv4and IPv6 addressing table and perform subnetting in IPv4 network.
CO3	Analyze Dynamic Host Configuration Protocol (DHCP) operation for scalable networks.
CO4	Configure and troubleshoot advanced operations of routers and implement Link State routing protocols (OSPF).
CO5	Design logically separate networks using Virtual LANs and IEEE802.1Q trunking protocol.
CO6	Examine redundancy using Spanning tree protocols and Ether-Channel for network scalability

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	-	-	-	-	3	-	3
CO2	3	3	3	3	3	-	-	-	-	3	-	3
CO3	3	3	3	3	3	-	-	-	-	3	-	3
CO4	3	3	3	3	3	2	2	2	3	3	-	3
CO5	3	3	3	3	3	2	2	2	3	3	-	3
CO6	3	3	3	3	3	2	2	2	3	3	-	3

Module No	Module Contents	Hours	COs
1	**Layered Architecture:** Layered Architecture and protocols, **Network Devices:** Switches, Routers, NIC, Access Points, Modem. **Topologies:** Mesh Topology, Star Topology, Bus Topology, Ring Topology, Hybrid Topology.	8	**CO1**
	HANDS-ON 1. **Basic Router Configuration: Configure Initial Router Settings, Configure Interfaces, Configure the Default Gateway, Ping and Traceroute Testing** 2. **SSH Configuration and verify the secure access to the network device.**		

2	**IPv4 Addressing:**IPv4 Address Structure, IPv4 Unicast, Broadcast, and Multicast, Types of IPv4 Addresses, Subnetting concept **DHCPv4:** DHCP4 Concepts Configure a Cisco IOS DHCP4 Server; Configure a DHCP4 Client **IPv6 Addressing:**IPv6 Address Representation, IPv6 Address Types, **SLAAC and DHCPv6:** IPv6 Global Unicast Address Assignment, SLAAC, DHCPv6	8	**CO2, CO3**
	HANDS-ON 1. **DHCPv4 Configuration** 2. **DHCPv6 Configuration**		
3	**Routing Concepts:** Path Determination, Packet Forwarding, IP Routing Table, Dynamic Routing, Default Static Route **Single-Area OSPF Concepts:** OSPF Features and Characteristics, OSPF Packets, OSPF Operation,	8	**CO4**
	HANDS-ON 1. **Configure IP Default Static Routes** 2. **Single-Area OSPFv2 Configuration**		
4	**VLANS:** Overview of VLANs, VLAN Configuration, VLAN Trunks, Dynamic Trunking Protocol, Inter VLAN routing	8	**CO5**
	HANDS-ON 1. **VLAN Configuration** 2. **Inter-VLAN routing Configuration**		
5	**Spanning Tree Protocol:** Purpose of STP,STP Operations, Evolution of STP,RSTP,RSTP+ **EtherChannel:** EtherChannel Operation, LACP, PAGP,	8	**CO6**
	HANDS-ON 1. **Spanning Tree Protocol Configuration** 2. **EtherChannel Configuration**		

TEXT BOOKS:

1. CISCO Netacad (ONLINE ACCESS)
2. CCNA Routing and Switching – Todd Lammle, 2nd Edition, Sybex Publisher (Wiley Brand), 2016.

REFERENCE BOOKS:

1. Data Communications and Networking. Forouzan,5th Edition, McGraw Hill, Reprint-2017.

Assessment Pattern

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	-	-	-
Understand	-	-	5
Apply	15	10	5
Analyze	10	5	-
Evaluate	-	-	-
Create	-	-	-

SEE- Semester End Examination (50 Marks)

Bloom's Taxonomy	SEE Marks
Remember	-
Understand	-
Apply	30
Analyze	20
Evaluate	-
Create	-

CISCO - ROUTING AND SWITCHING-II

Course Code : 20NHOP712 | **Credits : 3**
L:T:P:S : 3:0:0:0 | **CIE Marks : 50**
Exam Hours : 3 | **SEE Marks : 50**

Course Outcomes: At the end of the Course, the student will be able to:

CO1	Configure advanced operation of ACL and implement extended ACL for IPv4 and IPv6
CO2	Configure Network address translation (NAT) for IPv4
CO3	Configurea secured Wireless LAN setupusing Routers and extend wireless connectivity using Access Points
CO4	Examine the operations of WAN, WAN Authentication Protocols and best practices for network security
CO5	Examine the operation of virtual private network (VPN) and concepts of network automation and virtualization
CO6	Evaluate the network configurations, identify the errors and configure correctly for effective network communication for lifelong learning

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	-	-	-	-	3	-	3
CO2	3	3	3	3	3	-	2	-	-	3	-	3
CO3	3	3	3	3	3	2	2	-	-	3	-	3
CO4	3	3	3	3	3	2	2	2	2	3	2	3
CO5	3	3	3	3	3	2	2	-	2	3	2	3
CO6	3	3	3	3	3	2	2	2	2	3	2	3

Mapping of CO v/s PSO:

CO	PSO1	PSO2
CO1	3	2
CO2	3	2
CO3	3	2
CO4	3	3
CO5	3	3
CO6	-	3

Module No	Module Contents	Hours	COs
1	**ACL Concepts:**Overview of ACL operation, Guidelines for ACL Creation, Comparison of Standard and Extended ACLs, Implementation of Extended ACLs, Troubleshoot Scenarios. **(NETACAD-Course ENSA- Chapter 4 & 5.3, 5.4 Chapters),**	8	CO1, CO6
	HANDS-ON 1. **Configure Extended IPv4 ACLs and its comparison with Standard ACLs**		
2	**NAT for IPv4:** NAT Characteristics, Types of NAT, NAT Advantages and Disadvantages, Static NAT, Dynamic NAT, PAT, Troubleshoot Scenarios**.(NETACAD-Course ENSA- Chapter 6)**	8	CO2,CO6
	HANDS-ON 1. **Configure Static NAT** 2. **Configure Dynamic NAT**		
3	**WLAN Concepts:** Introduction to Wireless, Components of WLANs, WLAN Operation, Channel Management, Securing WLANs**(NETACAD - Course SRWEChapter 12 & Chapter 13)**	8	CO3
	HANDS-ON 1. **Remote Site WLAN Configuration(Wireless Router)** 2. **Configure a Basic WLAN on the WLC**		
4	**WAN Concepts:** Purpose of WANs ,WAN Operations, **(NETACAD-Course ENSA- Chapter 7)** **Network Security Concepts :** Threat Actors, Malware, Common Network Attacks, IP Vulnerabilities and Threats, TCP and UDP Vulnerabilities, **(NETACAD-Course ENSA-Chapter 3)**	8	CO4
	HANDS-ON **1.Configuration of WAN Point to Point Protocol (PPP) using Password Authentication Protocol (PAP).** **2. Configuration of WAN Point to Point Protocol (PPP) using Challenge Handshake Authentication Protocol (CHAP).**		
5	**Virtual Private Network:** VPN and IPsec Concepts: VPN Technology, Types of VPNs, **(NETACAD-Course ENSA-Chapter 8)** **Network Automation and Virtualization:**Data Formats, APIs, REST, Configuration Management Tools, Virtualization, Software-Defined Network. **(NETACAD-Course ENSA-Chapter 13 &14)**	8	CO5
	HANDS-ON **1. Configuration of VPN using GRE**		

TEXT BOOKS:

1. CISCO Netacad Course-3 : CCNAv7-Enterprise Network, Security and Automation(ONLINE ACCESS)
2. CCNA Routing and Switching – Todd Lammle, 2nd Edition, Sybex Publisher (Wiley Brand), 2016.

REFERENCE BOOKS:

1. Data Communications and Networking. Forouzan, 5th Edition, McGraw Hill, Reprint-2017.
2. CISCO Netacad Course-2 : CCNAv7-Switching, Routing and Wireless Essentials (ONLINE ACCESS)

Assessment Pattern

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	-	-	-
Understand	-	-	5
Apply	10	10	5
Analyze	10	5	-
Evaluate	05	-	-
Create	-	-	-

SEE- Semester End Examination (50 Marks)

Bloom's Taxonomy	SEE Marks
Remember	-
Understand	10
Apply	20
Analyze	10
Evaluate	10
Create	-

PHYSICAL DESIGN

Course Code : 20NHOP718A **Credits: 3**
L:T:P:S : 3:0:0:0 **CIE Marks: 50**
Exam Hours : 3 **SEE Marks: 50**

Course Outcomes: At the end of the Course, the student will be able to:

CO1	Understand VLSI Technology back-end design flow and its implementations
CO2	Apply the procedure of Floor planning in Physical Design
CO3	Use the placement algorithms in Physical Design
CO4	Examine routing and Design Rule Check for a given Physical Design
CO5	Evaluate clock tree synthesis and power management of the circuit
CO6	Engage in independent learning and perform the Physical Design of selected VLSI circuit

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	3	-	-	-	-	-	-	-
CO2	3	3	3	-	3	-	-	-	-	-	-	-
CO3	3	3	3	-	3	-	-	-	-	-	-	-
CO4	3	3	3	2	3	-	-	-	-	-	-	-
CO5	3	3	3	2	3	-	-	-	-	-	-	-
CO6	3	3	3	2	3	-	-	-	1	1	-	1

Correlationlevels:1-Slight (Low) 2-Moderate (Medium) 3-Substantial (High)

Module No	Module Contents	Hours	COs
1	**Introduction to Physical Design** Introduction to PD flow, Inputs of PD – Library files, Netlist, SDC(Synopsis Design Constraints), LEF(Library Exchange File),Output of PD – GDSII, Area, Power, Timing reports.	**08**	**CO1,CO6**
2	**Partitioning and Floor planning** Partitioning, Floorplanning, Pin Assignment, Floor plan-Die size estimation, Aspect Ratio, Core Utilization, Macros and Types –Soft macros, Hard macros, Firmmacros	**08**	**CO2,CO6**

3	**Placement** Type of Placement – Standard cell placement, Building block placement Cell types – Well tap cells, End cap cells, Decap cells, Filler cells, Spare cells, Timing driven placement, Congestion driven placement, Placement Congestion – Global route congestion, Congestion map, Easing congestion	**08**	**CO3,CO6**
4	**Routing** Routing types, Design Rule check, clock route vs signal route, shorts, opens, Getting attributes like route length, number of viasetc for a given net	**08**	**CO4,CO6**
5	Power plan – Rings, Stripes, Rails, Core power management, I/O cell power management, IR drop – types of IR drop Skew, Latency, Jitter, Useful skew, Hold fixing func mode and shift mode, Generated clocks, clock groups vs false paths, clock routing	**08**	**CO5,CO6**

TEXT BOOKS:

1. VLSI physical design automation : theory and practiceby Sadiq M Sait and Habib Yusuf, McGraw-Hill BookCo.
2. VLSI Physical Design: From Graph Partitioning to Timing Closure Andrew B. Kahng, Jens Lienig, Igor L. Markov, Jin Hu2011,Springer.

REFERENCE BOOKS:

1. J. Bhasker, R Chadha,., "Static Timing Analysis for Nanometer Designs: A Practical Approach", Springer, 2009.
2. Michael John Sebastian Smith, "Application - Specific Integrated Circuits" Addison Wesley Professional;2005.

Mapping of CO v/s PSO:

-	**PSO1**	**PSO2**
20NHOP718A	**Physical Design**	
CO1	-	-
CO2	3	3
CO3	3	3
CO4	3	3
CO5	3	3
CO6	3	3

Assessment Pattern

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	**Tests**	**Assignments**	**Quizzes**
Marks	**25**	**15**	**10**
Remember	-	-	-
Understand	-	-	5
Apply	15	5	5
Analyze	10	5	-
Evaluate	-	5	-
Create	-	-	-

SEE- Semester End Examination (50 Marks)

Bloom's Taxonomy	**SEE Marks**
Remember	-
Understand	-
Apply	20
Analyze	15
Evaluate	15
Create	-

PROGRAMMING OF INDUSTRIAL ROBOT	
Course Code: 20NHOP722A	**Credits: 3**
L:T:P:S : 3:0:0:0	**CIE Marks: 50**
Exam Hours: 3	**SEE Marks: 50**

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Infer the various coordinate systems and degrees of freedom for a robot
CO2	Illustrate the robotic coordinate systems by teaching the robot
CO3	Examine the functionalities of robotic end effectors
CO4	Develop various industrial applications using FANUC Robot ER-4iA
CO5	Model various applications using Roboguide simulation tool
CO6	Experiment with FANUC Robot ER-4iA using teach pendant

Mapping of Course Outcomes to Program Outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
20NHOP722A	**PROGRAMMING OF INDUSTRIAL ROBOT**											
CO1	3	3	1	1	3	1	-	-	-	-	-	1
CO2	3	3	2	1	3	-	-	-	-	-	-	1
CO3	3	3	2	1	3	-	-	-	-	-	2	1
CO4	-	3	3	3	3	-	-	-	-	-	3	1
CO5	-	3	3	3	3	-	-	-	-	-	3	1
CO6	-	3	3	3	3	-	-	-	-	-	3	1

Correlationlevels:1-Less (Low) 2-Moderate (Medium) 3-Substantial (High)

Module No	Module Contents	Hours	COs
1	**BASICS OF ROBOTICS** Basic Concepts – Definition – Three laws – Degrees of Freedom. Robot – Components of a robot, Classification of robots Articulated – Cartesian – Cylindrical – Polar – SCARA – Delta – Co-ordinate systems, Work envelope – Specifications – Pitch, yaw, roll, joint notations, speed of motion and pay load – Robot parts and their functions.	**08**	**CO1**
2	**ROBOT TEACHING** **Teach pendant programming**: Various Teaching Methods, Task Programming, Motion Interpolation. ***Hands on:*** i. Explanation on tool Orienting ii. Selection & Creation of Teach program iii. Explanation on Joint, Linear & Circular motion iv. Program testing, editing &Touch up v. Using and setting up of User frame vi. Using and setting up of Tool Frame	**08**	**CO2, CO6**
3	**ROBOT SENSORS, ACTUATORS,END EFFECTORS AND INSTRUCTION SET** **Sensors and Actuators:** PIR sensors, Optical Transducers, Servomotor, Stepper Motors. **End effectors** – Grippers: Mechanical grippers, Hydraulic & Pneumatic grippers, Magnetic grippers, Vacuum grippers, RCC grippers – Two and three fingered grippers –External grippers – Selection considerations, Gripper force analysis. **Instruction set** – Registers, Timers, Wait, Branching. ***Hands on:*** i. Practice on various I/O instructions ii. Practice on Timer/Wait and Branching Instructions iii. Practice on user Alarms	**08**	**CO3, CO6**

4	**INDUSTRIAL APPLICATIONS OF ROBOTS** **Robot Application**: Implementation of robots in industries Various steps, Machine loading/unloading. Assembly and Inspection, Feature Application, Material handling Applications – PICK and PLACE & Palletization, Robot cycle time analysis ***Hands on:*** i. Practice on Pick and Place application ii. Practice on Palletization iii. Practice on real time applications	**08**	**CO4, CO6**
5	**ROBOT PROGRAMMING AND SIMULATION** **Introduction to Robo Guide**: Create, program and simulate a robotic workcell - Integrated Virtual Teach Pendant looks and operates like a real Teach Pendant- Reach verification, collision detection, accurate cycle time and robot trajectory and other system- ***Hands on:*** Practice on i. reach verification ii. collision detection iii. accurate cycle time iv. robot trajectory v. other system	**08**	**CO5, CO6**

TEXTBOOKS:

[1]. Introduction to Robotics: mechanics and control, Craig J J, 3/E, Pearson Education India, 2008.

[2]. Deb S.R, "Robotics Technology and flexible automation", Tata McGraw-Hill Education,
2nd Edition, 2017.

[3]. Mikell P Groover & Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, Industrial Robotics, "Technology Programming and Applications", McGraw Hill, 2012.

REFERENCE BOOKS:

[1]. Introduction to Robotics: S K Saha, Tata McGraw-Hill Education, 2008

[2]. ROBOT GUIDE MANUAL, FANUC.

Mapping of CO v/s PSO:

CO	PSO1	PSO2
20NHOP722A	**PROGRAMMING OF INDUSTRIAL ROBOT**	
CO1	2	2
CO2	2	2
CO3	2	2
CO4	2	2
CO5	2	2
CO6	2	2

Assessment Pattern

CIE-Continuous Internal Evaluation Theory (50marks)

Bloom's Taxonomy	Tests	Assignments	Reports
Marks	**25**	**15**	**10**
Remember	-	-	-
Understand	**5**	-	**5**
Apply	**10**	**7.5**	**5**
Analyze	**5**	**7.5**	-
Evaluate	**5**	-	-
Create	-	-	-

SEE-Semester End Examination Theory (50 Marks)

Bloom's Taxonomy	SEE Marks
Remember	-
Understand	5
Apply	30
Analyze	5
Evaluate	5
Create	5

5G MOBILE COMMUNICATION	
Course Code : 20NHOP723A	**Credits: 3**
L:T:P:S : 3:0:0:0	**CIE Marks: 50**
Exam Hours : 03	**SEE Marks: 50**

COURSE OUTCOMES: At the end of the Course, the Student will be able to:

CO1	Understand 5G spectrum requirement, its channel model and use cases
CO2	Familiarize with 5G architecture options and physical layer concepts
CO3	Examine the multicarrier techniques and new waveform options for 5G communication
CO4	Appraise the current research avenues in 5G domain
CO5	Illustrate the concept of network slicing and V2V Communication
CO6	Interpret the Interference and Mobility management in 5G networks

Mapping of Course Outcomes to Program Outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
20NHOP723A	**5G MOBILE COMMUNICATION**											
CO1	3	2	-	-	-	3	3	-	-	-	-	2
CO2	3	3	3	3	3	-	-	-	3	3	-	3
CO3	3	3	3	3	3	-	-	-	2	2	-	3
CO4	3	3	3	3	3	2	2	2	3	3	-	3
CO5	3	3	2	2	-	3	-	-	-	-	-	2
CO6	3	3	2	-	-	-	-	-	-	-	-	-

Correlation levels:1-Slight (Low) 2-Moderate (Medium) 3-Substantial (High)

Module No	Module Contents	Hours	COs
1	**5G RADIO SPECTRUM:** 5G spectrum landscape and requirements, Spectrum access modes and sharing scenarios, 5G spectrum technologies. **5G CHANNEL MODEL**: The 5G wireless Propagation Channels: Channel modeling requirements, propagation scenarios and challenges in the 5G modeling. **5G USE CASES AND SYSTEM CONCEPT:** Use cases and requirements, 5G system concept. Textbook 1: 12.2,12.3,12.4, 13.1,13.2,13.3, 2.1,2.2	**8**	**CO1, CO4**
2	**RADIO INTERFACE ARCHITECTURE:** 5G architecture options, core network architecture, RAN architecture. **5G PHYSICAL LAYER:** Physical channels and signals, 5G frame structure, physical layer procedures (MIMO, Power control, link adaptation, beam forming). Textbook 3: 5.1,5.2,5.3,5.4, 6.3,6.4,6.11,6.12	**8**	**CO2**
3	**5G RADIO-ACCESS TECHNOLOGIES:** Access design principles for multi-user communications, multi-carrier with filtering: a new waveform, non-orthogonal schemes for efficient multiple access Textbook 1: 7.1,7.2,7.3	**8**	**CO3, CO4**
4	**INTRODUCTION TO 5G NETWORK SLICING**: Network Slicing, E2E Slicing, SDN and NFV Slicing **VEHICULAR COMMUNICATIONS:** From V2V to AV2X, key standards, VC architectures, V2X Use cases Textbook 2: 5.7	**8**	**CO4, CO5**
5	**MOBILITY AND HANDOFF MANAGEMENT IN 5G:** Network deployment types, Interference management in 5G, Mobility management in 5G, Dynamic network reconfiguration in 5G. Textbook 1: 11.1,11.2,11.3,11.4	**8**	**CO6**

TEXTBOOKS:

1. Afif Osseiran, Jose F Monserrat, Patrick Marsch, "5G Mobile and Wireless Communications Technology", Cambridge University Press, 2016
2. Saad Z. Asif, "5G Mobile Communications Concepts and Technologies", CRC Press, Taylor & Francis Group, First Edition, 2018
3. Harri Holma, Antti Toskala, Takehiro Nakamura, "5G Technology 3GPP NEW RADIO", John Wiley & Sons First Edition,2020

REFERENCES:

1. Gordon L. Stuber, "Principles of Mobile Communication", KLUWER ACADEMIC PUBLISHERS, 2nd Edition, 2002
2. Joseph C. Liberti, Theodore S. Rappaport, "Smart Antennas for Wireless Communications", Prentice Hall PTR, 1999

3. Ying Zhang, "Network Function Virtualization Concepts and Applicability in 5G Networks", John Wiley & Sons, 2018

Mapping of CO v/s PSO:

CO	PSO1	PSO2
20NHOP723A	5G MOBILE COMMUNICATION	
CO1	3	3
CO2	3	3
CO3	3	3
CO4	3	3
CO5	3	3
CO6	3	3

Assessment Pattern

CIE-Continuous Internal Evaluation

Theory (50marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	25	15	10
Remember	-	-	-
Understand	10	-	-
Apply	10	7.5	5
Analyze	5	7.5	5
Evaluate	-	-	-
Create	-	-	-

SEE-Semester End Examination

Theory (50Marks)

Bloom's Taxonomy	SEE Marks
Remember	-
Understand	15
Apply	20
Analyze	15
Evaluate	-
Create	-

VIII SEMESTER

(SYLLABUS)

Internet of Things

Course Code : 20ECE811A | **Credits : 3**
L:T:P:S : 3:0:0:0 | **CIE Marks : 50**
Exam Hours : 3 Hrs | **SEE Marks : 50**

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Understand the basic concepts of Internet of Things and API's
CO2	Illustrate the IoT Architectural features and Reference model
CO3	Analyze the difference between IoT and M2M and various network function virtualization
CO4	Identify the IoT protocols and IoT security issues
CO5	Design IoT applications in different domain and analyze their performance
CO6	Develop real time applications using IoT models

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-
CO3	3	3	3	-	-	-	-	-	-	-	-	-
CO4	3	3	3	2	-	-	-	-	-	-	-	-
CO5	3	3	3	2	1	-	-	-	-	-	-	2
CO6	3	3	3	2	1	-	-	-	-	-	-	2

SYLLABUS			
Module no	**Module Contents**	**Hrs**	**COs**
1	**Introduction to Internet of things** Introduction: Definition and characteristics of IoT, Physical design of IoT: Things in IoT, IoT protocols, Logical Design of IoT: IoT functional blocks, IoT communication models IoT API's, IoT enabling technologies Text 1 : 1.1 – 1.4	**9**	**CO1**
2	**IoT Architecture** Introduction, Reference Model and architecture, IoT reference Model. IoT Physical device and endpoint: What is an IoT device, Basic building blocks of IoT, Sensors for IoT Applications Text 2: 1.3 Text 1 : 7.1	**9**	**CO2**
3	**IoT & M2M** Introduction, Machine to Machine, Difference between IoT and	**9**	**CO3**

	M2M, SDN and NFV for IoT: Software define Network and Network Function Virtualization Text 1: 3.1- 3.4		
4	**IoT Privacy, Security and Vulnerabilities Solutions** Introduction, vulnerabilities and security requirements and threat analysis, Use Cases and misuse cases, IoT Security Tomography and Layered Attacker Model, Message Communication, Security Models, Profiles and Protocols for IoT Text 2: 10.1 – 10.6	**9**	**CO4, CO6**
5	**Domain specific applications of IoT** Home automation, Smart environment, smart cities, logistics, retail, smart energy, smart agriculture, industrial control and smart health. Text 1 : 2.1 – 2.9	**9**	**CO5, CO6**

Text Books:

1. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", 1stEdition, VPT, 2014.
2. Rajkamal, "INTERNET OF THINGS, Architecture and Design Principles", 1st edition, McGraw Hill Education (India) Private Limited, 2017.

Reference Books:

1. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.

2. Dr. Guillaume Girardin , Antoine Bonnabel, Dr. Eric Mounier, 'Technologies & Sensors for the Internet of Things Businesses & Market Trends 2014 - 2024',YoleDevelopment Copyrights ,2014

3. Waltenegus Dargie,Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice", Wiley Series on Wireless Communication and Mobile Computing 2010.

Mapping of CO v/s PSO:

-	PSO1	PSO2
20ECE811A	**Internet of Things**	
CO1	-	-
CO2	-	-
CO3	3	2
CO4	-	-
CO5	3	2
CO6	3	2

Assessment Pattern

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Category	Tests	Assignments	Quizzes
Marks (out of 50)	25	15	10
Remember	5	-	-
Understand	10	5	5
Apply	5	5	5
Analyze	5	5	-
Evaluate	-	-	-
Create	-	-	-

SEE- Semester End Examination (50Marks)

Bloom's Category	SEE Marks
Remember	5
Understand	20
Apply	15
Analyze	10
Evaluate	-
Create	-

VLSI Design Manufacturing

Course Code : 20ECE812A | **Credits : 3**
L:T:P:S : 3:0:0:0 | **CIE Marks : 50**
Exam Hours : 3Hrs | **SEE Marks : 50**

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Discuss the various initial steps involved in the VLSI fabrication process.
CO2	Analyze different Oxidation and lithography methods
CO3	Appraise the deposition and ion implantation mechanisms.
CO4	Apply possible metallization choices for VLSI fabrication
CO5	Analyze the fabrication of NMOS, CMOS memory and bipolar devices
CO6	Understand the nuances of assembly and packaging of VLSI devices.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	2
CO2	3	3	2	-	-	-	-	-	-	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-
CO5	3	3	2	2	-	-	-	-	-	-	-	2
CO6	3	-	-	-	-	-	-	-	-	-	-	-

SYLLABUS			
Module No	**Module Contents**	**Hrs**	**COs**
1	**Crystal growth, wafer preparation and epitaxy** Electronic Grade Silicon, Czochralski crystal growing, Silicon Shaping, processing considerations, Vapor phase Epitaxy, Molecular Beam Epitaxy, Silicon on Insulators, Epitaxial Evaluation. Text book 1- 1.1, 1.2, 1.3, 1.4, 1.5, 2.2, 2.3, 2.4, 2.5.	9	CO 1
2	**Oxidation, Lithography and Reactive plasma etching** Oxidation growth Mechanism and kinetics, Thin Oxides, Oxidation Techniques and Systems, Oxide properties, Redistribution of Dopants at interface, Oxidation of Polysilicon, Oxidation inducted Defects. Optical Lithography, Electron Lithography, X-Ray Lithography, Ion Lithography, Reactive Plasma Etching techniques and Equipment. Textbook 1- 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 4.1, 4.2, 4.3, 4.4, 4.5, 5.5	9	CO 2

3	**Diffusion, Ion implementation and Metallization.** Models of Diffusion in Solids, Diffusion in polycrystalline silicon, Diffusion in SiO_2, Diffusion Enhancements and Retardations, Ion Implantation Range theory, Implant equipment, Annealing, Shallow junctions,High energy implantation, Metallization choices, Physical vapor deposition – Patterning. Text book 1 – 7.1, 7.2, 7.8, 7.9, 7.10, 8.1, 8.2, 8.3, 8.4, 8.5, 8.6, 9.1, 9.3, 9.4, 9.5.	9	CO3 CO4
4	**Process simulation and VLSI process integration** Ion implantation, Diffusion and oxidation, Epitaxy, Lithography, Etching and Deposition, Fundamental considerations for IC Processing, NMOS IC Technology, CMOS IC Technology, MOS Memory IC technology, Bipolar IC Technology, IC Fabrication. Text book 1 –10.1, 10.2, 10.3, 10.5, 10.6, 11.1, 11.2, 11.3, 11.4, 11.5, 11.6, 11.7.	9	CO5
5	**Analytical, Assembly Techniques and Packaging of VLSI Devices** Analytical Beams, Beam Specimen interactions, Chemical methods, Package types, Packaging design considerations, VLSI assembly technology, Package fabrication technology. Text book 1 – 12.1, 12.2, 12.3, 12.4, 13.1, 13.2, 13.3, 13.4, 13.5.	9	CO6

Text Books:

1. S.M.Sze, “VLSI Technology”, Mc.Graw.Hill Second Edition. 2015.

Reference Books:

1. S.K. Ghandhi, "VLSI Fabrication Principles", John Wiley Inc., New York, 1994, Second Edition.
2. Wayne Wolf ,” Modern VLSI Design”, Prentice Hall India.1998.

Mapping of CO v/s PSO:

-	PSO1	PSO2
20ECE812A	**VLSI Design Manufacturing**	
CO1	-	-
CO2	3	3
CO3	3	3
CO4	3	3
CO5	3	3
CO6	3	3

Assessment Pattern

CIE – Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	5	---	---
Understand	5	5	---
Apply	5	5	5
Analyze	10	5	5
Evaluate	---	---	---
Create	---	---	---

SEE – Semester End Examination (50 Marks)

Bloom's Taxonomy	SEE Marks
Marks	**50**
Remember	10
Understand	10
Apply	10
Analyze	20
Evaluate	---
Create	---

Cellular Mobile Communication

Course Code : 20ECE813A | **Credits : 3**
L:T:P:S : 3:0:0:0 | **CIE Marks : 50**
Exam Hours : 3 Hrs | **SEE Marks : 50**

Course Outcomes: At the end of the Course, the student will be able to:

CO1	Analyze mobile radio propagation fading, diversity concepts and the channel modelling
CO2	Model GSM network architecture and system operation
CO3	Develop a scheme for idle mode, call set up, call progress handling and call tear down in a CDMA cellular network
CO4	Demonstrate the understanding on basic operations of Air interface in LTE 4G system.
CO5	Compare different multicarrier and multiuser technologies in LTE 4G systems
CO6	Evaluate the design considerations, computational complexity, radio resource allocation in cellular systems

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	-	-	-	-	-	-	-	-	-
CO2	3	3	3	-	-	-	-	-	-	-	-	2
CO3	3	3	3	2	-	-	-	-	-	-	-	2
CO4	3	3	3	-	-	-	-	-	-	-	-	-
CO5	3	3	3	-	-	-	-	-	-		-	-
CO6	3	3	3	2	1	-	-	-	-	-	-	2

SYLLABUS

Module No	Module Contents	Hours	COs
1	**Mobile Radio Propagation** – Large Scale Path Loss - Free Space Propagation Model, Relating Power to Electric Field, Three Basic Propagation Mechanisms – Reflection (Ground Reflection) , Diffraction, Scattering, Practical Link Budget, (Text 1 - 2.2 and Ref1 - Chapter 4). Fading and Multipath – Broadband wireless channel, Delay Spread and Coherence Bandwidth, Doppler Spread and Coherence Time, Angular spread and Coherence Distance (Text 1 – 2.4) , Statistical Channel Model of a Broadband Fading Channel (Text 1 – 2.5.1) The Cellular Concept – Cellular Concept , Analysis of Cellular Systems, Sectoring (Text 1- 2.3)	9	**CO1**
2	**GSM and TDMA Technology GSM System overview** – Introduction, GSM Network and System Architecture, GSM Channel Concept. GSM System Operations – GSM Identities, System Operations –Traffic cases, GSM Infrastructure Communications (Um Interface) (Text 2, Part1 and Part 2 of Chapter 5)	9	**CO2**

3	**CDMA Technology CDMA System Overview** – Introduction, CDMA Network and System Architecture CDMA Basics – CDMA Channel Concepts, CDMA System (Layer 3) operations, 3G CDMA (Text 2-Part 1, Part2 and Part 3 of Chapter 6)	9	**CO3**
4	**LTE** – 4G Key Enablers for LTE 4G – OFDM, SC-FDE, SC-FDMA, Channel Dependant Multiuser Resource Scheduling, Multi-Antenna Techniques, Flat IP Architecture, LTE Network Architecture. (Text 1, Sec 1.4) Multi-Carrier Modulation – Multicarrier concepts, OFDM Basics, OFDM in LTE, Timing and Frequency Synchronization, Peak to Average Ration, SC-Frequency Domain Equalization, Computational Complexity Advantage of OFDM and SC-FDE. (Text 1, Sec 3.1 – 3.7)	9	**CO4,C06**
5	**LTE** - 4G OFDMA and SC-FDMA – Multiple Access for OFDM Systems, OFDMA, SCFDMA, Multiuser Diversity and Opportunistic Scheduling, OFDMA and SC-FDMA in LTE, OFDMA system Design Considerations. (Text 1, Sec 4.1 – 4.6) The LTE Standard – Introduction to LTE and Hierarchical Channel Structure of LTE, Downlink OFDMA Radio Resources, Uplink SC-FDMA Radio Resources. (Text 1, Sec 6.1 – 6.4)	9	**C05,CO6**

TEXT BOOKS:

1. "Fundamentals of LTE" Arunabha Ghosh, Jan Zhang, Jefferey Andrews, Riaz Mohammed, Pearson education (Formerly Prentice Hall, Communications Engg and Emerging Technologies), ISBN-13: 978-0-13-703311-9.
2. "Introduction to Wireless Telecommunications Systems and Networks", Gary Mullet, First Edition, Cengage Learning India Pvt Ltd., 2006, ISBN - 13: 978-81-315-0559-5.

REFERENCE BOOKS:

1. "Wireless Communications: Principles and Practice" Theodore Rappaport, 2nd Edition, Prentice Hall Communications Engineering and Emerging Technologies Series, 2002, ISBN 0- 13-042232-0.
2. LTE for UMTS Evolution to LTE-Advanced' HarriHolma and Antti Toskala, Second Edition - 2011, John Wiley & Sons, Ltd. Print ISBN: 9780470660003.

Mapping of CO v/s PSO:

-	PSO1	PSO2
20EC813A	**Cellular Mobile Communication**	
CO1	3	2
CO2	3	-
CO3	3	2
CO4	3	2
CO5	3	2
CO6	3	2

Assessment Pattern

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	-	-	5
Understand	10	-	5
Apply	10	5	-
Analyze	5	5	-
Evaluate	-	5	-
Create	-	-	-

SEE- Semester End Examination (50 Marks)

Bloom's Taxonomy	SEE Marks
Remember	10
Understand	10
Apply	20
Analyze	10
Evaluate	-
Create	-

Industrial Automation

Course Code : 20ECE814A | **Credits : 3**
L:T:P:S : 3:0:0:0 | **CIE Marks : 50**
Exam Hours : 3 Hrs | **SEE Marks : 50**

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Understand the basic elements of an automated system ,its functions and repair diagnostics
CO2	Compare various industries and study various hardware components
CO3	Categorize automatic identification methods used for data capturing in industries
CO4	Analyze various components of manufacturing systems and its types in industrial applications
CO5	Construct ladder logic diagrams for Programmable devices
CO6	Interpret robot anatomy, its control system and applications of Industrial Robots

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-
CO3	3	3	3	-	-	-	-	-	-	-	-	-
CO4	3	3	3	-	-	-	-	-	-	-	-	2
CO5	3	3	3	-	-	-	-	-	-	-	-	2
CO6	3	3	3	-	-	-	-	-	-	-	-	2

SYLLABUS

Modul no	Module Contents	Hrs	COs
1	**Introduction:** Basic elements of an automated system: Power to accomplish the automated process, Program of Instructions, Control System, Advanced Automation Functions: Safety monitoring, Maintenance and Repair Diagnostics, error detection and recovery, Levels of Automation **(Text 1: Sections: 4.1,4,2,4.3)**	**9**	**CO1**
2	**Industrial Control systems and components** Industrial Control systems: Process Industries verses discrete manufacturing industries, continuous verses discrete control, Computer process control **(Text 1, Sections: 5.1,5,2,5,3)**	**9**	**CO2**

	Components: Sensors, Actuators, Analog to digital Conversions, Input/output devices for discrete data **(Text 1: Sections: 6.1,6.2,6.3,6.4)**		
3	**Automatic Identification methods and Manufacturing systems** Overview of Automatic Identification method, Bar Code Technology (Linear and Two dimensional), Radio Frequency identification, Magnetic stripes, Optical Character Recognition, Machine vision. **(Text 1: 12.1,12.2,12.3,12.4)** **Components of Manufacturing systems:** Production machines, Material Handling system, Types of Manufacturing systems: Types of operations, Number of workstations and layout, Level of automation, system flexibility **(Text1: 13.1.1,13.1.1.2,13.2)**	**9**	**CO3,CO4**
4	**Discrete control and Programmable Logic Controllers**: Discrete Process Control, Ladder logic diagrams, Programmable logic controllers, Personal Computers and programmable automation Controllers **(Text 1: Sections: 9.1,9.2,9.3,9.4)**	**9**	**CO5**
5	**Industrial Robotics** Robot anatomy and related attributes , Robot Control Systems , End effectors, Applications of Industrial Robots, Robot Programming , Robot accuracy and Repeatability . **(Text1 : Sections : 8.1,8,2,8.3,8.4,8.5,8.6)**	**9**	**CO6**

Text Books:

1. Automation, Production Systems, and Computer-integrated manufacturing, 4th edition, Mikell P.Groover, Pearson publications .

Reference books:

1. Industrial Instrumentation and Control By. S.K. Singh The McGraw Hill Companies
2. Process Control Instrumentation Technology By. C.D. Johnson, PHI
3. Industrial Instrumentation, Control and Automation, S. Mukhopadhyay, S. Sen and A.K. Deb, Jaico Publishing House, 2013

Mapping of CO v/s PSO:

-	PSO1	PSO2
20ECE814A	**Industrial Automation**	
CO1	-	-
CO2	-	-
CO3	3	3
CO4	3	3
CO5	3	3
CO6	3	3

Assessment Pattern

CIE – Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	5	---	---
Understand	5	---	5
Apply	5	5	5
Analyze	10	5	---
Evaluate	---	5	---
Create	---	---	---

SEE – Semester End Examination (50 Marks)

Bloom's Taxonomy	SEE Marks
Marks	**50**
Remember	10
Understand	10
Apply	10
Analyze	20
Evaluate	---
Create	---

Python and R Programming

Course Code : 20ECE815A | **Credits : 3**
L:T:P:S : 3:0:0:0 | **CIE Marks : 50**
Exam Hours : 3 Hrs | **SEE Marks : 50**

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Demonstrate the salient features, control flow tools of python
CO2	Develop stacks and queues using the concept of lists
CO3	Compare list with tuple and dictionaries
CO4	Illustrate object-oriented concepts using python programming
CO5	Understand the basic data structures available in R-programming
CO6	Develop interactive applications for a given real world requirements

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	-	-	-	-	-	-
CO2	3	3	3	-	1	-	-	-	-	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-
CO4	3	3	-	-	-		-	-	-	-	-	2
CO5	3	-	-	-	-	-	-	-	-	-	-	2
CO6	3	3	3	-	1	-	-	-	-	-	-	2

SYLLABUS			
S.No.	**Module Contents**	**Hrs**	**COs**
1	Running Python, The first Python program, Arithmetic operators, values and types, variables, expressions and statements: order of operation **Control flow tools**: IF statement, for, range function, break and continue statements, else clause in loops, pass statement, While statement. **Strings:** A string is a sequence, Len, Traversal with a for loop, String slices, Strings are immutable, Searching, Looping and counting, String methods, The in operator, String comparison **Text 1:** 1.1 – 1.5, 2.1 – 2.5, 8.1 – 8.10 ;**Text 2:** 4.1 – 4.5	**9**	**CO1, CO6**
2	**Defining functions**: Default Argument Values, Keyword Arguments, Arbitrary Argument Lists, Lambda Forms, Using Lists as Stacks, Using Lists as Queues, List Comprehensions **Lists:** A list is a sequence, Lists are mutable, traversing a list, List operations, List slices, List methods, Map, filter and reduce, deleting elements, Lists and strings, Objects and values, Aliasing, List arguments **Text 1**: 10.1 -10.12;	**9**	**CO2, CO6**

	Text 2 : 4.7.1 - 4.7.4, 5.1.1 - 5.1.4		
3	**Dictionaries:** A dictionary is a mapping, Dictionary as a collection of counters, Dictionaries and lists, Global variables **Tuple:**Tuples are immutable, Tuple assignment, Tuples as return values, Variable-length argument tuples, Lists and tuples, Dictionaries and tuples **Text1:** 11.1, 11.2, 11.5, 11.7 **Text1**: 12.1 – 12.6	**9**	**CO3, CO6**
4	**Files**: Reading and writing, Format operator, filenames and paths **Classes and objects**: Programmer-defined types, Attributes, Instances as return values, Objects are mutable, Copying **Classes and methods**: Object-oriented features, Printing objects, The init method, The __str__ method **Text 1:** 14.2 – 14.4, 15.1 – 15.6, 17.1-17.2, 17.5–17.6	**9**	**CO4,CO6**
5	**R- Programming**: How to run R, R session, Introduction to functions **Preview of R data structures:** Vectors, Scalars, Character Strings, Matrices, Lists, Data frames, Classes **Text 3:** 1.1 – 1.4	**9**	**CO5, CO6**

Text Books:

1. Allen B. Downey, ``Think Python: How to Think Like a Computer Scientist ‘‘,2nd Edition, Version 2.2.23, Green Tea Press.
2. An Introduction to Python, Guido van Rossum and Fred L. Drake Jr, Published by Network Theory Ltd, 2011.
3. THE ART OF R PROGRAMMING, Norman Matloff,2011 edition

Reference Books:

1. John V Guttag, “Introduction to Computation and Programming Using Python”, Revised and expanded Edition, MIT Press, 2013.
2. Robert Sedgewick, Kevin Wayne, Robert Dondero, ―Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.
3. Timothy A. Budd, ―Exploring Python‖, Mc-Graw Hill Education (India) Private Ltd., 2015

Mapping of CO v/s PSO:

-	PSO1	PSO2
20ECE815A	**Python and R Programming**	
CO1	3	3
CO2	3	3
CO3	3	3
CO4	3	3
CO5	-	-
CO6	3	3

Assessment Pattern

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Category	Tests	Assignments	Quizzes
Marks (out of 50)	**25**	**15**	**10**
Remember	5	-	-
Understand	10	5	5
Apply	5	5	5
Analyze	5	5	-
Evaluate	-	-	-
Create	-	-	-

SEE- Semester End Examination (50 Marks)

Bloom's Category	SEE Marks
Remember	5
Understand	20
Apply	15
Analyze	10
Evaluate	-
Create	-

Optical Networks

Course Code : 20ECE816A | **Credits : 3**
L:T:P:S : 3:0:0:0 | **CIE Marks : 50**
Exam Hours : 3 Hrs | **SEE Marks : 50**

Course Outcomes: At the end of the Course, the student will be able to:

CO1	Understand the structures of Optical fiber and modes of signal propagation
CO2	Apply the transmission characteristics to discuss the channel impairments and dispersion in optical fiber communication
CO3	Categorize the different Optical sources used in optical fiber communication
CO4	Illustrate the constructional features of optical detectors
CO5	Analyze the networking aspects for the design considerations of optical fiber
CO6	Understand the WDM Concepts, standards and its types.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	2
CO2	3	3	-	-	-	-	-	-	-	-	-	2
CO3	3	3	2	-	-	-	-	-	-	-	-	2
CO4	3	3	2	-	-	-	-	-	-	--	-	-
CO5	3	3	2	-	1	-	-	-	-	-	-	-
CO6	3	-	-	-	-	-	-	-	-	--	-	2

SYLLABUS			
Module No	**Module Contents**	**Hours**	**COs**
1	Optical fiber Communications: Historical development, The general system, Advantages of optical fiber communication, Optical fiber wave guides: Ray theory transmission, Modes in planar guide, Phase and group velocity, cylindrical fiber: Modes, Step index fibers, Graded index fibers, Single mode fibers, Cutoff wavelength, Mode field diameter, effective refractive index. Fiber Materials, Photonic crystal fibers. Text 1 :2.8 Text 2:1.1.-1.3,2.3(2.3.2,2.3.3,2.3.6) ,2.4,2.5.	9	**CO1**

2	Transmission characteristics of optical fiber: Attenuation, Material absorption losses, Linear scattering losses, Nonlinear scattering losses, Fiber bend loss, Dispersion, Chromatic dispersion, Intermodal dispersion: Multimode step index fiber. Optical Fiber Connectors: Fiber alignment and joint loss, Fiber splices: Fusion Splices, Mechanical splices, Fiber connectors: Cylindrical ferrule connectors, Duplex and Multiple fiber connectors, Fiber couplers: three and four port couplers, star couplers, Optical Isolators and Circulators. Text 1 10.2 & 10.3 Text 2:3.1-3.9 & 4.10.	9	**CO2**
3	Optical sources: Light Emitting diodes: LED Structures, Light Source Materials, Quantum Efficiency and LED Power, Modulation. Laser Diodes: Modes and Threshold conditions, Rate equation, External Quantum Efficiency, Resonant Frequencies. Text 2-4.2 &4.3	9	**CO3**
4	Photo detectors: Physical principles of Photodiodes, Photo detector noise, Detector response time. Optical Receiver: Optical Receiver Operation: Error sources, Front End Amplifiers, Receiver sensitivity, Quantum Limit. Text1-6.1-6.3 & 7.1-7.2	9	**CO4**
5	WDM Concepts and Components: Overview of WDM: Operational Principles of WDM, WDM standards, Mach-Zehnder Interferometer Multiplexers, Isolators and Circulators, Fiber grating filters, Dielectric Thin-Film Filters, Diffraction Gratings. Optical amplifiers: Basic application and Types, Semiconductor optical amplifiers, Erbium Doped Fiber Amplifiers, Raman Amplifiers, Wideband Optical Amplifiers. Text 1: 10.1-10.7 &11.1-11.8(Excluding 11.4-11.6)	9	**C05,CO6**

TEXT BOOKS:

1. Gerd Keiser , Optical Fiber Communication, 5thEdition, McGraw Hill Education(India) Private Limited, 2015. ISBN:1-25-900687-5.
2. John M Senior, Optical Fiber Communications, Principles and Practice, 3 rd Edition, Pearson Education, 2010, ISBN:978-81-317-3266-3

REFERENCE BOOKS:

1. Joseph C Palais, Fiber Optic Communication, Pearson Education, 2005, ISBN:0130085103.

Mapping of CO v/s PSO:

-	PSO1	PSO2
20ECE816A	**Optical Networks**	
CO1	-	-
CO2	3	2
CO3	3	2
CO4	-	-
CO5	3	2
CO6	-	-

Assessment Pattern

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	-	-	5
Understand	10	-	5
Apply	10	5	-
Analyze	5	5	-
Evaluate	-	5	-
Create	-	-	-

SEE- Semester End Examination (50 Marks)

Bloom's Taxonomy	SEE Marks
Remember	10
Understand	10
Apply	20
Analyze	10
Evaluate	-
Create	-

Switching and Finite Automata Theory

Course Code : 20ECE821A | **Credits : 3**
L:T:P:S : 3:0:0:0 | **CIE Marks : 50**
Exam Hours : 3 Hrs | **SEE Marks : 50**

Course Outcomes: At the end of the Course, the student will be able to:

CO1	Make use of mapping tool to synthesize threshold logic
CO2	Analyse effects of hazards and fault diagnosis in digital logical circuits
CO3	Examine the capabilities of Finite State Machines by minimization Procedures
CO4	Model the structures of sequential machines
CO5	Develop the methods of state identification and fault detection
CO6	Design the fault detection algorithm

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	2	-	-	-	-	-	-	-	-
CO3	3	3	3	-	-	-	-	-	-	-	-	-
CO4	3	3	3	2	-	-	-	-	-	-	-	-
CO5	3	3	3	-	1	-	-	-	-	-	-	1
CO6	3	3	3	-	1	-	-	-	-	-	-	1

SYLLABUS			
Module No	**Module Contents**	**Hours**	**COs**
1	Threshold Logic: Introductory Concepts: Threshold element, capabilities and limitations of threshold logic, Elementary Properties, Synthesis of Threshold networks: Unate functions, Identification and realization of threshold functions, The map as a tool in synthesizing threshold networks. Text1: Sections 7.1, 7.2	9	**CO1**
2	Reliable Design and Fault Diagnosis: Hazards, static hazards, Design of Hazard-free Switching Circuits, Fault detection in combinational circuits, Fault detection in combinational circuits: The faults, The Fault Table, Covering the fault table, Fault location experiments: Preset experiments, Adaptive experiments, Boolean differences, Fault detection by path sensitizing. Text1: Sections 8.1, 8.2, 8.3, 8.4, 8.5	9	**CO2**

3	Sequential Machines: Capabilities, Minimization and Transformation the Finite state model and definitions, capabilities and limitations of finite state machines, State equivalence and machine minimization: k-equivalence, The minimization Procedure, Machine equivalence, Simplification of incompletely specified machines. Text1: Section 10.1, 10.2, 10.3, 10.4	9	**CO3**
4	Structure of Sequential Machines: Introductory example, State assignment using partitions: closed partitions, The lattice of closed partitions, Reduction of output dependency, Input dependence and autonomous clocks, Covers and generation of closed partitions by state splitting: Covers, The implication graph, An application of state splitting to parallel decomposition. Text1: (Section 12.1, 12.2, 12.3, 12.4, 12.5, 12.6	9	**CO4**
5	State–Identification and Fault Detection Experiments: Experiments, Homing experiments, Distinguishing experiments, Machine identification, Fault detection experiments, Design of diagnosable machines, Second algorithm for the design of fault detection experiments. Text1: Sections 13.1, 13.2, 13.3, 13.4, 13.5, 13.6, 13.7	9	**C05,CO6**

TEXT BOOKS:

1. Switching and Finite Automata Theory – ZviKohavi, McGraw Hill, 2nd edition, 2010 ISBN: 0070993874.

REFERENCE BOOKS:

1. Fault Tolerant And Fault Testable Hardware Design-Parag K Lala, Prentice Hall Inc. 1985.
2. Digital Circuits and Logic Design.-Charles Roth Jr, Larry L. Kinney, Cengage Learning, 2014, ISBN: 978-1-133-62847-7.

Mapping of CO v/s PSO:

-	PSO1	PSO2
20ECE821A	**Switching and Finite Automata Theory**	
CO1	-	-
CO2	3	2
CO3	3	2
CO4	3	2
CO5	3	2
CO6	3	2

Assessment Pattern

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	-	-	5
Understand	10	-	5
Apply	10	5	-
Analyze	5	5	-
Evaluate	-	5	-
Create	-	-	-

SEE- Semester End Examination (50 Marks)

Bloom's Taxonomy	SEE Marks
Remember	10
Understand	10
Apply	20
Analyze	10
Evaluate	-
Create	-

Digital Neurocomputing

Course Code : 20ECE822A | **Credits : 3**
L:T:P:S : 3:0:0:0 | **CIE Marks : 50**
Exam Hours : 3 Hrs | **SEE Marks : 50**

Course Outcomes: At the end of the Course, the student will be able to:

CO1	Understand the basics of Neuro Science and brain theory
CO2	Examine the fundamentals of Neural Networks and Genetic Algorithms
CO3	Analyze various aspects of learning techniques in Machine Learning.
CO4	Apply neural networks and genetic algorithms effectively for appropriate applications
CO5	Analyze Instance based learning techniques and learning rule sets.
CO6	Differentiate reinforcement and analytical learning techniques by inspecting various approaches and choose the right method for related applications

Mapping of Course Outcomes to Program Outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-
CO3	3	3	3	2	1	-	-	-	-	-	-	2
CO4	3	3	3	-	1	-	-	-	-	-	-	2
CO5	3	3	3	-	-	-	-	-	-	-	-	-
CO6	3	3	3	2	-	-	-	-	-	-	-	2

SYLLABUS			
Module No	**Module Contents**	**Hours**	**COs**
1	**Introduction:** Computational Neuroscience, Tools and specializations in neuroscience, Brain theory, basic synaptic mechanism and dendritic processing, simplified neuron and population models, spiking neurons, population dynamics, Network with non-classical synapses Text-1: 1.1, 1.3, 2.1, 2.2, 2.3 (up to 2.3.4), 3.1,3.2,3.4,3.5	9	**CO1**
2	**Neural Networks and Genetic Algorithms:** Neural Network Representation, Problems, Perceptrons, Multilayer Networks and Back Propagation Algorithms, Advanced Topics, Genetic Algorithms, Hypothesis Space Search, Genetic Programming, Models of Evolution and Learning. Text-2: 4.2,4.3,4.4,4.5,4.6,9.2,9.4,9.5,9.6	9	**CO2**

3	**Bayesian and Computational Learning:** Bayes Theorem, Concept Learning, Maximum Likelihood, Minimum Description Length Principle, Bayes Optimal Classifier, Gibbs Algorithm, Naïve Bayes Classifier, Bayesian Belief Network, EM Algorithm, Probably Learning, Sample Complexity for Finite and Infinite Hypothesis Spaces, Mistake Bound Model. Text-2: 6.2, 6.3,6.6,6.7, 6. 8,6.9, 6.11, 6.12, 7.2,7.3,7.4,7.5	9	**CO3, CO4**
4	**Instance- Based Learning and Learning Sets of Rules:** K-Nearest Neighbor Learning, Locally Weighted Regression, Radial Basis Functions, Case-Based Reasoning, Sequential Covering Algorithms, Learning Rule Sets, Learning First Order Rules, Learning Sets of First Order Rules, Induction as Inverted Deduction, Inverting Resolution. Text-2: 8.2, 8.3, 8.4, 8.5, 10.2, 10.3, 10.4, 10.5,10.6, 10.7	9	**CO4, CO5**
5	**Analytical Learning and Reinforced Learning:** Perfect Domain Theories, Explanation Based Learning, Inductive-Analytical Approaches - FOCL Algorithm, Reinforcement Learning, Task, Q-Learning, Temporal Difference Learning Text-2: 11.2,11.3,11.4,12.2, 12.5.1, 13.3, 13.5	9	**CO6**

TEXT BOOKS:

1. "Fundamental of Computational Neuroscience", Thomas Trappenber, OUP Oxford, 2010
2. "Machine Learning" Tom M. Mitchell, McGraw-Hill Education, 2013.

REFERENCE BOOKS:

1. "Introduction to Machine Learning", Ethem Alpaydin PHI Learning Pvt. Ltd 2nd Ed., 2013
2. "The Elements of Statistical Learning", T. Hastie, R. Tibshirani, J. H. Friedman Springer, 1st edition, 2001

Mapping of CO v/s PSO:

-	PSO1	PSO2
20ECE822A	**Digital Neurocomputing**	
CO1	-	-
CO2	3	3
CO3	3	3
CO4	3	3
CO5	3	3
CO6	3	3

Assessment Pattern

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	-	-	5
Understand	10	-	5
Apply	10	5	-
Analyze	5	5	-
Evaluate	-	5	-
Create	-	-	-

SEE- Semester End Examination (50 Marks)

Bloom's Taxonomy	SEE Marks
Remember	10
Understand	10
Apply	20
Analyze	10
Evaluate	-
Create	-

Pattern Recognition & Application

Course Code : 20ECE823A | **Credits : 3**
L:T:P:S : 3:0:0:0 | **CIE Marks : 50**
Exam Hours : 3 Hrs | **SEE Marks : 50**

Course Outcomes: At the end of the Course, the student will be able to:

CO1	Understand the basic concepts in pattern Recognition and compute features useful for image representation
CO2	Differentiate procedures, methods and algorithms related to pattern recognition
CO3	Analyze pattern recognition theories, such as Bayes classifier, linear discriminant analysis
CO4	Compare the different pattern classification
CO5	Analyze state-of-the-art algorithms used in pattern recognition
CO6	Make use of pattern recognition techniques for solving complex problems.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	--	-	-	-	-	-	-
CO3	3	3	2	-	-	-	-	-	-	-	-	-
CO4	3	3	2	-	-	-	-	-	-	-	-	2
CO5	3	3	2	-	-	-	-	-	-	-	-	2
CO6	3	3	3	2	-	-	-	-	-	-	-	2

SYLLABUS			
Module No	**Module Contents**	**Hours**	**COs**
1	**Introduction:** Feature extraction and Pattern Representation Concept of Supervised and Unsupervised classification Introduction to Application Areas.	9	**CO1**
2	**Statistical Pattern Recognition** Bayes Decision Theory, Minimum Error and Minimum Risk Classifiers, Discriminant Function and Decision Boundary Normal Density, Discriminant Function for Discrete Features, Parameter estimation	9	**CO2,CO3**

3	**Dimensionality Problem** Dimension and accuracy, Computational Complexity, Dimensionality Reduction, Fisher Linear Discriminant, Multiple Discriminant Analysis **Nonparametric Pattern Classification** Density Estimation, Nearest Neighbour Rule, Fuzzy Classification	9	**CO3,CO4**
4	**Linear Discriminant Functions** Separability, Two Category and Multi Category Classification, Linear Discriminators, Perceptron Criterion, Relaxation Procedure, Minimum Square Error Criterion, Widrow-Hoff Procedure, Ho-Kashyap Procedure, Kesler's Construction. **Neural Network Classifier** Single and Multilayer Perceptron, Back Propagation Learning, Hopfield Network, Fuzzy Neural Network.	9	**CO3,CO4**
5	**Time Varying Pattern Recognition** First Order Hidden Markov Model, Evaluation, Decoding, Learning **Unsupervised Classification** Clustering, Hierarchical Clustering, Graph Based Method, Sum of Squared Error Technique	9	**CO4, CO5, CO6**

TEXT BOOKS:

1. Richard O. Duda, Peter E. Hart and David G. Stork, "Pattern Classification", John Wiley & Sons, 2001.
2. Earl Gose, Richard Johsonbaugh and Steve Jost, "Pattern Recognition and Image Analysis", Prentice Hall, 1999.

REFERENCES:

1. M. Narasimha Murthy and V. Susheela Devi, "Pattern Recognition", Springer 2011.
2. Andrew Webb, "Stastical Pattern Recognition", Arnold publishers, London,1999
3. S. Theodoridis and K. Koutroumbas, "Pattern Recognition", 4th Ed., Academic Press. 2009
4. Christopher M. Bishop,"Pattern Recognition and Machine Learning", Springer publisher,2006

Mapping of CO v/s PSO:

-	PSO1	PSO2
20ECE823A	**Pattern Recognition & Application**	
CO1	-	-
CO2	3	2
CO3	3	2
CO4	-	-
CO5	3	3
CO6	3	2

Assessment Pattern

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes	Self-Study
Marks	**20**	**10**	**10**	**10**
Remember	5	5	-	-
Understand	5	5	5	-
Apply	5	-	5	5
Analyze	5	-	-	5
Evaluate	-	-	-	-
Create	-	-	-	-

SEE- Semester End Examination (50 Marks)

Bloom's Taxonomy	SEE Marks
Remember	15
Understand	15
Apply	10
Analyze	10
Evaluate	-
Create	-

Radar Networks

Course Code : 20ECE824A | **Credits : 3**
L:T:P:S : 3:0:0:0 | **CIE Marks : 50**
Exam Hours : 3 Hrs | **SEE Marks : 50**

Course Outcomes: At the end of the Course, the student will be able to:

CO1	Understand the fundamental concepts of radar
CO2	Select the radar system for the prediction of moving targets
CO3	Inspect the tracking principles of RADAR
CO4	Infer the noise signals in automatic detection of radar
CO5	Apply the information from Radar signals for real time applications
CO6	Analyze Radar range measurement for different radar applications

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	3	-	-	-	-	-	-	-	-	2
CO3	3	3	3	2	-	-	-	-	-	-	-	2
CO4	3	3	-	-	-	-	1	-	-	-	-	-
CO5	3	3	3	2	1	-	-	-	-	-	-	2
CO6	3	3	3	2	-	-	-	-	-	-	-	-

SYLLABUS

Module No	Module Contents	Hours	COs
1	**Introduction to Radar:** Basic Radar, The Simply Form of the Radar Equations, Radar Block Diagram, Radar Frequencies, Applications of Radar. The Radar Equation: Detection of Signals in Noise, Receiver Noise and the Signal-to-Noise Ratio, Probabilities of Detection and False Alarm, Integration of Radar Pulses, Radar Cross Section of Targets, Radar Cross Section of Targets, Radar Cross-Section Fluctuations, Transmitter Power, Pulse Repetition Frequency, Antenna Parameters, System Losses, Problems. Antenna Patterns **Text1:** 1.1,1.2,1.3,1.4,1.5,2.1,2.2,2.3,2.4,2.5,2.6,2.7,2.8,2.9,2.10,2.11,2.12 **Text 2 :**Chapter 1 & 2 – 2.2	9	**CO1**
2	**MTI and Pulse Doppler Radar:** Introduction to Doppler and MTI Radar, Delay-Line Cancelers, Staggered Pulse Repetition Frequencies, Doppler Filter Banks,	9	**CO2**

	Digital MTI Processing, Moving Target Detector, Limitations to MTI Performance **Text 1 :**3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8,		
3	**Tracking Radar:** Tracking with Radar, Mono pulse Tracking, Conical Scan and Sequential Lobing, Limitations to tracking Accuracy, Low Angle Tracking, Tracking in Range, Other Tracking Radar Topics, Comparison of Trackers, Automatic Tracking with Surveillance Radars (ADT) **Text 1:** 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9	9	**CO3**
4	**Detection of Signals in Noise:** Introduction, Detection Criteria, Detectors, Automatic Detection, Integrators, Constant-False-Alarm Rate Receivers. **Text 1**:5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7	9	**CO4**
5	**Information from Radar Signals:** Basic Radar Measurements, Theoretical Accuracy of Radar Measurements, Ambiguity Diagram, Pulse Compression, Target Recognition, Land Clutter, Sea Clutter, Weather Clutter Waveform and Signal Processing –Range Measurements, Angle Measurements, Doppler Measurements **Text 1:** 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 7.3, 7.4, 7.6 **Text 2 :**Chapter 5 5.1,5.2,5.3,5.4,5.5	9	**CO5**

Text Books:

1. Merrill I. Skolnik “Introduction to Radar Systems” Third Edition,2001, McGraw Hill Higher Education.

Reference Books:

1. J.C. Toomay , Paul J. Hannen “ Principles of Radar” Third Edition,PHI 2010

Mapping of CO v/s PSO:

-	PSO1	PSO2
20ECE824A	**Radar Networks**	
CO1	-	-
CO2	3	3
CO3	3	3
CO4	-	-
CO5	3	3
CO6	3	3

Assessment Pattern

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes	Self-Study
Marks	**20**	**10**	**10**	**10**
Remember	5	5	-	-
Understand	5	5	5	-
Apply	5	-	5	5
Analyze	5	-	-	5
Evaluate	-	-	-	-
Create	-	-	-	-

SEE- Semester End Examination (50 Marks)

Bloom's Taxonomy	SEE Marks
Remember	15
Understand	15
Apply	10
Analyze	10
Evaluate	-
Create	-

Wireless and High-Speed Integrated Circuits and Systems

Course Code : 20ECE825A | **Credits : 3**
L:T:P:S : 3:0:0:0 | **CIE Marks : 50**
Exam Hours : 3 Hrs | **SEE Marks : 50**

Course Outcomes: At the end of the Course, the student will be able to:

CO1	Analyze the effect of nonlinearity and noise in RF and microwave design
CO2	Apply the knowledge of analog and digital Communication concepts in RF communication
CO3	Interpret basic techniques of interconnection and concepts of wave propagation for high-speed VLSI design
CO4	Examine the propagation delays in the single and multilevel parallel and crossing interconnections using numerical algorithms
CO5	Analyze the crosstalk effects in the single and multilevel parallel and crossing interconnections
CO6	Develop a model of very high-speed VLSI circuits for the crosstalk analysis

Mapping of Course Outcomes to Program Outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	2
CO3	3	3	3	-	-	-	-	-	-	-	-	2
CO4	3	3	-	-	-	-	-	-	-	-	-	-
CO5	3	3	3	-	-	-	-	-	-	-	-	-
CO6	3	3	3	2	1	1	1	-	-	-	-	2

Module No	Module Contents	Hours	COs
1	**Introduction to RF Design, Wireless Technology and Basic Concepts:** A wireless world, RF design is challenging, The big picture. General considerations, Analog and Digital Technology, Effects of Nonlinearity, Noise, Sensitivity and dynamic range, Passive impedance transformation. **Text-1:Chapter 1:1.1-1.3, Chapter2: 2.1- 2.5.**	9	**CO1**
2	**Communication Concepts:** General concepts, analog modulation, digital modulation, spectral re-growth, coherent and non-coherent detection, Mobile RF communications, Multiple access techniques, Wireless standards, Appendix 1: Differential phase shift keying. Text-1: Chapter 3: 3.1- 3.8.	9	**CO2**
3	**High Speed VLSI Design:** Interconnections for VLSI Applications, Copper Interconnections, Method of Images, Method of Moments, Even- and Odd-Mode Capacitances, Transmission Line Equations, Miller's Theorem, Inverse Laplace Transformation, Resistive Interconnection as Ladder Network, Propagation Modes in Micro strip Interconnection, Slow-Wave Mode Propagation, Propagation Delays.**Text-2:1.1-1.12.**	9	**CO3,CO4**
4	**Interconnection Delays**: Metal–Insulator–Semiconductor Microstrip line Model of an Interconnection, Transmission Line Analysis of Single-Level Interconnections, Transmission Line Analysis of Parallel Multilevel Interconnections, Analysis of Crossing Interconnections, Parallel Interconnections Modelled as Multiple Coupled Microstrips.Very High Frequency Losses in Microstrip Interconnection, Compact Expressions for Interconnection Delays, Interconnection Delays in Multilayer Integrated Circuits.**Text-2:3.1-3.5, 3.7- 3.9**	9	**CO4, CO5**
5	Crosstalk Analysis: Lumped-Capacitance Approximation, Coupled Multiconductor MIS Microstrip line Model of Single-Level Interconnections, Frequency-Domain Modal Analysis of Single-Level Interconnections. Transmission Line Analysis of Parallel Multilevel Interconnections, Analysis of Crossing Interconnections, Compact Expressions for Crosstalk Analysis, Multiconductor Buses in GaAs High-Speed Logic Circuits. **Text-2: 4.1-4.7**	9	**CO5,CO6**

TEXT BOOKS:

1. "RF Microelectronics", B. Razavi , PHI second edition,1998.
2. "High-Speed VLSI Interconnections", Ashok K. Goel, Wiley, 2007.

REFERENCE BOOKS:

1. "CMOS Circuit Design, layout and Simulation", R. Jacob Baker, H.W. Li, D.E. Boyce, PHI 1998
2. "Design of CMOS RF Integrated Circuits", Thomas H. Lee, Cambridge University press 1998
3. " Mixed Analog and Digital Devices and Technology", Y.P. Tsividis TMH 1996

Mapping of CO v/s PSO:

-	PSO1	PSO2
20ECE825A	**Wireless and High-Speed Integrated Circuits and Systems**	
CO1	3	2
CO2	3	2
CO3	3	2
CO4	3	2
CO5	3	2
CO6	3	2

Assessment Pattern

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	-	-	5
Understand	10	-	5
Apply	10	5	-
Analyze	5	5	-
Evaluate	-	5	-
Create	-	-	-

SEE- Semester End Examination (50 Marks)

Bloom's Taxonomy	SEE Marks
Remember	10
Understand	10
Apply	20
Analyze	10
Evaluate	-
Create	-

Block Chain Technology

Course Code : 20ECE826A | **Credits : 3**
L:T:P:S : 3:0:0:0 | **CIE Marks : 50**
Exam Hours: 3 Hrs | **SEE Marks : 50**

Course Outcomes: At the end of the Course, the student will be able to:

CO1	Understand the basic concepts of blockchain
CO2	Apply the basic distributed computing and crypto primitives in blockchain
CO3	Inspect the technological challenges faced by BITCOIN 1 and real-world consensus
CO4	Distinguish between BITCOIN 1 and 2 based on functionalities
CO5	Describe the mechanisms in smart contracts and Ethereum blockchain
CO6	Summarize the benefits of blockchain outside of currencies.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-
CO3	3	3	3	-	-	-	-	-	-	-	-	-
CO4	3	3	3	-	-	-	-	-	-	-	-	-
CO5	3	-	-	-	-	-	-	-	-	-	-	-
CO6	3	3	-	-	-	-	-	-	-	-	-	-

SYLLABUS			
Module No	**Module Contents**	**Hours**	**COs**
1	**Blockchain 101:** Distributed systems, History of blockchain, Introduction to blockchain, Types of blockchain, CAP theorem and blockchain, Benefits and limitations of blockchain. Text 1 : Chapter 1	**9**	**CO1**
2	**Decentralization and Cryptography:** Decentralization using blockchain, Methods of decentralization, Routes to decentralization, Decentralized organizations. Cryptography and Technical Foundations: Cryptographic primitives, Asymmetric cryptography, Public and private keys Text 1 : Chapter 2, Chapter 3	**9**	**CO2**

3	**Bitcoin and Alternative Coins** **A**: Bitcoin, Transactions, Blockchain, Bitcoin payments B: Alternative Coins: Theoretical foundations, Bitcoin limitations, Namecoin, Litecoin, Primecoin, Zcash Text 1 : Chapter 4, Chapter 5	**9**	**CO3, CO4**
4	**Smart Contracts and Ethereum 101**: Smart Contracts: Definition, Ricardian contracts. Ethereum 101: Introduction, Ethereum blockchain, Elements of the Ethereum blockchain, Precompiled contracts. Text 1 : Chapter 6, Chapter 7	**9**	**CO5**
5	**Alternative Blockchains:** Blockchains Blockchain-Outside of Currencies: Internet of Things, Government, Health, Finance, Media Text 1 : Chapter 10, Chapter 11	**9**	**CO6**

Textbook

1. Mastering Blockchain - Distributed ledgers, decentralization and smart contracts explained, Author- Imran Bashir, Packt Publishing Ltd, Second Edition, ISBN 978-1-78712-544-5, 2017

Reference Books

1. Bitcoin and Cryptocurrency Technologies, Author- Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, Steven Goldfeder, Princeton University, 2016
2. Blockchain Basics: A Non-Technical Introduction in 25 Steps, Author- Daniel Drescher, Apress, First Edition, 2017
3. Mastering Bitcoin: Unlocking Digital Cryptocurrencies, Andreas M. Antonopoulos, O'Reilly Media, First Edition, 2014

Mapping of CO v/s PSO:

-	**PSO1**	**PSO2**
20ECE826A	**Block Chain Technology**	
CO1	-	-
CO2	3	2
CO3	3	2
CO4	3	2
CO5	-	-
CO6	-	-

Assessment Pattern

CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Taxonomy	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	-		-
Understand	10	7.5	5
Apply	10	7.5	5
Analyze	5	-	-
Evaluate	-	-	-
Create	-	-	-

SEE- Semester End Examination (50 Marks)

Bloom's Taxonomy	SEE Marks
Remember	-
Understand	15
Apply	20
Analyze	15
Evaluate	-
Create	-

INTERNSHIP			
Course Code	**20ECL83A**	**Credits**	**04**
L: T: P: S	**0:0:0:0**	**CIE Marks**	**50**
Exam Hours	**03**	**SEE Marks**	**50**

Course Outcomes: At the end of the Course, the student will be able to:

CO1	Understand industry/Organization customs and practices
CO2	Demonstrate professional and technical skills that pertain directly to the internship experience
CO3	Demonstrate effective listening skills verbal and written communication skills
CO4	Demonstrate appropriate workplace attitudes and individual responsibility
CO5	Participate well as a team member, Allocate time effectively and build professional network
CO6	Demonstrate effective management of personal behavior, ethics and attitudes and practice ethical standards appropriate to the internship site

Mapping of Course Outcomes to Program Outcomes:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	3	-	-	-
CO2	-	-	3	3	3				3	-	3	-	-	-
CO3	-	-	-	-	-	-	-	-		3	-	-	-	-
CO4	-	-	-	-	-	-	-	-	3	-	3	-	-	-
CO5	-	-	-	-	-	-	-		3	-	3	3	-	-
CO6	-	-	-	-	-	-		3	3	-	3	-	-	-

CIE - Continuous Internal Evaluation (50)

Bloom's Taxonomy	Internship
Marks (Out of 50)	-
Remember	-
Understand	20
Apply	20
Analyze	10
Evaluate	-
Create	-

SEE – Semester End Examination (50)

Bloom's Taxonomy	Internship
Remember	-
Understand	-
Apply	20
Analyze	20
Evaluate	10
Create	-

Project Phase- 2			
Course Code	**20ECL84A**	**Credits**	**10**
L: T: P: S	**0:0:10:0**	**CIE Marks**	**150**
Exam Hours	**03**	**SEE Marks**	**150**

Course Outcomes: At the end of the Course, the student will be able to:

CO1	Engage in independent study to undertake problem identification, formulation and selection of appropriate method for providing solution
CO2	Apply the identified concept and engineering tools to arrive at design solutions for identified problem
CO3	Analyze and interpret results of experiments conducted on the design solution to draw valid conclusions
CO4	Investigate the impact of engineering solutions and also demonstrate concern for environment in a global and social context.
CO5	Ability to perform the budget analysis of the project through the utilization of resources
CO6	Ability to perform in the team, contribute to the team and mentor/lead the team thus enhance professional etiquette and ethics
CO7	Ability to engage in effective oral and written communication through the project presentation and report
CO8	Ability to abide by the norms of professional ethics

Mapping of Course Outcomes to Program Outcomes:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	3	3	3
CO2	3	3	3	-	3	-	-	-	-	-	-	-	3	3
CO3	-	3	3	3	3	-	-	-	-	-	-	-	3	3
CO4	-	-	-	-	-	3	3	-	-	-	-	-	-	-
CO5	-	-	-	-	-	-	-	-	-	-	3	-	-	-
CO6	-	-	-	-	-	-	-	3	3	-	-	-	-	-
CO7	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO8	-	-	-	-	-	-	-	3	-	-	-	-	-	-

CIE - Continuous Internal Evaluation (150)

Bloom's Taxonomy	**Project Phase - 2**
Marks (Out of 150)	**-**
Remember	-
Understand	-
Apply	50
Analyze	50
Evaluate	25
Create	25

SEE – Semester End Examination (150)

Bloom's Taxonomy	**Project Phase - 2**
Remember	-
Understand	-
Apply	50
Analyze	50
Evaluate	25
Create	25

APPENDIX A

Outcome Based Education

Outcome-based education (OBE) is an educational theory that bases each part of an educational system around goals (outcomes). By the end of the educational experience each student should have achieved the goal. There is no specified style of teaching or assessment in OBE; instead classes, opportunities, and assessments should all help students achieve the specified outcomes.

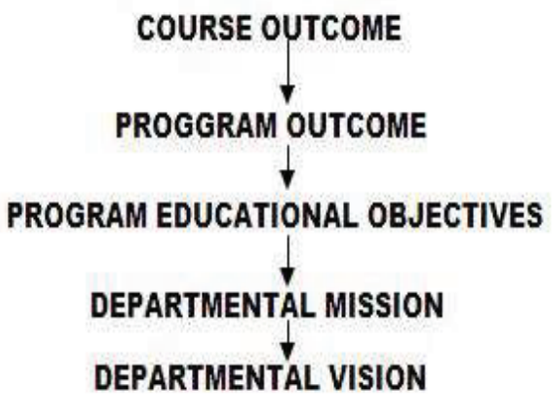
There are three educational Outcomes as defined by the National Board of Accreditation:

Program Educational Objectives: The Educational objectives of an engineering degree program are the statements that describe the expected achievements of graduate in their career and also in particular what the graduates are expected to perform and achieve during the first few years after graduation. [nbaindia.org]

Program Outcomes: What the student would demonstrate upon graduation. Graduate attributes are separately listed in Appendix C

Course Outcome: The specific outcome/s of each course/subject that is a part of the program curriculum. Each subject/course is expected to have a set of Course Outcomes

Mapping of Outcomes



APPENDIX B

The Graduate Attributes of NBA

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

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

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

Conduct investigations of complex problems: The problems that cannot be solved by straightforward application of knowledge, theories and techniques applicable to the engineering discipline that may not have a unique solution. For example, a design problem can be solved in many ways and lead to multiple possible solutions that require consideration of appropriate constraints/requirements not explicitly given in the problem statement (like: cost, power requirement, durability, product life, etc.) which need to be defined (modeled) within appropriate mathematical framework that often require use of modern computational concepts and tools.

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

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

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

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

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

Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write

effective reports and design documentation, make effective presentations, and give and receive clear instructions.

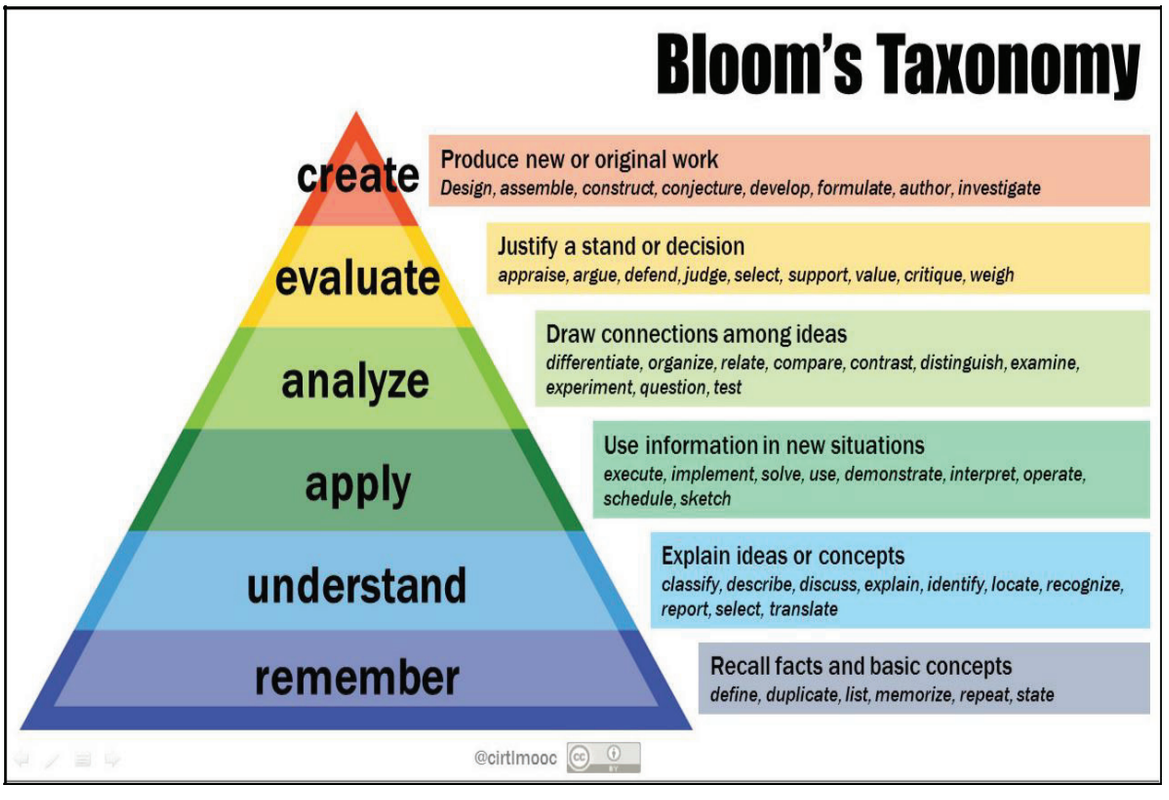
Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

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

APPENDIX C

BLOOM'S TAXONOMY

Bloom's taxonomy is a classification system used to define and distinguish different levels of human cognition—i.e., thinking, learning, and understanding. Educators have typically used Bloom's taxonomy to inform or guide the development of assessments (tests and other evaluations of student learning), curriculum (units, lessons, projects, and other learning activities), and instructional methods such as questioning strategies.



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