

# Department of Electronics and Communication Engineering

**Academic Year 2023-24**

**5<sup>rd</sup> and 6<sup>th</sup> Semester**

**Scheme and Syllabus**

**BATCH: 2021-25**

**CREDITS: 160**



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# **NEW HORIZON COLLEGE OF ENGINEERING INSTITUTION**

## **Vision**

To emerge as an institute of eminence in the fields of engineering, technology and management in serving the industry and the nation by empowering students with a high degree of technical, managerial and practical competence.

## **Mission**

- To strengthen the theoretical, practical and ethical dimensions of the learning process by fostering a culture of research and innovation among faculty members and students.
- To encourage long-term interaction between the academia and industry through their involvement in the design of curriculum and its hands-on implementation.
- To strengthen and mould students in professional, ethical, social and environmental dimensions by encouraging participation in co-curricular and extracurricular activities.

## **Quality Policy**

To provide educational services of the highest quality both curricular and co-curricular to enable students integrate skills and serve the industry and society equally well at global level.

## **Values**

- |                    |                         |
|--------------------|-------------------------|
| ❖ Academic Freedom | ❖ Professionalism       |
| ❖ Innovation       | ❖ Inclusiveness         |
| ❖ Integrity        | ❖ Social Responsibility |

## 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)

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

### PEO to Mission Statement Mapping

<b>Mission Statements</b>	<b>PEO1</b>	<b>PEO2</b>	<b>PEO3</b>	<b>PEO4</b>
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	<b>Engineering knowledge</b>	<b>PO1:</b> 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	<b>Problem analysis</b>	<b>PO2:</b> 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	<b>Design/development of solutions</b>	<b>PO3:</b> 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	<b>Conduct investigations of complex problems</b>	<b>PO4:</b> 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	<b>Modern tool usage</b>	<b>PO5:</b> 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	<b>The engineer and society</b>	<b>PO6:</b> 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	<b>Environment and sustainability</b>	<b>PO7:</b> 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	<b>Ethics</b>	<b>PO8:</b> Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9	<b>Individual and team work</b>	<b>PO9:</b> Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10	<b>Communication</b>	<b>PO10:</b> 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	<b>Project management and finance</b>	<b>PO11:</b> 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	<b>Life-long learning</b>	<b>PO12:</b> 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

<b>PSO1</b>	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.
<b>PSO2</b>	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
<b>PEO1</b>	3	3	2	2	2	1	1	1	1	1	1	1	1	1
<b>PEO2</b>	3	3	3	3	3	2	2	2	2	2	2	2	3	2
<b>PEO3</b>	3	3	3	3	3	3	3	2	2	2	2	2	3	3
<b>PEO4</b>	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**  
**B. E. in Electronics and Communication Engineering**  
**Scheme of Teaching and Examinations for 2021- 2025 BATCH (2021 Scheme)**

**V Semester**

S. No.	Course and Course Code	Course Title	BoS	Credit Distribution				Overall Credits	Contact Hours	Marks		
				L	T	P	S			CIE	SEE	Total
1	PCC 21ECE51	Communication Systems - I	ECE	3	0	0	0	3	3	50	50	100
2	PCCL 21ECL51	Communication Systems - I Lab	ECE	0	0	1	0	1	2	50	50	100
3	PCC 21ECE52	CMOS VLSI Design	ECE	3	0	0	0	3	3	50	50	100
4	PCCL 21ECL52	CMOS VLSI Design Lab	ECE	0	0	1	0	1	2	50	50	100
5	PCC 21ECE53	Linear ICs and Applications	ECE	3	0	0	0	3	3	50	50	100
6	PEC 21ECE54X	Professional Elective Course - I	ECE	3	0	0	0	3	3	50	50	100
7	AEC 21ECL55X	Ability Enhancement Course - V	ECE	0	0	1	0	1	2	50	50	100
8	MP 21ECE56	Mini Project	ECE	0	0	1	0	1	2	50	50	100
9	AEC 21ECK57	Research Methodology and IPR	ECE	1	0	0	0	1	2	50	50	100
10	UHV 21ECK58	Innovation and Design Thinking	Any	1	0	0	0	1	1	50	50	100
Total								18	23	500	500	1000

NCMC	21NSS84	National Service Scheme (NSS)	NSS coordinator	All students have to register for any one of the courses namely National Service Scheme, Physical Education (PE) (Sports and Athletics) and Yoga with the concerned coordinator of the course during the first week of V semester. The activities shall be carried out from (for 4 semesters) between V semester to VIII semester. SEE in the above courses shall be conducted during VIII semester examinations and the accumulated CIE marks shall be added to the SEE marks. Successful completion of the registered course is mandatory for the award of the degree. The events shall to be reflected in the calendar prepared for the NSS, PE and Yoga activities.
	21PE84	Physical Education (PE) (Sports and Athletics)	Physical Education Director	
	21YOG84	Yoga	Yoga Teacher	



**PPC:** Professional Core Course, **PCCL:** Professional Core Course laboratory, **UHV:** Universal Human Value Course, **NCMC:** Non-Credit Mandatory Course, **AEC:** Ability Enhancement Course, **PEC:** Professional Elective Course, **PROJ:** Mini Project work **L:** Lecture, **T:** Tutorial, **P:** Practical **S:** **SDA:** Self Study for Skill Development, **CIE:** Continuous Internal Evaluation, **SEE:**Semester End Evaluation

Professional Elective Course-I			
21ECE541	Internet of Things	21ECE544	Programming with Data Structures using C
21ECE542	Electromagnetic Field Theory	21ECE545	Nanoelectronics
21ECE543	DSP Algorithms and Architecture		

Ability Enhancement Course-V			
21ECL551	ALP with Microcontrollers	21ECL554	Electronics Applications using Scilab
21ECL552	Antenna simulation using Ansys	21ECL555	Optical Communication using Optsim
21ECL553	Network simulation using NS-2		

**Professional Elective Courses (PEC):** A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering.

**Mini-project work:** Mini Project is a laboratory-oriented/hands on course that will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications etc. Based on the ability/abilities of the student/s and recommendations of the mentor. A student can do mini project as

- (i) A group of 2 if mini project work is single discipline (applicable to all IT allied branches)
- (ii) A group of 2- 4 if mini project work is single discipline (applicable to all Core Branches)
- (iii) A group of 2 - 4 students if the Mini Project work is a multidisciplinary (Applicable to all Branches)

**CIE procedure for Mini-project:**

**(i) Single discipline:** The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two faculty members of the Department, one of them being the Guide. The CIE marks awarded for the Mini-project work shall be based on the evaluation of the project report, project presentation skill, and question and answer session in the ratio of 50:25:25. The marks awarded for the project report shall be the same for all the batches mates.

**(ii) Interdisciplinary:** Continuous Internal Evaluation shall be group-wise at the college level with the participation of all the guides of the project. The CIE marks awarded for the Mini-project, shall be based on the evaluation of the project report, project presentation skill, and question and answer session in the percentage ratio of 50:25:25. The marks awarded for the project report shall be the same for all the batch mates

<b>Credit Definition:</b> 1-hour Lecture (L) per week=1Credit 2-hours Tutorial(T) per week=1Credit 2-hours Practical / Drawing (P) per week=1Credit 2-hous Self Study for Skill Development (SDA) per week = 1 Credit	03-Credits courses are to be designed for 40 hours in Teaching-Learning Session 02- Credits courses are to be designed for 25 hours of Teaching-Learning Session 01-Credit courses are to be designed for 15 hours of Teaching-Learning Sessions
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**NEW HORIZON COLLEGE OF ENGINEERING**  
**B. E. in Electronics and Communication Engineering**  
**Scheme of Teaching and Examinations for 2021- 2025 BATCH (2021 Scheme)**

VI Semester												
S. No.	Course and Course Code	Course Title	BoS	Credit Distribution				Overall Credits	Contact Hours	Marks		
				L	T	P	S			CIE	SEE	Total
1	HSMC	21ECE61	Operations Research and Management	ECE	3	0	0	0	3	50	50	100
2	PCC	21ECE62	Embedded System Design	ECE	3	0	0	0	3	50	50	100
3	PCCL	21ECL62	Embedded System Design Lab	ECE	0	0	1	0	1	50	50	100
4	PCC	21ECE63	Communication Systems - II	ECE	3	0	0	0	3	50	50	100
5	PCCL	21ECL63	Communication Systems - II Lab	ECE	0	0	1	0	1	50	50	100
6	PEC	21ECE64X	Professional Elective Course - II	ECE	3	0	0	0	3	50	50	100
7	UHV	21ECK65	Social Connect and Responsibility	ECE	0	0	1	0	1	50	50	100
8	INT	21ECE66	Innovation / Entrepreneurship / Societal Internship	ECE	0	0	3	0	3	50	50	100
9	MP	21ECE67	Mini Project	ECE	0	0	1	0	1	50	50	100
10	OEC	21NHOP6XX	Industrial Open Elective Course - I	ECE	3	0	0	0	3	50	50	100
<b>Total</b>									<b>22</b>	<b>23</b>	<b>500</b>	<b>1000</b>

**HSMC:** Humanity and Social Science & Management Course, **PCC:** Professional Core Course laboratory, **NCMC:** Non-Credit Mandatory Course, **AEC:** Ability Enhancement Course, **PEC:** Professional Elective Course, **OEC:** Open Elective Course, **PROJ:** Project work, **L:** Lecture, **T:** Tutorial, **P:** Practical **S:** SDA: Self Study for Skill Development, **CIE:** Continuous Internal Evaluation, **SEE:**Semester End Evaluation.

**Industrial Open Elective Course (OEC):** Credit for OEC is 03 (L: T: P: S) can be considered as (3: 0: 0 : 0). The teaching and learning of these Courses will be based on hands-on. The Course Assessment will be based on CIE and SEE in practical mode. This Courses will be offered by Centre of Excellence to students of all the branches. Registration to Industrial open electives shall be documented and monitored on college level.

**Professional Elective Courses (PEC):** A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering.

**21XXX61(HSMC)**- This course must be pertaining to economics and management of the concerned degree program. The course syllabus should have both economics and management topics and the course title should bear the word Management.  
**For IT allied Branches:** Software Product Management  
**For Core Branches:** Engineering Economics and Management / Industrial Management / Construction Management

Professional Elective Course-II		
21ECE641	Fiber Optic Communication	21ECE644
21ECE642	Biomedical Signal Processing	21ECE645
21ECE643	Low Power VLSI Design	

<p><b>Credit Definition:</b>            1-hour Lecture (L) per week=1Credit            2-hours Tutorial(T) per week=1Credit            2-hours Practical / Drawing (P) per week=1Credit            2-hous Self Study for Skill Development (SDA) per week = 1            Credit</p>	<p>03-Credits courses are to be designed for 40 hours in Teaching-Learning Session            02- Credits courses are to be designed for 25 hours of Teaching-Learning Session            01-Credit courses are to be designed for 15 hours of Teaching-Learning Sessions</p>
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**FIFTH SEMESTER**  
**(SYLLABUS)**

<b>COMMUNICATION SYSTEMS - I</b>															
<b>Course Code</b>	<b>21ECE51</b>										<b>CIE Marks</b>		<b>50</b>		
<b>L:T:P:S</b>	<b>3:0:0:0</b>										<b>SEE Marks</b>		<b>50</b>		
<b>Hrs / Week</b>	<b>3</b>										<b>Total Marks</b>		<b>100</b>		
<b>Credits</b>	<b>03</b>										<b>Exam Hours</b>		<b>03</b>		
<b>Course outcomes:</b>															
At the end of the course, the student will be able to:															
21ECE51.1	Compare the Generation and Detection of Analog modulation techniques														
21ECE51.2	Evaluate the Power consumption and Bandwidth utilization in Analog modulation techniques														
21ECE51.3	Examine the statistical averages associated with random processes														
21ECE51.4	Apply the fundamentals of digital Communication for baseband signal processing and coding														
21ECE51.5	Categorize digital modulation techniques based on Bit Error Rate performance														
21ECE51.6	Estimate the signal in presence of noise by appropriate receiver design														
<b>Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:</b>															
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PS01</b>	<b>PS02</b>	
21ECE51.1	3	-	-	-	2	-	-	-	-	-	-	2	3	3	
21ECE51.2	3	2	1	-	2	-	-	-	-	-	-	2	3	3	
21ECE51.3	3	2	-	-	2	-	-	-	-	-	-	2	3	3	
21ECE51.4	3	-	-	-	2	-	-	-	-	-	-	2	3	3	
21ECE51.5	3	2	1	-	2	-	-	-	-	-	-	2	3	3	
21ECE51.6	3	2	1	-	2	1	1	-	-	-	-	2	3	3	
<b>MODULE-1</b>	<b>ANALOG MODULATION</b>										<b>21ECE51.1, 21ECE51.2</b>		<b>8 Hours</b>		
Introduction, Amplitude Modulation, Double side band-suppressed carrier modulation, Quadrature Carrier Multiplexing, Single-sideband modulation, VSB Modulation, Theme Example: VSB Transmission of Analog and Digital Television, Frequency Translation, Frequency- Division Multiplexing. Phase and Frequency modulation: Basic definitions, Frequency Modulation, Phase-Locked Loop.															
Self-study / Case Study / Applications		Investigate the applications of AM and FM in today's Communication scenario													
Text Book		Text Book 1: 3.1-3.8, 4.1 - 4.4													
<b>MODULE-2</b>	<b>RANDOM VARIABLES AND PROCESSES</b>										<b>21ECE51.3</b>		<b>8 Hours</b>		
Introduction, Probability, Random variables, Statistical averages, Random processes, Mean, correlation, and Covariance functions. Power spectral density, Gaussian process, Noise, Narrowband noise.															
Self-study / Case Study / Applications		Investigate the effect of noise in Communication Systems and methods to tackle it.													
Text Book		Text Book 1: 5.1 - 5.6, 5.8 - 5.11													
<b>MODULE-3</b>	<b>SAMPLING PROCESS AND WAVEFORM CODING TECHNIQUES</b>										<b>21ECE51.4</b>		<b>8 Hours</b>		
Sampling Theorem, Quadrature sampling of band pass signals, Reconstruction of a message process from its samples, Practical aspects of sampling and signal recovery, Pulse Amplitude Modulation, Time Division Multiplexing. Pulse code modulation, Quantization noise and Signal-to-noise ratio, Robust quantization, Differential PCM, Delta modulation.															
Self-study / Case Study / Applications		Explore the uses of analog-to-digital conversion in current Digital Systems.													

Text Book	Text Book 2: 4.1 – 4.3,4.5-4.7, 5.1,5.3-5.6			
<b>MODULE-4</b>	<b>DIGITAL MODULATION TECHNIQUES</b>	<b>21ECE51.5</b>	<b>8 Hours</b>	
Digital Modulation formats, Coherent binary modulation techniques- Coherent Binary PSK, Coherent Binary FSK, Coherent quadrature modulation techniques-Quadri phase-shift keying, Noncoherent binary modulation techniques-Differential PSK.				
Self-study / Case Study / Applications	Explore the applications of digital modulation techniques in today's Communication scenario.			
Text Book	Text Book 2: 7.1 – 7.2, 7.3 (1), 7.4 (2)			
<b>MODULE-5</b>	<b>DETECTION AND ESTIMATION</b>	<b>21ECE51.6</b>	<b>8 Hours</b>	
Model of Digital Communication System, Gram-Schmidt Orthogonalization procedure, geometric interpretation of signals, response of bank of correlators to noisy input, Detection of known signals in noise, correlation receiver, matched filter receiver. Estimation: concepts and criteria, Maximum Likelihood Estimation.				
Self-study / Case Study / Applications	Survey on the different detection techniques used in existing Communication Systems.			
Text Book	Text Book 2: 3.1–3.5,3.7-3.8, 3.10 ,3.11			
<b>CIE Assessment Pattern (50 Marks – Theory)</b>				
<b>RBT Levels</b>		<b>Marks Distribution</b>		
		<b>Test (s)</b>	<b>Qualitative Assessment (s)</b>	<b>MCQ's</b>
		<b>25</b>	<b>15</b>	<b>10</b>
L1	Remember	5	-	5
L2	Understand	5	-	5
L3	Apply	10	10	-
L4	Analyze	5	5	-
L5	Evaluate	-	-	-
L6	Create	-	-	-
<b>SEE Assessment Pattern (50 Marks – Theory)</b>				
<b>RBT Levels</b>		<b>Exam Marks Distribution (50)</b>		
L1	Remember	10		
L2	Understand	10		
L3	Apply	20		
L4	Analyze	10		
L5	Evaluate	-		
L6	Create	-		
<b>Suggested Learning Resources:</b>				
<b>Text Books:</b>				
1) Communications Systems, 5th Edition, Simon Haykin, Michael Moher, Publisher: WILEY India Pvt. Ltd, 2019 ISBN: 978-81-265-2151-7				
2) Digital Communications, Simon Haykin, Publisher: WILEY India Pvt. Ltd, 2006, ISBN-10 : 8126508248, ISBN-13 : 978-8126508242				
<b>Reference Books:</b>				
1) An Introduction to Analog and Digital Communication, Simon Haykin, 2008, John Wiley India Pvt. Ltd.				
2) Modern digital and analog Communication systems, B. P. Lathi, 3rd edition, 2015, Oxford University Press.				
3) Electronic communication systems, Kennedy and Davis, 5th edition, 2011, TMH.				

**Web links and Video Lectures (e-Resources):**

- <https://www.youtube.com/watch?v=-PWg-0k2oks>
- [https://www.youtube.com/watch?v=wMflxR3KsXg&list=PLt3Fk5B7L7NZIv3PAZkxW83Fp7ww6\\_IJ](https://www.youtube.com/watch?v=wMflxR3KsXg&list=PLt3Fk5B7L7NZIv3PAZkxW83Fp7ww6_IJ)
- <https://www.youtube.com/watch?v=ZW1glqkIgcw&t=135s>
- <https://www.youtube.com/watch?v=692SRjrT2MY>

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Visit to any communication-based company/public sector enterprise.
- Simulation demonstration on modulation processes.
- Video demonstration of latest trends in communication sector.
- Contents related activities (Activity-based discussions)
  - For active participation of students, instruct the students to prepare presentations on current research topics in communication sector.
  - Organizing Group wise discussions on applications or products.
  - Seminars.

<b>COMMUNICATION SYSTEMS – I LAB</b>															
<b>Course Code</b>	<b>21ECL51</b>								<b>CIE Marks</b>	<b>50</b>					
<b>L:T:P:S</b>	<b>0:0:1:0</b>								<b>SEE Marks</b>	<b>50</b>					
<b>Hrs / Week</b>	<b>2</b>								<b>Total Marks</b>	<b>100</b>					
<b>Credits</b>	<b>01</b>								<b>Exam Hours</b>	<b>03</b>					
<b>Course outcomes:</b>															
At the end of the course, the student will be able to:															
21ECL51.1	Demonstrate generation and detection of analog modulation techniques														
21ECL51.2	Analyze pulse modulation systems and their performance														
21ECL51.3	Examine the different digital modulation schemes used in the field of communication														
21ECL51.4	Evaluate the performance of modulation and demodulation techniques in various transmission environments														
<b>Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:</b>															
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	
21ECL51.1	3	3	2	1	3	-	-	-	2	-	-	3	3	3	
21ECL51.2	3	3	2	1	3	-	-	-	2	-	-	3	3	3	
21ECL51.3	3	3	2	1	3	-	-	-	2	-	-	3	3	3	
21ECL51.4	3	3	2	1	3	-	-	-	2	-	-	3	3	3	
<b>Exp. No. / Pgm. No.</b>	<b>List of Experiments / Programs</b>											<b>Hours</b>	<b>COs</b>		
<b>Prerequisite Experiments / Programs / Demo</b>															
	To Learn the basics of using MATLAB simulation software and also to learn the communication system toolbox in MATLAB. <a href="https://youtu.be/UI9lup_hjnY">https://youtu.be/UI9lup_hjnY</a>											2	NA		
<b>PART-A</b>															
1	To generate Amplitude Modulation technique using transistor.											2	21ECL51.1 21ECL51.4		
2	Generation and detection of ASK.											2	21ECL51.3 21ECL51.4		
3	Generation and detection of PAM.											2	21ECL51.2 21ECL51.4		
4	Generation of PWM.											2	21ECL51.2 21ECL51.4		
5	Generation of FSK using IC 555 Timer											2	21ECL51.3 21ECL51.4		
6	Generation of PSK.											2	21ECL51.3 21ECL51.4		
<b>PART-B</b>															
7	Frequency Modulation and Demodulation using MATLAB.											2	21ECL51.1 21ECL51.4		
8	Implementation and analysis of QPSK modulation and demodulation.											2	21ECL51.3 21ECL51.4		
9	Generation and detection of Pulse Code Modulation using MATLAB.											2	21ECL51.2		



			21ECL51.4
10	Realize Time Division Multiplexing and Demultiplexing of two band limited signals.	2	21ECL51.4
11	Signal to Noise ratio calculation using MATLAB.	2	21ECL51.4
12	Simulation of QAM Generation and Detection Schemes.	2	21ECL51.4

**PART-C**

**Beyond Syllabus Virtual Lab Content**

(To be done during Lab but not to be included for CIE or SEE)

- Method to set and measure the depth of modulation and trapezoidal display.  
<https://web.njit.edu/~gilhc/ECE489/ece489-V.htm>
- Study the envelope of a wideband signal.  
<https://web.njit.edu/~gilhc/ECE489/ece489-VI.htm>
- Explore Two path channel pass band simulation.  
<https://www.etti.unibw.de/labalive/experiment/two-path-channel-baseband/>
- Examination of AM transmission - synchronous detector.  
<https://www.etti.unibw.de/labalive/experiment/amtransmissionsynchronousdetector/>
- Encode and decode messages and observe the impact of coding on error detection and correction.  
<https://in.mathworks.com/help/comm/ug/error-detection-and-correction.html>
- Computation of BER for QAM System with AWGN Using MATLAB.  
<https://in.mathworks.com/help/comm/gs/use-pulse-shaping-on-16-qam-signal.html>

**CIE Assessment Pattern (50 Marks - Lab)**

RBT Levels		Test (s)	Weekly Assessment
		20	30
L1	Remember	-	-
L2	Understand	-	5
L3	Apply	10	10
L4	Analyze	5	10
L5	Evaluate	5	5
L6	Create	-	-

**SEE Assessment Pattern (50 Marks - Lab)**

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	05
L3	Apply	20
L4	Analyze	15
L5	Evaluate	10
L6	Create	-

**Suggested Learning Resources:**

**Reference Books:**

- Raveendranathan, K. C. Communication systems modelling and simulation: using MATLAB and Simulink. Universities Press, 2011. ISBN: 978-81-737-1722-2.
- Hari, Bhat KN. Digital Communications With Lab Manual, 3/E. Pearson Education India, 2010. ISBN-10. 8131732371 ; ISBN-13. 978-8131732373.

<b>CMOS VLSI DESIGN</b>														
<b>Course Code</b>	<b>21ECE52</b>								<b>CIE Marks</b>			<b>50</b>		
<b>L:T:P:S</b>	<b>3:0:0:0</b>								<b>SEE Marks</b>			<b>50</b>		
<b>Hrs / Week</b>	<b>3</b>								<b>Total Marks</b>			<b>100</b>		
<b>Credits</b>	<b>03</b>								<b>Exam Hours</b>			<b>03</b>		
<b>Course outcomes:</b>														
At the end of the course, the student will be able to:														
21ECE52.1	Understand the generic model and basic concepts of MOSFET													
21ECE52.2	Identify the process sequence for the fabrication of ICs and the relevant layout design rules													
21ECE52.3	Employ the delay model to the combinational MOS circuits													
21ECE52.4	Differentiate the different combinational circuit designs that are currently in use													
21ECE52.5	Examine the sequential circuits in terms of the delay constraints													
21ECE52.6	Evaluate the Combinational and Sequential Circuits in terms of timing													
<b>Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:</b>														
	<b>PO 1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>
21ECE52.1	2	-	-	-	-	-	-	-	-	-	-	-	3	2
21ECE52.2	3	3	-	-	-	-	-	-	-	-	-	2	3	2
21ECE52.3	3	3	-	-	-	-	-	-	-	-	-	2	3	2
21ECE52.4	3	3	1	-	-	-	-	-	-	-	-	2	3	2
21ECE52.5	3	3	1	-	-	-	-	-	-	-	-	2	3	2
21ECE52.6	3	3	1	-	-	-	-	-	-	-	-	2	3	2
<b>MODULE-1 MOS TRANSISTORS</b> <span style="float: right;"><b>21ECE52.1</b> <b>8 Hours</b></span>														
MOS Transistors: Introduction, MOS transistors, CMOS Logic, Design portioning. MOS Transistor Theory: Introduction, Long-Channel I-V characteristics, C-V Characteristics - Simple MOS Capacitance Models, Non-ideal I-V effects, DC transfer characteristics.														
Case Study	Investigate how to Enhance the Power Efficiency in Mobile Devices with Advanced MOS Transistor Technology.													
Text Book	Text Book-1: 1.3, 1.4, 1.6, 2.1, 2.2, 2.3 (up to 2.3.1), 2.4, 2.5													
<b>MODULE-2 CMOS PROCESSING TECHNOLOGY</b> <span style="float: right;"><b>21ECE52.2</b> <b>8 Hours</b></span>														
CMOS Processing Technology: CMOS Fabrication and Layout, Exercises for stick diagram and layout, Euler path, Lambda design rule, CMOS Technologies, Layout Design Rules, CMOS Process Enhancements.														
Applications	Explore the Significance of CMOS technology in various electronic applications.													
Text Book	Text Book 1: 1.5, 3.1, 3.2, 3.3, 3.4													
<b>MODULE-3 DELAY &amp; COMBINATIONAL CIRCUIT BASICS</b> <span style="float: right;"><b>21ECE52.3,</b> <b>21ECE52.4</b> <b>8 Hours</b></span>														
Delay: Introduction, Transient Response, RC Delay Model – Effective Resistance, Gate and Diffusion Capacitance, Equivalent RC Circuits, Transient Response, Elmore Delay, Layout Dependence of Capacitance, Linear Delay Model - Logical Effort, Parasitic Delay, Delay in a Logic Gate, Drive. Combinational Circuit Basics: Introduction, Circuit Families - Static CMOS.														

Self-Study	Optimization of combinational circuits to minimize delay.			
Text Book	Text Book 1: 4.1, 4.2, 4.3 (excluding 4.3.7), 4.4 (up to 4.4.4), 9.1, 9.2 (up to 9.2.1)			
<b>MODULE-4</b>	<b>COMBINATIONAL &amp; SEQUENTIAL CIRCUIT DESIGN</b>	<b>21ECE52.4, 21ECE52.5</b>	<b>8 Hours</b>	
Combinational Circuit Design: Circuit Families - Ratioed Circuits, Cascode Voltage Switch Logic, Dynamic Circuits- Domino Logic, Silicon-On-Insulator Circuit Design. Sequential Circuit Design: Introduction, Sequencing Static Circuits, Circuit Design of Latches and Flip-Flops - Conventional CMOS Latches, Conventional CMOS Flip-Flops, Pulsed Latches, Resettable Latches and Flip-Flops.				
Self-Study	Introduction to System-on-Chip (SoC) Design.			
Text Book	Text Book 1: 9.2 (up to 9.2.4.1), 9.5, 10.1, 10.2, 10.3 (up to 10.3.4)			
<b>MODULE-5</b>	<b>TIMING ANALYSIS</b>	<b>21ECE52.6</b>	<b>8 Hours</b>	
Timing Analysis: Delay in general, Slew Balancing & Transistor Equivalency, Design of 2-Inputs NAND & NOR Gates for Equal Rise and Fall Slew, MOS Capacitances, Design Techniques for Delay Reduction, Intrinsic Delay of Inverter and its Sizing Effect on Propagation Delay, Inverter Chain Design, Timing Terms - Analysis - Models - Goals, Static Timing Analysis, Timing Constraints & Verification, Timing Convergence, Timing driven Logic and Layout Synthesis.				
Case Study	Emphasizes the importance of timing analysis and optimization in the context of CMOS VLSI design.			
Text Book	Text Book 2: 10.1 - 10.6, 10.8 - 10.10, 10.12 - 10.15, 10.19 - 10.39			
<b>CIE Assessment Pattern (50 Marks - Theory)</b>				
<b>RBT Levels</b>		<b>Marks Distribution</b>		
		<b>Test (s)</b>	<b>Qualitative Assessment (s)</b>	<b>MCQ's</b>
		<b>25</b>	<b>15</b>	<b>10</b>
<b>L1</b>	<b>Remember</b>	<b>5</b>	<b>-</b>	<b>5</b>
<b>L2</b>	<b>Understand</b>	<b>5</b>	<b>-</b>	<b>5</b>
<b>L3</b>	<b>Apply</b>	<b>10</b>	<b>10</b>	<b>-</b>
<b>L4</b>	<b>Analyze</b>	<b>5</b>	<b>5</b>	<b>-</b>
<b>L5</b>	<b>Evaluate</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>L6</b>	<b>Create</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>SEE Assessment Pattern (50 Marks - Theory)</b>				
<b>RBT Levels</b>		<b>Exam Marks Distribution (50)</b>		
<b>L1</b>	<b>Remember</b>	<b>10</b>		
<b>L2</b>	<b>Understand</b>	<b>10</b>		
<b>L3</b>	<b>Apply</b>	<b>20</b>		
<b>L4</b>	<b>Analyze</b>	<b>10</b>		
<b>L5</b>	<b>Evaluate</b>	<b>--</b>		
<b>L6</b>	<b>Create</b>	<b>--</b>		
<b>Suggested Learning Resources:</b>				
<b>Text Books:</b>				
1) "CMOS VLSI Design – A Circuits and Systems Perspective", Neil H. E. Weste, David Money Harris, 4th Edition, Pearson Education, 2015.				
2) VLSI Design, Debaprasad Das, 2nd edition, 2016, Oxford University Press.				
<b>Reference Books:</b>				

- 1) CMOS Digital Integrated Circuits, Analysis and Design, Sung-Mo Kang & Yusuf Leblebici, 3rd Edition, 2007, TMH.
- 2) Digital Integrated Circuits – A design Perspective, Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, 2nd Edition, 2009, Prentice-Hall.
- 3) Basic VLSI Design, Douglas A. Pucknell and Kamran Eshraghian, 3rd Edition, 2011, PHI.
- 4) Static Timing Analysis for Nanometer Designs - A Practical Approach, J. Bhasker, Rakesh Chadha, Springer, 2009.

**Web links and Video Lectures (e-Resources):**

- [https://onlinecourses.nptel.ac.in/noc21\\_ee09/preview](https://onlinecourses.nptel.ac.in/noc21_ee09/preview)
- <https://nptel.ac.in/courses/117101105>
- <https://resources.pcb.cadence.com/blog/2020-cmos-vlsi-design-and-circuit-simulation-tasks>
- <http://pages.hmc.edu/harris/cmosvlsi/4e/index.html>
- [https://www.tutorialspoint.com/vlsi\\_design/index.htm](https://www.tutorialspoint.com/vlsi_design/index.htm)

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Visit to any VLSI Industry.
- Demonstration of Layout/STA/Fabrication Process.
- Demonstration of working of Silicon Fab.
- Demonstration of purification Silicon from MGS to EGS.
- Video demonstration of latest trends in Semiconductor and VLSI Industry.
- Contents related activities (Activity-based discussions)
  - For active participation of students, instruct the students to prepare Flowcharts and Handouts.
  - Organizing Group wise discussions on issues.
  - Seminars.

<b>CMOS VLSI DESIGN Lab</b>															
<b>Course Code</b>	<b>21ECL52</b>										<b>CIE Marks</b>	<b>50</b>			
<b>L:T:P:S</b>	<b>0:0:1:0</b>										<b>SEE Marks</b>	<b>50</b>			
<b>Hrs / Week</b>	<b>2</b>										<b>Total Marks</b>	<b>100</b>			
<b>Credits</b>	<b>01</b>										<b>Exam Hours</b>	<b>03</b>			
<b>Course outcomes:</b>															
At the end of the course, the student will be able to:															
21ECL52.1	Demonstrate the working of analog and digital CMOS circuits through simulation														
21ECL52.2	Use the schematics of CMOS circuits to construct and verify their layouts														
21ECL52.3	Apply Switch level description to digital CMOS circuits Modeling														
21ECL52.4	Employ the Gate level description of digital CMOS circuits for simulation and synthesis														
<b>Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:</b>															
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	
21ECL52.1	3	3	2	1	3	-	-	-	2	-	-	3	3	2	
21ECL52.2	3	-	-	-	3	-	-	-	2	-	-	3	3	2	
21ECL52.3	3	-	-	-	3	-	-	-	2	-	-	3	3	2	
21ECL52.4	3	3	2	1	3	-	-	-	2	-	-	3	3	2	
<b>Exp. No. / Pgm. No.</b>															
<b>List of Experiments / Programs</b>												<b>Hours</b>	<b>COs</b>		
<b>Prerequisite Experiments / Programs / Demo</b>															
	Introduction to CMOS VLSI Design and analog VLSI Design. Introduction to Verilog and System Design using Verilog.											2	NA		
<b>PART-A</b>															
1	Draw the schematic of CMOS Inverter for the given specifications, and verify using Transient and DC Analyses.											2	21ECL52.1 21ECL52.2		
2	Draw the schematic of the following circuits for the given specifications, and verify using Transient and DC Analyses: i) 2-input CMOS NAND gate, ii) 2-input CMOS NOR gate.											2	21ECL52.1 21ECL52.2		
3	Draw the schematic of transmission gate for the given specifications, and verify using Transient and DC Analyses.											2	21ECL52.1 21ECL52.2		
4	Draw the schematic of the following amplifiers for the given specifications, and verify the same using Transient, DC and AC Analyses: i) Common Source amplifier, ii) Common Drain amplifier.											2	21ECL52.1 21ECL52.2		
5	Draw the layout of the CMOS Inverter and perform physical verification using DRC, ERC and LVS. Extract RC and back-annotate the same and verify the Design.											2	21ECL52.1 21ECL52.2		
6	Draw the layout of the following circuits and perform physical verification using DRC, ERC and LVS. Extract RC and back-annotate the same and verify the Design: i) 2-input CMOS NAND gate ii) 2-input CMOS NOR gate.											2	21ECL52.1 21ECL52.2		
<b>PART-B</b>															
7	For the following circuits, write the switch level Verilog Code, and verify using Test Bench: i) CMOS inverter, ii) 2-input CMOS NAND and NOR gates.											2	21ECL52.1 21ECL52.3		

8	For the following circuits, write the switch level Verilog Code and verify using Test Bench: i) 2-input EXOR gate using CMOS logic, ii) 2-input EXOR gate using PTL.	2	21ECL52.1 21ECL52.3
9	Synthesize the following circuits using the gate level Verilog Code, with the given Constraints: i) CMOS inverter, ii) 2-input CMOS NAND and NOR gates.	2	21ECL52.1 21ECL52.4
10	For the following circuits, write the Verilog Code, verify using Test Bench, and then synthesize with the given Constraints: i) 4-bit Parallel adder ii) D Flip-flop.	2	21ECL52.1 21ECL52.4
11	For the following circuits, write the Verilog Code, verify using Test Bench, and then synthesize with the given Constraints: i) T Flip-flop, ii) 4-bit Synchronous counter.	2	21ECL52.1 21ECL52.4
12	Write the Verilog Code for Sequence detector using Mealy and Moore, verify using Test Bench, and then synthesize with the given Constraints.	2	21ECL52.1 21ECL52.4

**PART-C**  
**Beyond Syllabus Virtual Lab Content**  
**(To be done during Lab but not to be included for CIE or SEE)**

1. MOSFET - To plot the (i) output characteristics & (ii) transfer characteristics of an n-channel and p-channel MOSFET  
[http://vlsi-iitg.vlabs.ac.in/MOSFET\\_theory.html](http://vlsi-iitg.vlabs.ac.in/MOSFET_theory.html)
2. Ring Oscillator - To design and plot the output characteristics of a 3-inverter ring oscillator.  
[http://vlsi-iitg.vlabs.ac.in/RingOscillator\\_theory.html](http://vlsi-iitg.vlabs.ac.in/RingOscillator_theory.html)
3. 4X1 multiplexer - To design and plot the characteristics of 4x1 digital multiplexer using pass transistor logic.  
[http://vlsi-iitg.vlabs.ac.in/Multiplexer\\_theory.html](http://vlsi-iitg.vlabs.ac.in/Multiplexer_theory.html)
4. Latches - To design and plot the characteristics of a positive and negative latch based on multiplexers.  
[http://vlsi-iitg.vlabs.ac.in/Latches\\_theory.html](http://vlsi-iitg.vlabs.ac.in/Latches_theory.html)

**CIE Assessment Pattern (50 Marks - Lab)**

RBT Levels		Test (s)	Weekly Assessment
		20	30
L1	Remember	-	-
L2	Understand	-	5
L3	Apply	10	10
L4	Analyze	5	10
L5	Evaluate	5	5
L6	Create	-	-

**SEE Assessment Pattern (50 Marks - Lab)**

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	05
L3	Apply	20
L4	Analyze	15
L5	Evaluate	10
L6	Create	-

**Suggested Learning Resources:****Reference Books:**

- 1) "CMOS VLSI Design - A Circuits and Systems Perspective", Neil H. E. Weste, David Money Harris, 4th Edition, Pearson Education, 2015
- 2) VLSI Design, Deba prasad Das, 2nd edition, 2016, Oxford University Press.
- 3) Digital System design Using Verilog, Charles H. Roth Jr., Lizy Kurian John, Byeong Kil Lee, 1st Edition, 2015, CL Engineering.
- 4) Digital Design: An Embedded Systems approach Using VERILOG, Peter J. Ashenden, 2014, Elsevier.

<b>LINEAR ICS AND APPLICATIONS</b>														
<b>Course Code</b>	<b>21ECE53</b>										<b>CIE Marks</b>		<b>50</b>	
<b>L:T:P:S</b>	<b>3:0:0:0</b>										<b>SEE Marks</b>		<b>50</b>	
<b>Hrs / Week</b>	<b>3</b>										<b>Total Marks</b>		<b>100</b>	
<b>Credits</b>	<b>03</b>										<b>Exam Hours</b>		<b>03</b>	
<b>Course outcomes:</b>														
At the end of the course, the student will be able to:														
21ECE53.1	Apply the basic concepts of the circuits for the design of various configuration of OPAMP													
21ECE53.2	Compare the DC and AC characteristics of operational amplifiers													
21ECE53.3	Build linear and non-linear analog circuits using operational amplifiers													
21ECE53.4	Analyze switching circuits, signal processing and signal converting circuits using operational amplifiers													
21ECE53.5	Examine filter circuits using operational amplifiers													
21ECE53.6	Analyze the behavior of timer IC and other linear IC's													
<b>Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:</b>														
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>
21ECE53.1	3	-	-	-	-	-	-	-	-	-	-	2	3	2
21ECE53.2	3	3	-	-	-	-	-	-	-	-	-	2	3	2
21ECE53.3	3	3	2	-	2	-	-	-	-	-	-	2	3	2
21ECE53.4	3	3	2	-	2	-	-	-	-	-	-	2	3	2
21ECE53.5	3	3	2	-	2	-	-	-	-	-	-	2	3	2
21ECE53.6	3	3	2	-	2	-	-	-	-	-	-	2	3	2
<b>MODULE-1 OPERATIONAL AMPLIFIER FUNDAMENTALS</b>														
											<b>21ECE53.1, 21ECE53.2</b>		<b>8 Hours</b>	
Basic Op-Amp circuit, Op-Amp parameters – Input and output voltage, CMRR and PSRR, offset voltages and currents, Input and output impedances, Slew rate, Frequency limitations. Op-Amps as DC Amplifiers- Direct coupled – Voltage Followers, Non-inverting Amplifiers, Inverting amplifiers, Summing amplifiers, Difference amplifier.														
Case Study			Explore how to Create a function generator using Op-Amps to generate different waveforms, such as sine, square, triangle, and sawtooth waves.											
Text Book			Text Book 1: 1.1, 2.3 - 2.6, 3.2 - 3.7, 4.1, 4.3, 4.5											
<b>MODULE-2 OP-AMP AS AC AMPLIFIERS</b>														
											<b>21ECE53.2</b>		<b>8 Hours</b>	
Capacitor coupled Voltage Follower, Capacitor coupled Non-inverting Amplifiers, and Capacitor coupled Inverting amplifiers. High input impedance - Capacitor coupled Voltage Follower, setting the upper cut-off frequency, Use of a single polarity power supply														
Self-Study			Investigate how to calculate voltage gain and analyze frequency response in AC amplifier circuits.											
Text Book			Text Book 1: 4.2, 4.6, 4.8, 5.1, 5.2, 5.4, 5.6, 5.9 (2 <sup>nd</sup> Edition)											
<b>MODULE-3 OP-AMP APPLICATIONS</b>														
											<b>21ECE53.3, 21ECE53.4</b>		<b>8 Hours</b>	
Voltage sources, current sources, Integrator and differentiator, Log and antilog amplifiers, Analog Multiplier and Divider, Instrumentation amplifier, Precision rectifiers, Limiting Circuits, Sample and hold circuits, Zero crossing detectors, Inverting Schmitt trigger circuits.														



Applications	Develop a bio-signal amplifier circuit using an instrumentation amplifier for biomedical applications.			
Text Book	Text Book 1: 7.1, 7.2, 8.6 (Basic Differentiating circuit),8.7 (Basic Integrating circuit, 3.6, 7.6, 3.8, 9.1,9.2, 9.3, 9.6, 8.2(Zero Crossing Detector), 8.3 Text Book 2: 4.9 (Analog Multiplier)			
<b>MODULE-4</b>	<b>FILTERS AND IC REGULATORS</b>	<b>21ECE53.5, 21ECE53.6</b>	<b>8 Hours</b>	
RC low-pass and high pass circuit, Active Filters – First and second order Low pass & High pass filters, Band pass and Band Elimination filters, Voltage regulators using IC 78XX and 79XX, 723 general purpose regulators, Switching regulator.				
Applications	Explore real-world applications of filters, including audio processing, communications, and signal conditioning.			
Text Book	Text Book 1: 12.1,12.2,12.3,12.5,12.6 Text Book 2: 6.3,6.4,6.5			
<b>MODULE-5</b>	<b>OTHER IC APPLICATIONS</b>	<b>21ECE53.6</b>	<b>8 Hours</b>	
555 Timer and its different circuit applications as Astable & Monostable multivibrator, PHASE LOCKED LOOP -operating principles, Phase detector / comparator, LM566 VCO, DAC and ADC converters - DAC using R2R, ADC using SAR and counter type.				
Applications	Use PLL ICs to build a frequency synthesizer for generating stable and precise frequencies in RF applications.			
Text Book	Text Book 2: 8.1, 8.2, 8.3, 8.4,9.1, 9.2, 9.3, 9.4,10.2, 10.3.2, 10.3.4			
<b>CIE Assessment Pattern (50 Marks - Theory)</b>				
<b>RBT Levels</b>		<b>Marks Distribution</b>		
		<b>Test (s)</b>	<b>Qualitative Assessment (s)</b>	<b>MCQ's</b>
		<b>25</b>	<b>15</b>	<b>10</b>
<b>L1</b>	<b>Remember</b>	<b>5</b>	<b>-</b>	<b>5</b>
<b>L2</b>	<b>Understand</b>	<b>5</b>	<b>-</b>	<b>5</b>
<b>L3</b>	<b>Apply</b>	<b>10</b>	<b>10</b>	<b>-</b>
<b>L4</b>	<b>Analyze</b>	<b>5</b>	<b>5</b>	<b>-</b>
<b>L5</b>	<b>Evaluate</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>L6</b>	<b>Create</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>SEE Assessment Pattern (50 Marks - Theory)</b>				
<b>RBT Levels</b>		<b>Exam Marks Distribution (50)</b>		
<b>L1</b>	<b>Remember</b>	<b>10</b>		
<b>L2</b>	<b>Understand</b>	<b>10</b>		
<b>L3</b>	<b>Apply</b>	<b>20</b>		
<b>L4</b>	<b>Analyze</b>	<b>10</b>		
<b>L5</b>	<b>Evaluate</b>	<b>-</b>		
<b>L6</b>	<b>Create</b>	<b>-</b>		
<b>Suggested Learning Resources:</b>				
<b>Text Books:</b>				
1) Operational Amplifiers and Linear IC's, David A. Bell, 3 <sup>rd</sup> edition, 2011, Oxford University Press.				
2) Linear Integrated Circuits, D. Roy Choudhary and Shail B. Jain, 4 <sup>th</sup> edition, 2015, New Age International.				
3) Ramakant A. Gayakwad, "Op-Amps and Linear Integrated Circuits", 4th edition, 2015, Pearson.				
<b>Reference Books:</b>				
1) Op amps - Design, Applications and Troubleshooting, Terrell, 3rd edition, 2006, Elsevier.				

- 2) Operational Amplifiers, George Clayton and Steve Winder, 5th edition, 2008, Elsevier.  
3) Operational Amplifiers and Linear Integrated Circuits, Robert. F. Coughlin & Fred F. Driscoll, 2006, PHI/Pearson.  
4) Design with Operational Amplifiers and Analog Integrated Circuits, Sergio Franco, 3rd edition, 2005, TMH.

**Web links and Video Lectures (e-Resources):**

- [https://onlinecourses.nptel.ac.in/noc21\\_ee31/preview](https://onlinecourses.nptel.ac.in/noc21_ee31/preview)
- <https://youtu.be/UWPxa6N7VvA>
- <https://www.khanacademy.org/science/electrical-engineering/ee-amplifiers/ee-opamp/v/ee-opamp-intro>
- <https://www.youtube.com/playlist?list=PL285BE2DDBC6839F>
- <https://archive.nptel.ac.in/courses/108/106/108106184/>

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Video demonstration of latest trends in Linear ICs and its applications.
- Contents related activities (Activity-based discussions)
  - For active participation of students, instruct the students to prepare Flowcharts and Handouts.
  - Organizing Group wise discussions on issues .
  - Seminars.

<b>INTERNET OF THINGS</b>														
<b>Course Code</b>	<b>21ECE541</b>							<b>CIE Marks</b>			<b>50</b>			
<b>L:T:P:S</b>	<b>3:0:0:0</b>							<b>SEE Marks</b>			<b>50</b>			
<b>Hrs / Week</b>	<b>3</b>							<b>Total Marks</b>			<b>100</b>			
<b>Credits</b>	<b>03</b>							<b>Exam Hours</b>			<b>03</b>			
<b>Course outcomes:</b>														
At the end of the course, the student will be able to:														
21ECE541.1	Describe IoT architectures and its Challenges													
21ECE541.2	Characterize the smart objects and communication protocols for IoT network													
21ECE541.3	Interpret design principles and cloud computing for IoT network													
21ECE541.4	Apply software design concepts and program MQTT clients and server													
21ECE541.5	Identify the security attacks and solutions in IoT network													
21ECE541.6	Investigate the IoT applications for resolving real-world problems and life-long learning													
<b>Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:</b>														
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>
21ECE541.1	2	-	-	-	-	-	-	-	-	-	-	2	3	2
21ECE541.2	3	-	-	-	-	-	-	-	-	-	-	2	3	2
21ECE541.3	3	-	-	-	-	-	-	-	-	-	-	2	3	2
21ECE541.4	3	3	2	1	-	-	-	-	-	-	-	2	3	2
21ECE541.5	3	3	2	-	-	-	-	-	-	-	-	2	3	2
21ECE541.6	3	3	2	1	2	2	1	-	2	-	-	2	3	2
<b>MODULE-1</b>	<b>IOT OVERVIEW AND ARCHITECTURE</b>							<b>21ECE541.1</b>			<b>8 Hours</b>			
<b>Overview of Internet of Things:</b> Genesis of IoT -IoT and Digitization, IoT Impact, IoT Challenges. <b>IoT Network Architecture:</b> Drivers Behind New Network Architectures, Comparing IoT Architectures, A Simplified IoT Architecture, The Core IoT Functional Stack, IoT Data Management and Compute Stack.														
Self-Study	Explore the significance of IoT in the modern world.													
Text Book	Text Book 1: 1,2													
<b>MODULE-2</b>	<b>SMART OBJECTS AND COMMUNICATION PROTOCOLS IN IOT</b>							<b>21ECE541.2</b>			<b>8 Hours</b>			
<b>Smart Objects-</b> The “Things” in IoT, Sensors, Actuators, and Smart Objects, Sensor Networks. <b>Design Principles for Web Connectivity-</b> Web communication protocols for connected devices, Message communication protocols (CoAP-SMS, CoAP-MQ, MQTT, XMPP) for IoT/M2M device.														
Self-Study	Explore various IoT devices, sensors, and actuators used to collect and transmit data.													
Text Book	Text Book 1: 2, Text Book 2: 3.2,3.3													
<b>MODULE-3</b>	<b>IOT DESIGN AND COMPUTING</b>							<b>21ECE541.3</b>			<b>8 Hours</b>			
<b>Design Principles for IoT-</b> Introduction, Internet connectivity, Internet- based communication, IPv4, IPv6,6LoWPAN protocol, IP Addressing in the IoT. <b>Data Collection, Storage and Computing using a Cloud Platform-</b> Introduction, Cloud computing paradigm for data collection, storage and computing, Cloud service models, IoT Cloud- based data collection, storage and computing services using Nimbits.														
<b>Case Study</b>	Study wireless communication technologies such as Wi-Fi, Bluetooth, Zigbee, LoRaWAN, and Cellular (e.g., 4G LTE, 5G) for IoT connectivity.													

Text Book	Text Book 2: 4.1,4.2,4.3.1, 4.3.2, 4.4, 6.1,6.2,6.3,6.4.2		
<b>MODULE-4</b>	<b>PROTOTYPE AND SOFTWARE FOR IOT APPLICATIONS</b>	<b>21ECE541.4</b>	<b>8 Hours</b>
<b>Prototyping and Designing Software for IoT Applications-</b> Introduction, Prototyping Embedded device software, Programming Embedded Device Arduino Platform using IDE, Reading data from sensors and devices, Devices, Gateways, Internet and Web/Cloud services software development, Programming MQTT clients and MQTT server.			
<b>Application</b>	Analyze the impact of IoT in the automotive industry, including connected car technologies, autonomous vehicles, and predictive maintenance.		
Text Book	Text Book 2: 9.1, 9.2.1,9.2.2,9.3		
<b>MODULE-5</b>	<b>SECURITY AND SMART APPLICATION</b>	<b>21ECE541.5 21ECE541.6</b>	<b>8 Hours</b>
<b>Introduction to IoT privacy and security</b> - Vulnerabilities, security requirements and threat analysis, IoT Security Tomography and layered attacker model, Identity management, and establishment, access control and secure message communication.			
<b>Connected Cities and Smart Transportation-</b> IoT applications for smart homes, cities, environment-monitoring and agriculture			
<b>Case Study</b>	Investigate how IoT is used in agriculture for soil monitoring, crop management, and precision agriculture.		
Text Book	Text Book 2: 10.1, 10.2, 10.4, 12.3.1, 12.5		
<b>CIE Assessment Pattern (50 Marks – Theory)</b>			
<b>RBT Levels</b>		<b>Marks Distribution</b>	
		<b>Test (s)</b>	<b>Qualitative Assessment (s) (NPTEL)</b>
		<b>25</b>	<b>25</b>
<b>L1</b>	<b>Remember</b>	<b>5</b>	<b>-</b>
<b>L2</b>	<b>Understand</b>	<b>5</b>	<b>5</b>
<b>L3</b>	<b>Apply</b>	<b>10</b>	<b>10</b>
<b>L4</b>	<b>Analyze</b>	<b>5</b>	<b>10</b>
<b>L5</b>	<b>Evaluate</b>	<b>-</b>	<b>-</b>
<b>L6</b>	<b>Create</b>	<b>-</b>	<b>-</b>
<b>SEE Assessment Pattern (50 Marks – Theory)</b>			
<b>RBT Levels</b>		<b>Exam Marks Distribution (50)</b>	
<b>L1</b>	<b>Remember</b>	<b>10</b>	
<b>L2</b>	<b>Understand</b>	<b>10</b>	
<b>L3</b>	<b>Apply</b>	<b>20</b>	
<b>L4</b>	<b>Analyze</b>	<b>10</b>	
<b>L5</b>	<b>Evaluate</b>	<b>-</b>	
<b>L6</b>	<b>Create</b>	<b>-</b>	
<b>Suggested Learning Resources:</b>			
<b>Text Books:</b>			
1) David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", First Edition, Cisco Press, 2017.			
2) Raj Kamal, "Internet of Things: Architecture and Design Principles", First Edition, McGraw Hill Education, 2017.			
<b>Reference Books:</b>			
1) Adrian Mcewen, HakinCassimally, "Designing the Internet of Things", First Edition, Wiley, 2014.			

2) Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Aves and, Stamatis Karnouskos, David Boyle, From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, 1<sup>st</sup> Edition, Academic Press, 2014.

3) Alessandro Bassi, Martin Bauer, Martin Fiedler, Thorsten Kramp, Rob van Kranenburg, Sebastian Lange, Stefan Meissner, Enabling things to talk Designing IoT solutions with the IoT Architecture Reference Model, 2013, Springer Open, USA.

**Web links and Video Lectures (e-Resources):**

- [https://onlinecourses.nptel.ac.in/noc23\\_cs83/preview](https://onlinecourses.nptel.ac.in/noc23_cs83/preview)
- <https://www.youtube.com/watch?v=irq66O8NdvA>
- <https://www.youtube.com/watch?v=36zducUX16w>

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Video demonstration of latest trends and applications of IoT.
- Contents related activities (Activity-based discussions)
  - Seminars on architecture designs for IoT applications and programming sensors.

<b>ELECTROMAGNETIC FIELD THEORY</b>															
<b>Course Code</b>	<b>21ECE542</b>								<b>CIE Marks</b>	<b>50</b>					
<b>L:T:P:S</b>	<b>3:0:0:0</b>								<b>SEE Marks</b>	<b>50</b>					
<b>Hrs / Week</b>	<b>3</b>								<b>Total Marks</b>	<b>100</b>					
<b>Credits</b>	<b>03</b>								<b>Exam Hours</b>	<b>03</b>					
<b>Course outcomes:</b>															
At the end of the course, the student will be able to:															
21ECE542.1	Utilize laws and theorems to solve electrostatic field variables														
21ECE542.2	Apply the static characteristics of electric and magnetic fields to various charge and current distribution														
21ECE542.3	Analyze the boundary characteristics of electric fields on various medium														
21ECE542.4	Illustrate the concept of capacitance and inductance using electric and magnetic fields														
21ECE542.5	Categorize the Maxwell's Equations for static and time varying electromagnetic fields														
21ECE542.6	Analyze the characteristics of electromagnetic waves over various medium														
<b>Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:</b>															
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	
21ECE542.1	3	-	-	-	-	-	-	-	-	-	-	-	3	2	
21ECE542.2	3	-	-	-	-	-	-	-	-	-	-	-	3	2	
21ECE542.3	3	3	2	1	-	-	-	-	-	-	-	-	3	2	
21ECE542.4	3	3	2	-	-	2	2	-	-	-	-	3	3	2	
21ECE542.5	3	3	2	-	-	2	2	-	-	-	-	3	3	2	
21ECE542.6	3	3	2	1	-	2	2	-	-	-	-	3	3	2	
<b>MODULE-1</b>															
<b>COULOMB'S LAW, ELECTRIC FIELD INTENSITY, FLUX DENSITY GAUSS'S LAW AND DIVERGENCE</b>								<b>21ECE542.1</b> <b>21ECE542.2</b>				<b>8 Hours</b>			
Vector Analysis, Various Coordinate systems, Experimental law of Coulomb, Electric field intensity, Field due to infinite line charge, Electric flux density and Gauss law, Concept of Divergence, Maxwell 's First equation (Electrostatics) and divergence theorem.															
Case Study	Expression for gradient, divergence and curl in rectangular, cylindrical and spherical co-ordinate systems.														
Text Book	Text-1: Chapter 1, 2.1, 2.2, 2.3, 2.4, 3.1, 3.2, 3.5, 3.6, 3.7														
<b>MODULE-2</b>															
<b>POTENTIAL AND CURRENT</b>								<b>21ECE542.3</b> <b>21ECE542.4</b>				<b>8 Hours</b>			
Definition of potential and potential difference, potential gradient, Current and current density, Concept of Continuity equation, Conductor properties and boundary conditions.															
<b>Poisson's and Laplace's Equations</b>															
Concept of capacitance, Derivation of Poisson 's and Laplace 's Equations, Examples of the solution of Laplace 's equation: Parallel plate capacitor, Co-axial cable and spherical capacitor.															
Case Study	Parallel plate capacitor with two dielectrics with dielectric interface parallel to the conducting plates.														
Text Book	Text-1: 4.3, 4.6, 5.1, 5.2, 5.4, 6.3, 7.1, 7.3														
<b>MODULE-3</b>															
<b>STEADY MAGNETIC FIELD</b>								<b>21ECE542.1</b> <b>21ECE542.2</b> <b>21ECE542.4</b>				<b>8 Hours</b>			
Biot-Savart Law and its application: Magnetic Field due to straight current carrying conductor, Ampere 's circuital law and its application: Magnetic Field due to co-axial cable, Concept of Curl, Stokes' theorem, Scalar and Vector Magnetic Potentials.															
<b>Magnetic Materials and Inductance</b> :Magnetic circuits, Inductance and mutual inductance															

Case Study	Nature of magnetic materials, magnetization and permeability.		
Text Book	Text-1: 8.1, 8.2 , 8.3, 8.4 , 8.6 , 9.8 , 9.10		
<b>MODULE-4</b>	<b>TIME-VARYING FIELDS AND MAXWELL'S EQUATIONS</b>	<b>21ECE542.5</b>	<b>8 Hours</b>
Faraday's law, displacement current, Maxwell 's equations in point form and integral form.			
Applications	Retarded Potentials.		
Text Book	Text-1: 10.1, 10.2, 10.3, 10.4		
<b>MODULE-5</b>	<b>UNIFORM PLANE WAVE</b>	<b>21ECE542.6</b>	<b>8 Hours</b>
Wave propagation in free space, dielectrics and good conductors. Poynting's theorem and wave power, Skin Effect, Reflection of uniform plane waves at normal incidence and Standing wave ratio.			
Applications	VSWR Measurement for various EM structures.		
Text Book	Text-1: 12.1, 12.2, 12.3, 12.4, 13.1, 13.2		
<b>CIE Assessment Pattern (50 Marks – Theory)</b>			
<b>RBT Levels</b>		<b>Marks Distribution</b>	
		<b>Test (s)</b>	<b>Qualitative Assessment (s) (NPTEL)</b>
		<b>25</b>	<b>25</b>
<b>L1</b>	<b>Remember</b>	<b>5</b>	<b>-</b>
<b>L2</b>	<b>Understand</b>	<b>5</b>	<b>5</b>
<b>L3</b>	<b>Apply</b>	<b>10</b>	<b>10</b>
<b>L4</b>	<b>Analyze</b>	<b>5</b>	<b>10</b>
<b>L5</b>	<b>Evaluate</b>	<b>-</b>	<b>-</b>
<b>L6</b>	<b>Create</b>	<b>-</b>	<b>-</b>
<b>SEE Assessment Pattern (50 Marks – Theory)</b>			
<b>RBT Levels</b>		<b>Exam Marks Distribution (50)</b>	
<b>L1</b>	<b>Remember</b>	<b>10</b>	
<b>L2</b>	<b>Understand</b>	<b>10</b>	
<b>L3</b>	<b>Apply</b>	<b>20</b>	
<b>L4</b>	<b>Analyze</b>	<b>10</b>	
<b>L5</b>	<b>Evaluate</b>	<b>--</b>	
<b>L6</b>	<b>Create</b>	<b>--</b>	
<b>Suggested Learning Resources:</b>			
<b>Text Books:</b>			
1) W.H. Hayt and J.A. Buck, "Engineering Electromagnetics", 7th Edition, Tata McGraw Hill, 2009, ISBN-978-0-07-061223-5.			
<b>Reference Books:</b>			
1) John Krauss and Daniel, A Fleisch, "Electromagnetics with applications", McGraw- Hill, 2017			
2.) N. Narayana Rao, " Fundamentals of Electromagnetics for Engineering" , Pearson, 2008.			
<b>Web links and Video Lectures (e-Resources):</b>			
<ul style="list-style-type: none"> <li>• <a href="https://onlinecourses.nptel.ac.in/noc21_ee83/preview#:~:text=The%20course%20covers%20static%20and%20numerical%20methods%20are%20also%20discussed.">https://onlinecourses.nptel.ac.in/noc21_ee83/preview#:~:text=The%20course%20covers%20static%20and%20numerical%20methods%20are%20also%20discussed.</a></li> <li>• <a href="https://byjus.com/jee/electromagnetic-spectrum-and-electromagnetic-waves/">https://byjus.com/jee/electromagnetic-spectrum-and-electromagnetic-waves/</a></li> <li>• <a href="https://www.youtube.com/watch?v=508Zsmsllno">https://www.youtube.com/watch?v=508Zsmsllno</a></li> </ul>			
<b>Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning</b>			
<ul style="list-style-type: none"> <li>• Demonstration of Magnetic field and flux density</li> <li>• Demonstration of working of EM waves</li> <li>• Video classes for the EM wave propagations</li> </ul>			

<b>DSP ALGORITHMS AND ARCHITECTURE</b>														
<b>Course Code</b>	<b>21ECE543</b>								<b>CIE Marks</b>			<b>50</b>		
<b>L:T:P:S</b>	<b>3:0:0:0</b>								<b>SEE Marks</b>			<b>50</b>		
<b>Hrs / Week</b>	<b>3</b>								<b>Total Marks</b>			<b>100</b>		
<b>Credits</b>	<b>03</b>								<b>Exam Hours</b>			<b>03</b>		
<b>Course outcomes:</b>														
At the end of the course, the student will be able to:														
21ECE543.1	Understand the fundamental concepts of fixed- and floating-point architecture of different DSP Processor													
21ECE543.2	Analyze the architecture of digital signal processors													
21ECE543.3	Develop the programming knowledge using the instruction set of DSP processor													
21ECE543.4	Analyze the signal processing algorithms in DSP													
21ECE543.5	Apply the signal architecture in embedded applications													
21ECE543.6	Utilize the advantages of modern digital signal processors for real world signal processing applications													
<b>Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:</b>														
	<b>P01</b>	<b>P02</b>	<b>P03</b>	<b>P04</b>	<b>P05</b>	<b>P06</b>	<b>P07</b>	<b>P08</b>	<b>P09</b>	<b>P010</b>	<b>P011</b>	<b>P012</b>	<b>PS01</b>	<b>PS02</b>
21ECE543.1	2	-	-	-	-	-	-	-	-	-	-	3	3	3
21ECE543.2	3	3	2	-	-	-	-	-	-	-	-	3	3	3
21ECE543.3	3	3	-	-	2	-	-	-	2	-	-	3	3	3
21ECE543.4	3	3	2	-	2	-	-	-	-	-	-	3	3	3
21ECE543.5	3	3	-	-	2	-	-	-	2	-	-	3	3	3
21ECE543.6	3	3	2		2	-	-	-	2	-	-	3	3	3
<b>MODULE-1 INTRODUCTION OF DSP PROCESSOR</b>														
												<b>21ECE543.1, 21ECE543.2</b>		<b>8 Hours</b>
DSPs are different from other Microprocessors, Circular Buffering, Architecture of the Digital signal Processor, Fixed versus Floating point, C versus Assembly, Requirements of DSP Processor, Evolution of Digital signal processor in market.														
Self-study	Importance of DSP in Smartphone.													
Text Book	Text Book 1: 28.1-28.7													
<b>MODULE-2 PROGRAMMABLE DSP PROCESSOR</b>														
												<b>21ECE543.2, 21ECE543.3</b>		<b>8 Hours</b>
Architecture, Finite word length, Data Addressing Modes of TMS32054XX, Instruction set and Programming, Pipeline Operation of DSP Processor, Introduction to TMS320C6713 DSP Processor and C6713 DSK.														
Self-study	Explore different DSP architectures such as fixed-point vs floating point and their impact on signal processing tasks.													
Text Book	Text Book 2: 5.3,5.4,5.5,5.7,5.10 ; Text Book 3: 10.1,10.3													
<b>MODULE-3 IMPLEMENTATION OF DSP ALGORITHMS</b>														
												<b>21ECE543.4</b>		<b>8 Hours</b>
FIR Filters, IIR Filters, FFT Algorithm for DFT Computation, Overflow and Scaling, Bit-Reversed Index Generation & Implementation on the TMS320C67XX, Introduction to adaptive filters.														
Applications	Design of an adaptive filter in digital signal processor for active noise control.													
Text Book	Text Book 2 :7.3,7.4,7.5,7.6,8.2,8.3,8.4,8.5,8.6													
<b>MODULE-4 EMBEDDED SIGNAL PROCESSING AND CONCEPTS</b>														
												<b>21ECE543.5</b>		<b>8 Hours</b>
Introduction to micro signal architecture, Overview of Blackfin Processor, Data arithmetic unit, address arithmetic unit, control unit, Bus Architecture and memory.														
Case Study	Investigate how to design a Real Time Graphic Equalizer using Blackfin Processor.													
Text Book	Text Book 4: 5.1.1,5.1.2,5.1.3,5.1.4													



<b>MODULE-5</b>	<b>APPLICATIONS OF DSP PROCESSORS</b>	<b>21ECE543.6</b>	<b>8 Hours</b>
CODEC Interface Circuit. DSP Based Bio-telemetry Receiver, audio equalization and filtering, speech recognition system, An Image Processing System, DTMF Detection using modified Goertzel algorithm.			
Case Study	Research and analyze real-world applications of DSP processors, such as noise cancellation headphones, medical imaging devices, or radar systems to represent their findings and discuss the DSP principles involved.		
Text Book	Text Book 3: 8.8,8.9,9.1,9.2,9.4 Reference Book 3: Chapter 1		

**CIE Assessment Pattern (50 Marks – Theory)**

RBT Levels		Marks Distribution	
		Test (s)	Qualitative Assessment (s) (NPTEL)
		25	25
L1	Remember	5	-
L2	Understand	5	5
L3	Apply	10	10
L4	Analyze	5	10
L5	Evaluate	-	-
L6	Create	-	-

**SEE Assessment Pattern (50 Marks – Theory)**

RBT Levels		Exam Marks Distribution (50)
L1	Remember	10
L2	Understand	10
L3	Apply	20
L4	Analyze	10
L5	Evaluate	--
L6	Create	--

**Suggested Learning Resources:**

**Text Books:**

- 1) Steven W. Smith, 2002, The Scientist and Engineer's Guide to Digital Signal Processing, California Technical Publishing.
- 2) Avatar Singh and S. Srinivasan, 2004, "Digital Signal Processing", Thomson Learning, 2004
- 3) Andhe Pallavi & K. Uma Rao, 2012, "Digital Signal Processors-Architecture, Programming and Applications", Sanguine Technical Publishers.
- 4) Woon Seng Gan, Sen M. Kuo, Hoboken,2007, "Embedded Signal processing with the micro signal architecture", New Jersey Publisher.

**Reference Books:**

- 1) B Venkataramani and M Bhaskar,2010, "Digital Signal Processors", TMH, 2<sup>nd</sup> edition.
- 2) Sen M. Kuo and Woon-Seng Gan. 2004, "Digital Signal Processors: Architectures, Implementations, and Applications",
- 3) Chiouguey J Chen, 1996, "Application report on: "Modified Goertzel algorithm in DTMF Detection using TMS320C80.

4)R. Chassaing, 2004 ,‘Digital Signal Processing and Applications with the C6713 and C6416 DSK’, John Wiley and Sons, Inc., New York.

**Web links and Video Lectures (e-Resources):**

- <https://www.dspguide.com/ch12.htm>
- [https://www.ti.com/lit/ug/spru307a/spru307a.pdf?ts=1691420154210&ref\\_url=https%253A%252F%252Fwww.google.com%252F](https://www.ti.com/lit/ug/spru307a/spru307a.pdf?ts=1691420154210&ref_url=https%253A%252F%252Fwww.google.com%252F)
- [https://www.ti.com/lit/ug/spru733a/spru733a.pdf?ts=1691469745326&ref\\_url=https%253A%252F%252Fwww.google.com%252F](https://www.ti.com/lit/ug/spru733a/spru733a.pdf?ts=1691469745326&ref_url=https%253A%252F%252Fwww.google.com%252F)
- <https://www.slideshare.net/pantechsolutions/blackfin-core-architectureslides>
- <https://onlinelibrary.wiley.com/doi/10.1002/acs.959>
- <https://www.nxp.com/docs/en/application-note/AN2110.pdf>

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Demonstration of DSP program with actual hardware or software simulation tools to implement and test signal processing algorithm.
- Video demonstration of Digital Signal Processor market Overview.
- Contents related activities (Activity-based discussions)
  - For active participation of students, debate the advantage and limitation of different DSP Techniques.
  - Assign pre-recorded video lectures or readings for students to review before class, freeing up class time for interactive discussions, problem-solving, and hands-on activities.
  - Seminars

<b>PROGRAMMING WITH DATA STRUCTURES USING C</b>														
<b>Course Code</b>	<b>21ECE544</b>				<b>CIE Marks</b>				<b>50</b>					
<b>L:T:P:S</b>	<b>3:0:0:0</b>				<b>SEE Marks</b>				<b>50</b>					
<b>Hrs / Week</b>	<b>3</b>				<b>Total Marks</b>				<b>100</b>					
<b>Credits</b>	<b>03</b>				<b>Exam Hours</b>				<b>03</b>					
<b>Course outcomes:</b> At the end of the course, the student will be able to:														
21ECE544.1	Understand the concept of memory allocation techniques, Pointers, Arrays and structure, union													
21ECE544.2	Apply appropriate algorithm for problem solving using arrays, stacks, queues													
21ECE544.3	Identify the various linked lists, and their operations													
21ECE544.4	Explore advanced data structures and implement corresponding algorithms for operations like traversal and manipulation													
21ECE544.5	Utilize the concepts of searching and sorting to solve real time problems													
21ECE544.6	Design appropriate data structures for solving computing problems													
<b>Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:</b>														
	<b>PO 1</b>	<b>PO 2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>
21ECE544.1	2	-	-	-	2	-	-	-	-	-	-	-	2	2
21ECE544.2	3	2	-	-	2	-	-	-	-	-	-	2	2	2
21ECE544.3	3	2	-	-	2	-	-	-	-	-	-	2	2	2
21ECE544.4	3	2	-	-	2	-	-	-	-	-	-	2	2	2
21ECE544.5	3	2	2	1	2	-	-	-	-	-	-	2	2	2
21ECE544.6	3	2	2	1	2	-	-	1	2	-	-	2	2	2
<b>MODULE-1 INTRODUCTION</b>														
<b>21ECE544.1</b>										<b>8 Hours</b>				
Basics: Arrays, Structures, unions, Pointers, Dynamic Memory Allocation, Algorithm Specification, The Abstract Data type. ADT of Natural Numbers. Introduction to Data structure: primitive and non-primitive data types, Types of Data Structures.														
Applications			Study the real time usage of Arrays, Structures and Unions.											
Text Book			Text Book 1: 1.2. 2.1, 2.2, 2.3											
<b>MODULE-2 STACKS AND QUEUES</b>														
<b>21ECE544.2</b>										<b>8 Hours</b>				
Stack ADT, representation of stacks and operations performed on Stacks, Application of Stacks: infix to postfix conversion-postfix evaluation. Queues ADT, representation of Queues and operations performed on queues, Circular queues, Application of Queues - job scheduling.														
Self-study			Exercises on Infix, Postfix and prefix conversions, Study the real time use of Stacks and Queues											
Text Book			Text Book 1: 3.1,3.2, 3.4											
<b>MODULE-3 LINKED LISTS</b>														
<b>21ECE544.3</b> <b>21ECE544.6</b>										<b>8 Hours</b>				

<p><b>Linked Lists:</b> Singly Linked Lists, Operations on Singly Linked Lists, other operations on lists: Delete a Node from the front end, insert a node at the rear end, delete a Node from the rear end, Search for an item in a list</p> <p><b>Doubly Linked Lists:</b> Insert a node at the front end, insert a node at the rear end, delete a node from front end, Delete a node from rear end.</p> <p>Theoretical Introduction to circular Singly and circular doubly Linked lists.</p>			
Self-study	Exercises on Linked lists operations like Insert a Node at a specified Position, rotating a list, counting frequency of nodes.		
Text Book	Text Book 2: Ch 9.2, 9.3.1-9.3.3, 9.3.8, 9.8.1-9.8.4. Text Book 1: Ch 4.5.2		
<b>MODULE-4</b>	<b>TREES</b>	<b>21ECE544.4</b> <b>21ECE544.6</b>	<b>8 Hours</b>
Introduction of trees and its Terminology, Tree as an ADT, Binary Search Tree (BST), properties of Binary search Trees, construction of binary search tree, operations performed on Binary search Tree, Binary Tree Traversal: In order traversal, preorder traversal, post order traversal.			
Case Study	Study on AVL Trees.		
Text Book	Text Book 1: Chapter 5.1, 5.2, 5.3, 5.7.1-5.7.2		
<b>MODULE-5</b>	<b>SEARCHING AND SORTING</b>	<b>21ECE544A.5</b> <b>21ECE544A.6</b>	<b>8 Hours</b>
Searching: Linear search (Sequential search), Binary search. Sorting: Bubble sort, Quick sort, Insertion sort, Selection sort, Merge sort, Heap Sort.			
Applications	Practice Sorting and searching Algorithms for solving real time applications.		
Text Book	Text Book 2: 11.10.1-11.10.2,11.2 to 11.7		
<b>CIE Assessment Pattern (50 Marks - Theory)</b>			
<b>RBT Levels</b>		<b>Marks Distribution</b>	
		<b>Test (s)</b>	<b>Qualitative Assessment (s) (NPTEL)</b>
		<b>25</b>	<b>25</b>
<b>L1</b>	<b>Remember</b>	<b>5</b>	<b>-</b>
<b>L2</b>	<b>Understand</b>	<b>5</b>	<b>5</b>
<b>L3</b>	<b>Apply</b>	<b>10</b>	<b>10</b>
<b>L4</b>	<b>Analyze</b>	<b>5</b>	<b>10</b>
<b>L5</b>	<b>Evaluate</b>	<b>-</b>	<b>-</b>
<b>L6</b>	<b>Create</b>	<b>-</b>	<b>-</b>
<b>SEE Assessment Pattern (50 Marks - Theory)</b>			
<b>RBT Levels</b>		<b>Exam Marks Distribution (50)</b>	
<b>L1</b>	<b>Remember</b>	<b>10</b>	
<b>L2</b>	<b>Understand</b>	<b>10</b>	
<b>L3</b>	<b>Apply</b>	<b>20</b>	
<b>L4</b>	<b>Analyze</b>	<b>10</b>	
<b>L5</b>	<b>Evaluate</b>	<b>-</b>	
<b>L6</b>	<b>Create</b>	<b>-</b>	

**Suggested Learning Resources:****Text Books:**

1. Horowitz, Sahni, Anderson-Freed, "Fundamentals of Data Structures in C, 2<sup>nd</sup> Edition, 2011, Universities Press.
2. Padmareddy, Systematic Approach to Data structures using C, Sri Nandi Publications, 2012

**Reference Books:**

1. Yedidyah Langsam, Moshe Augenstein, Aaron M. Tenenbaum, "Data Structures using C & C++", Second Edition, Pearson, Tenth Impression 2020.
2. Richard F. Gilberg and Behrouz A. Forouzan, "Data Structures - A Pseudo code approach with C", Second Edition, CENGAGE LEARNING, Sixth Indian Reprint 2016.
3. E. Balagurusamy, Data Structures using C, 2017, McGraw Hill Education.

**Web links and Video Lectures (e-Resources):**

- [https://onlinecourses.nptel.ac.in/noc23\\_cs95/preview](https://onlinecourses.nptel.ac.in/noc23_cs95/preview)
- <https://log2base2.com/courses/data-structures-in-c/>
- <https://www.geeksforgeeks.org/data-structures/>

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Conduct on spot problem solving based on Data Structures and C.
- Develop simple algorithms and programs to build projects and applications.

<b>NANOELECTRONICS</b>														
<b>Course Code</b>	<b>21ECE545</b>						<b>CIE Marks</b>				<b>50</b>			
<b>L:T:P:S</b>	<b>3:0:0:0</b>						<b>SEE Marks</b>				<b>50</b>			
<b>Hrs / Week</b>	<b>3</b>						<b>Total Marks</b>				<b>100</b>			
<b>Credits</b>	<b>03</b>						<b>Exam Hours</b>				<b>03</b>			
<b>Course outcomes:</b>														
At the end of the course, the student will be able to:														
21ECE545.1	Discuss the fundamental principles, synthetic method of fabrication of nanomaterials													
21ECE545.2	Compare the concepts of characterization techniques used in Nanoscience and Nanotechnology													
21ECE545.3	Recognize the basic principles of Quantum physics and various semiconductor nanostructures													
21ECE545.4	Explore various nanostructures of carbon and the nature of the carbon bond itself													
21ECE545.5	Illustrate the functioning and properties of the nano sensors													
21ECE545.6	Investigate the applications of semiconductor nanostructures and their significance													
<b>Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:</b>														
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>
21ECE545.1	2	-	-	-	-	-	-	-	-	-	-	2	3	2
21ECE545.2	3	-	-	-	-	-	-	-	-	-	-	2	3	2
21ECE545.3	3	3	-	-	-	-	-	-	-	-	-	2	3	2
21ECE545.4	3	3	-	-	-	-	-	-	-	-	-	2	3	2
21ECE545.5	3	3	3	-	-	-	2	-	-	-	-	2	3	2
21ECE545.6	3	3	3	-	-	-	2	-	-	-	-	2	3	2
<b>MODULE-1 INTRODUCTION TO NANOELECTRONICS: 21ECE545.1 8 Hours</b>														
Classification of Nanostructures, Nanoscale architecture, Electronic properties of atoms and solids: Isolated atom, Bonding between atoms, Giant molecular solids, Free electron models and energy bands, crystalline solids, Periodicity of crystal lattices, Electronic conduction, effects of nanometer length scale, Fabrication methods: Top down processes, Bottom up processes methods for templating the growth of nanomaterials, ordering of nano systems.														
Text Book			Text Book 1: 1.1, 1.2, 1.3, 1.4											
<b>MODULE-2 CHARACTERIZATION OF NANOMATERIALS 21ECE545.2 8 Hours</b>														
Characterization tools of Nanomaterials: Microscopy techniques, scanning electron microscopy, Transmission electron microscopy, Field ion microscopy, Scanning tunnelling microscopy, atomic force microscopy, Diffraction technique: Diffraction technique, Surface diffraction technique, Spectroscopy technique: Photon spectroscopy, Radio frequency spectroscopy, Electron spectroscopy.														
Case study		Different Microscopic and spectroscopic Techniques												
Text Book		Text Book 1: 2.2, 2.3.4, 2.3.5, 2.4, 2.5.1, 2.5.2, 2.6,2.7												
<b>MODULE-3 QUANTUM NANOSTRUCTURES 21ECE545.3 8 Hours</b>														
Characteristic lengths in mesoscopic systems, Quantum mechanical coherence, Quantum wells, wires, and dots, Density of states and dimensionality, Semiconductor heterostructures, Quantum transport Quantum Nanostructures: MOSFET structures, Heterojunctions, Modulation-doped quantum well, Multiple Quantum well, The concept of superlattice.														
Text Book		Text Book 2: 1.2, 1.3 to 1.8, 5.2, 5.3, 5.4, 5.5.1												
<b>MODULE-4 CARBON NANOTUBES 21ECE545.4 8 Hours</b>														
Carbon molecules, Carbon Clusters, Carbon Nanotubes, Fabrication, Structure, Electrical, Vibrational and Mechanical properties, Applications of carbon nanotubes: Field Emission and shielding, Computers, Fuel cells, Chemical sensors, Catalysis, Mechanical Reinforcement.														

Seminar	Applications of nanotubes.		
Text Book	Text Book 3: 5.1,5.2,5.3,5.4,5.5		
<b>MODULE-5</b>	<b>NANOSENSORS AND APPLICATIONS</b>	<b>21ECE545.5, 21ECE545.6</b>	<b>8 Hours</b>
Introduction to Nano sensors, Order from Chaos, Characterization, Perception, Nano sensors Based On Quantum Size Effects, Electrochemical Sensors, Sensors Based On Physical Properties, Nano biosensors, Smart dust Sensor for the future. Injection lasers, quantum cascade lasers, single-photon sources, biological tagging, optical memories, coulomb blockade devices, photonic structures			
Case Study	Various Nano sensors that are currently applied in the healthcare sector		
Text Book	Text Book 4: 12.1 to 12.11 Text Book 1: 3.8		
<b>CIE Assessment Pattern (50 Marks – Theory)</b>			
<b>RBT Levels</b>		<b>Marks Distribution</b>	
		<b>Test (s)</b>	<b>Qualitative Assessment (s) NPTEL</b>
		<b>25</b>	<b>25</b>
<b>L1</b>	<b>Remember</b>	<b>5</b>	<b>-</b>
<b>L2</b>	<b>Understand</b>	<b>5</b>	<b>5</b>
<b>L3</b>	<b>Apply</b>	<b>10</b>	<b>10</b>
<b>L4</b>	<b>Analyze</b>	<b>5</b>	<b>10</b>
<b>L5</b>	<b>Evaluate</b>	<b>-</b>	<b>-</b>
<b>L6</b>	<b>Create</b>	<b>-</b>	<b>-</b>
<b>SEE Assessment Pattern (50 Marks – Theory)</b>			
<b>RBT Levels</b>		<b>Exam Marks Distribution (50)</b>	
<b>L1</b>	<b>Remember</b>	<b>10</b>	
<b>L2</b>	<b>Understand</b>	<b>10</b>	
<b>L3</b>	<b>Apply</b>	<b>20</b>	
<b>L4</b>	<b>Analyze</b>	<b>10</b>	
<b>L5</b>	<b>Evaluate</b>	<b>-</b>	
<b>L6</b>	<b>Create</b>	<b>--</b>	
<b>Suggested Learning Resources:</b>			
<b>Text Books:</b>			
1) Edited by Robert Kelsall, Ian Hamley and Mark Geoghegan, "Nanoscale Science and Technology", John Wiley, 2007.			
2) J.M. Martinez-Duart, R.J. Martin Palma, F. Agulle Rueda Nanotechnology for Microelectronics and optoelectronics, Elsevier, 2006			
3) Charles P Poole, Jr, Frank J Owens, "Introduction to Nanotechnology", John Wiley, Copyright 2006, Reprint 2011			
4) T Pradeep, "Nano: The Essentials-Understanding Nanoscience and Nanotechnology", TMH,2007			
<b>Reference Books:</b>			
1) Edited by William A Goddard III, Donald W Brenner, Sergey E. Lyshevski and Gerald J Iafrate, "Hand Book of Nanoscience Engineering and Technology", CRC press, 2003			

**Web links and Video Lectures (e-Resources):**

- [https://onlinecourses.nptel.ac.in/noc23\\_mm37/preview](https://onlinecourses.nptel.ac.in/noc23_mm37/preview)
- <https://www.coursera.org/learn/nanotechnology>
- <https://www.youtube.com/watch?v=2voX3fjMGjA&t=129s>
- <https://www.youtube.com/watch?v=5Uh6b3CDRaA&t=10s>

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Video demonstration of nanotubes
- Group Discussion on latest trends in nano sensors
- Contents related activities (Activity-based discussions)
  - For active participation of students, instruct the students to prepare pictures and Handouts
  - Organizing Group wise discussions on significance of nanostructures Seminars



<b>ALP WITH MICROCONTROLLERS</b>															
<b>Course Code</b>	<b>21ECL551</b>					<b>CIE Marks</b>					<b>50</b>				
<b>L:T:P:S</b>	<b>0:0:1:0</b>					<b>SEE Marks</b>					<b>50</b>				
<b>Hrs / Week</b>	<b>2</b>					<b>Total Marks</b>					<b>100</b>				
<b>Credits</b>	<b>01</b>					<b>Exam Hours</b>					<b>03</b>				
<b>Course outcomes:</b>															
At the end of the course, the student will be able to:															
21ECL551.1	Write 8051 assembly level programs to perform arithmetic and logical operations, code conversion programs														
21ECL551.2	Apply the basic knowledge of addressing modes and instructions to write assembly language program in 8051 Microcontroller														
21ECL551.3	Analyze the code in assembly level for application of 8051 Timers, Interrupts and Serial Communication interface														
21ECL551.4	Demonstrate the peripheral interfacing of 8051														
<b>Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:</b>															
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PS01</b>	<b>PS02</b>	
21ECL551.1	3	3	3	2	3	-	-	-	2	-	-	-	3	3	
21ECL551.2	3	3	3	-	3	-	-	-	2	-	-	-	3	3	
21ECL551.3	3	3	3	2	3	-	-	-	2	-	-	2	3	3	
21ECL551.4	3	3	3	2	3	-	-	-	2	-	-	2	3	3	
<b>Exp. No. / Pgm. No.</b>	<b>List of Experiments / Programs</b>											<b>Hou rs</b>	<b>COs</b>		
<b>Prerequisite Experiments / Programs / Demo</b>															
	To understand the architecture of 8051 Microcontroller and to aspire design aspects of I/O and Memory interfacing circuits. Knowledge in modern tools and engage in self-learning to carry out real world projects											2	NA		
<b>PART-A</b>															
1	Data Transfer - Block move, Exchange											2	21ECL551.1		
2	Arithmetic Instructions – Addition, subtraction, multiplication and division, square, Cube – (16 bits Arithmetic operations – bit addressable)											2	21ECL551.1		
3	Boolean & Logical Instructions (Bit manipulations).											2	21ECL551.1 21ECL551.2		
4	Code conversion: BCD – ASCII; ASCII – Decimal; Decimal - ASCII; HEX - Decimal and Decimal - HEX .											2	21ECL551.2		
5	Sorting and finding largest/smallest element in an array.											2	21ECL551.2		
6	Counters											2	21ECL551.3		
<b>PART-B</b>															
7	Programs to generate delay, Programs using serial port and on-Chip timer / counter.											2	21ECL551.3		
8	Assembly Level Programming to illustrate the interfacing of stepper motor in clockwise /anti –clockwise rotation with the microcontroller 8051.											2	21ECL551.4		
9	Assembly Level Programming to illustrate the interfacing of simple switches with the microcontroller 8051											2	21ECL551.4		
10	Assembly Level Programming to illustrate the interfacing of LCD modules with the microcontroller 8051											2	21ECL551.4		

11.	Assembly Level Programming to illustrate the interfacing of LED modules with the microcontroller 8051	2	21ECL551.4
12.	Write a Assembly Level Program to transfer letter "A" serially at 4800 baud , continuously	2	21ECL551.4

**PART-C**

**Beyond Syllabus Virtual Lab Content**

(To be done during Lab but not to be included for CIE or SEE)

1.Representation of Integers and their Arithmetic

<https://cse11-iiith.vlabs.ac.in/exp/integers-arithmetic/>

2. Floating Point Numbers Representation

<https://cse11-iiith.vlabs.ac.in/exp/floating-point-numbers/>

3.Interfacing of ADC and data transfer by software polling, study of aliasing

<http://vlabs.iitkgp.ernet.in/rtes/exp4/index.html>

4.MCU-DAC interfacing and generation of ramp wave

<http://vlabs.iitkgp.ernet.in/rtes/exp3/index.html>

5.Interfacing 4x4 switch matrix with the microcontroller

<http://vlabs.iitkgp.ernet.in/rtes/exp12/index.html>

**CIE Assessment Pattern (50 Marks - Lab)**

RBT Levels		Test (s)	Weekly Assessment
		20	30
L1	Remember	-	-
L2	Understand	-	5
L3	Apply	10	10
L4	Analyze	5	10
L5	Evaluate	5	5
L6	Create	-	-

**SEE Assessment Pattern (50 Marks - Lab)**

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	05
L3	Apply	20
L4	Analyze	15
L5	Evaluate	10
L6	Create	-

**Suggested Learning Resources:**

**Reference Books:**

1) "The 8051 Microcontroller and Embedded Systems - using assembly and C", Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinlay; PHI, 2006 / Pearson, 2006.

2) "The 8051 Microcontroller Architecture, Programming & Applications", Kenneth J. Ayala ;, Penram International, 1996 /Thomson Learning 2005.

<b>ANTENNA SIMULATION USING ANSYS</b>														
<b>Course Code</b>	<b>21ECL552</b>					<b>CIE Marks</b>					<b>50</b>			
<b>L:T:P:S</b>	<b>0:0:1:0</b>					<b>SEE Marks</b>					<b>50</b>			
<b>Hrs / Week</b>	<b>2</b>					<b>Total Marks</b>					<b>100</b>			
<b>Credits</b>	<b>01</b>					<b>Exam Hours</b>					<b>03</b>			
<b>Course outcomes:</b>														
At the end of the course, the student will be able to:														
21ECL552.1	Analyze the fundamental principles and concepts of different types of antennas													
21ECL552.2	Demonstrate proficiency in using ANSYS HFSS for antenna modeling and simulation													
21ECL552.3	Measure the radiation pattern of wired, aperture, planar and array antennas													
21ECL552.4	Optimize antenna designs to achieve desired specifications													
<b>Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:</b>														
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>
21ECL552.1	3	-	-	-	2	-	-	-	1	-	-	2	3	3
21ECL552.2	3	3	2	2	2	-	-	-	1	-	-	2	3	3
21ECL552.3	3	3	2	2	2	-	-	-	1	-	-	2	3	3
21ECL552.4	3	3	2	2	2	-	-	-	1	-	-	2	3	3
<b>Exp. No.</b>	<b>List of Experiments / Programs</b>											<b>Hours</b>	<b>Cos</b>	
<b>Prerequisite Experiments / Programs / Demo</b>														
	Electromagnetics Fundamentals: A solid understanding of electromagnetic theory, including concepts such as Maxwell's equations, wave propagation, and electromagnetic fields, is essential for comprehending the underlying principles of antenna simulation.											2	NA	
<b>PART-A</b>														
1	Introduction of HFSS Ansys simulation tool for antenna design											2	21ECL552.1	
2	Design a Monopole (Quarter wave) antenna for 88 MHz-108MHz application using Ansys.											2	21ECL552.1	
3	Design a dipole (Half-wave) antenna analyze its radiation pattern, gain, and impedance characteristics.											2	21ECL552.1	
4	Design a rectangular microstrip patch antenna for a specific frequency and optimize its performance by adjusting parameters like substrate material, patch dimensions.											2	21ECL552.2	
5	Design a rectangular microstrip patch antenna for a specific frequency and optimize its performance using CPW feed line											2	21ECL552.2	
6	Design a circular microstrip patch antenna for a specific frequency and optimize its performance by adjusting parameters like substrate material, patch dimensions											2	21ECL552.2	
<b>PART-B</b>														
7	Design of probe feed microstrip patch antenna and optimize its performance.											2	21ECL552.3	
8	Helical Antenna Simulation: Simulate a helical antenna and analyze its circular polarization characteristics and axial ratio.											2	21ECL552.3	
9	Broadband Antenna Design: Design and simulate a broadband antenna capable of covering a wide frequency range. Optimize the antenna's impedance matching and radiation patterns.											2	21ECL552.3 21ECL552.4	

10	Antenna Array Pattern Synthesis: Implement pattern synthesis techniques to achieve specific radiation patterns	2	21ECL552.3 21ECL552.4
11	Design and analysis of a 2x2 antenna array using Ansys simulation software for 3.5 GHz.	2	21ECL552.3 21ECL552.4
12	Design and analysis of 5G array antenna using Ansys simulation software.	2	21ECL552.3 21ECL552.4

**PART-C**

**Beyond Syllabus Virtual Lab Content**

(To be done during Lab but not to be included for CIE or SEE)

1. Introduction to HFSS.

<https://www.youtube.com/watch?v=2ADK971gKKU>

2. To plot the radiation pattern of Dipole Antenna in E & H planes on log & linear scales on polar and Cartesian plots.

<https://vlab.amrita.edu/?sub=3&brch=179&sim=400&cnt=1>

3. Radiation Pattern of Horn Antenna.

<http://eem-iitd.vlabs.ac.in/exp7.html>

4. PCB Antenna design and Optimization.

[https://www.mathworks.com/videos/pcb-antenna-design-and-optimization-1663652506751.html?s\\_tid=vid\\_pers\\_recs](https://www.mathworks.com/videos/pcb-antenna-design-and-optimization-1663652506751.html?s_tid=vid_pers_recs)

**CIE Assessment Pattern (50 Marks - Lab)**

RBT Levels		Test (s)	Weekly Assessment
		20	30
L1	Remember	-	-
L2	Understand	-	5
L3	Apply	10	10
L4	Analyze	5	10
L5	Evaluate	5	5
L6	Create	-	-

**SEE Assessment Pattern (50 Marks - Lab)**

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	05
L3	Apply	20
L4	Analyze	15
L5	Evaluate	10
L6	Create	-

**Reference Books:**

- 1) Balanis, C. A. (2005). Antenna theory: Analysis and design (3rd ed.). John Wiley.
- 2) Frank Gross, Smart antennas for wireless communications, McGra-Hill, 2006.
- 3) S. Chandran, Adaptive antenna arrays, trends and applications, Springer, 2009.
- 4) NPTEL online course.  
[https://www.youtube.com/watch?v=wx\\_tlvaaajAI&list=PL3UZlxOnyu9CRoBFsG5x-VqYeC69FmMzT&ab\\_channel=Antennas](https://www.youtube.com/watch?v=wx_tlvaaajAI&list=PL3UZlxOnyu9CRoBFsG5x-VqYeC69FmMzT&ab_channel=Antennas)

<b>NETWORK SIMULATION USING NS-2</b>														
<b>Course Code</b>	<b>21ECL553</b>								<b>CIE Marks</b>			<b>50</b>		
<b>L:T:P:S</b>	<b>0:0:1:0</b>								<b>SEE Marks</b>			<b>50</b>		
<b>Hrs / Week</b>	<b>2</b>								<b>Total Marks</b>			<b>100</b>		
<b>Credits</b>	<b>01</b>								<b>Exam Hours</b>			<b>03</b>		
<b>Course outcomes:</b>														
At the end of the course, the student will be able to:														
21ECL553.1	Use the network simulator for learning and practice of network algorithms													
21ECL553.2	Illustrate the operations of network protocols and algorithms using C programming													
21ECL553.3	Simulate the network with different configurations to measure the performance parameters													
21ECL553.4	Implement the data link and routing protocols using C programming													
<b>Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:</b>														
	<b>P01</b>	<b>P02</b>	<b>P03</b>	<b>P04</b>	<b>P05</b>	<b>P06</b>	<b>P07</b>	<b>P08</b>	<b>P09</b>	<b>P010</b>	<b>P011</b>	<b>P012</b>	<b>PS01</b>	<b>PS02</b>
21ECL553.1	3	3	3	2	2	-	-	-	1	-	-	2	3	3
21ECL553.2	3	3	3	2	2	-	-	-	1	-	-	2	3	3
21ECL553.3	3	3	3	2	2	-	-	-	1	-	-	2	3	3
21ECL553.4	3	3	3	2	2	-	-	-	1	-	-	2	3	3
<b>Exp. No. / Pgm. No.</b>														
<b>List of Experiments / Programs</b>												<b>Hour s</b>	<b>Cos</b>	
<b>Prerequisite Experiments / Programs / Demo</b>														
<ul style="list-style-type: none"> <li>➤ Experiments on different network topologies.</li> <li>➤ Demo on packet formats.</li> </ul>												2	NA	
<b>PART-A</b>														
1	Implement a point-to-point network with four nodes and duplex links between them. Analyze the network performance by setting the queue size and varying the bandwidth.											2	21ECL553.1	
2	Implement a four-node point-to-point network with links n0-n2, n1-n2 and n2-n3. Apply TCP agent between n0-n3 and UDP between n1-n3. Apply relevant applications over TCP and UDP agents changing the parameter and determining the number of packets sent by TCP/UDP.											2	21ECL553.1	
3	Implement Ethernet LAN using n (6-10) nodes. Compare the throughput by changing the error rate and data rate.											2	21ECL553.1	
4	Implement Ethernet LAN using n nodes and assign multiple traffic to the nodes and obtain congestion window for different sources/ destinations.											2	21ECL553.3	
5	Implement ESS with transmission nodes in Wireless LAN and obtain the performance parameters.											2	21ECL553.3	
6	Implementation of Link state routing algorithm.											2	21ECL553.3	
<b>PART-B</b>														
7	Write a program for a HDLC frame to perform the following. i) Bit stuffing ii) Character stuffing.											2	21ECL553.2	

8	Write a program for a distance vector algorithm to find a suitable path for transmission.	2	21ECL553.2
9	For the given data, use the CRC-CCITT polynomial to obtain the CRC code. Verify the program for the cases a. Without error b. With error	2	21ECL553.2
10	Implementation of Stop and Wait Protocol and Sliding Window Protocol	2	21ECL553.4
11	Write a program for congestion control using a leaky bucket algorithm.	2	21ECL553.4
12	Implement Dijkstra's algorithm to compute the shortest routing path.	2	21ECL553.4

**PART-C**

**Beyond Syllabus Virtual Lab Content**

**(To be done during Lab but not to be included for CIE or SEE)**

1. Basics of Network Simulation.  
<http://vlabs.iitkgp.ernet.in/ant/1/>
2. Simulating a Local Area Network.  
<http://vlabs.iitkgp.ernet.in/ant/2/>
3. Concept of network performance evaluation, and different related metrics  
<http://vlabs.iitkgp.ernet.in/ant/3/theory/>
4. Simulating a Mobile Adhoc Network.  
<http://vlabs.iitkgp.ernet.in/ant/7/>
5. Implement OSPF protocol using 5 routers scenario.  
<http://www.nittrkol.ac.in/vlab-cse-nl-exp-1.php#top>

**CIE Assessment Pattern (50 Marks - Lab)**

RBT Levels		Test (s)	Weekly Assessment
		20	30
L1	Remember	-	-
L2	Understand	-	5
L3	Apply	10	10
L4	Analyze	5	10
L5	Evaluate	5	5
L6	Create	-	-

**SEE Assessment Pattern (50 Marks - Lab)**

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	05
L3	Apply	20
L4	Analyze	15
L5	Evaluate	10
L6	Create	-

**Suggested Learning Resources:**

**Text Books:**

- 1) Computer Networking. Textbooks B.A. Forouzan, Data Communications, and Networking, 4th Edition, McGraw Hill, 2007 Peterson and Davie, Computer Networks
- 2) Andrew S. Tanenbaum, Computer Networks, Third Edition, Prentice Hall of India Private Limited, New Delhi.

**Reference Books:**

- 1) Data Communication & Computer Networks (First Edition) by Tanmaya Kumar Das and Dili Kumar Mahapatra.
- 2) Stallings W., Data and Computer Communications, Pearson Education, 7th Edition, 2003.

<b>ELECTRONICS APPLICATIONS USING SCILAB</b>														
<b>Course Code</b>	21ECL554								<b>CIE Marks</b>				50	
<b>L:T:P:S</b>	0:0:1:0								<b>SEE Marks</b>				50	
<b>Hrs / Week</b>	2								<b>Total Marks</b>				100	
<b>Credits</b>	01								<b>Exam Hours</b>				03	
<b>Course outcomes:</b>														
At the end of the course, the student will be able to:														
21ECL554.1	Apply powerful numerical computation capabilities, making it suitable for analyzing and designing electronic circuits													
21ECL554.2	Simulate the various electronic circuits and study the circuit behavior, and optimize designs for various applications													
21ECL554.3	Analyze the model of complex electronic circuits and assess their performance													
21ECL554.4	Explore complex electronics signal scenarios for real time applications													
<b>Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:</b>														
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>
21ECL554.1	3	3	2	2	2	-	-	-	1	-	-	2	3	3
21ECL554.2	3	3	2	2	2	-	-	-	1	-	-	2	3	3
21ECL554.3	3	3	2	2	2	-	-	-	1	-	-	2	3	3
21ECL554.4	3	3	2	2	2	-	-	-	1	-	-	2	3	3
<b>Exp. No. / Pgm. No.</b>	<b>List of Experiments / Programs</b>											<b>Hours</b>	<b>Cos</b>	
<b>Prerequisite Experiments / Programs / Demo</b>														
	<b>Basic Electronics Knowledge:</b> Fundamental understanding of electronics principles, circuits, and components <b>Scilab Proficiency:</b> Familiarity with Scilab is essential. <b>Circuit Simulation Knowledge:</b> Create and analyze electronic circuit models using simulation tools can be highly advantageous. <b>Mathematical Concepts:</b> Electronics applications often involve mathematical operations, such as solving equations, differential equations, and signal processing.											2	NA	
<b>PART-A</b>														
1	Determine the base, emitter, collector current of Common Base configuration for the given alpha value.											2	21ECL554.1	
2	Determine operating point of Fixed Bias circuit, given transistor gain and base to emitter voltage.											2	21ECL554.1	
3	Determine output voltage of circuit given $V_{be}$ for transistors Q1, Q2.											2	21ECL554.1	
4	Determine value of drain current $I_d$ and gate source voltage $V_{gs}$ for self-bias circuit.											2	21ECL554.1	
5	Design Zener Shunt voltage regulator for the given specifications											2	21ECL554.2	
6	Determine the value of $R_s$ to achieve self-bias condition of N channel JFET											2	21ECL554.2	
<b>PART-B</b>														
7	Find the capacitance value in Wien-bridge oscillator given value of R and Freq of oscillation.											2	21ECL554.2	
8	Find Freq of RC phase shift oscillator if the 3 resistances are equal and 3 capacitances are equal.											2	21ECL554.2	



9	Determine input, output impedance voltage and current gain given h-parameters of transistor.	2	21ECL554.3
10	Design Schmitt Trigger circuit using 2 silicon NPN transistors with given configuration 243	2	21ECL554.3
11	Write a program to generate an exponential Sequence. $X(n) = (a)^n$ for (i) $0 \leq a \leq 1$ (ii) $-1 \leq a \leq 0$ (iii) $a \leq -1$ (iv) $a > 1$	2	21ECL554.4
12	Write a program to generate the signal $S(n) = 2 * n * (0.8^n)$ corrupted by the noise $d(n)$ resulting the signal $X(n)$ . $X(n) = s(n) + d(n)$ .	2	21ECL554.4

### PART-C

#### Beyond Syllabus Virtual Lab Content

**(To be done during Lab but not to be included for CIE or SEE)**

1. To study I-V Characteristics of Diode.

<https://ee-iitb.vlabs.ac.in/exp1/index.html>

2. To study the operation of rectifiers

<https://ee-iitb.vlabs.ac.in/exp2/index.html>

3. To study the output characteristics of BJT

<https://ee-iitb.vlabs.ac.in/exp4/index.html>

4. To study the voltage comparator

<https://ae-iitr.vlabs.ac.in/exp/voltage-comparator/>

5. To study log and antilog amplifier.

<https://ae-iitr.vlabs.ac.in/exp/log-antilog-amplifier/>

#### CIE Assessment Pattern (50 Marks – Lab)

RBT Levels		Test (s)	Weekly Assessment
		20	30
L1	Remember	-	-
L2	Understand	-	5
L3	Apply	10	10
L4	Analyze	5	10
L5	Evaluate	5	5
L6	Create	-	-

#### SEE Assessment Pattern (50 Marks – Lab)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	05
L3	Apply	20
L4	Analyze	15
L5	Evaluate	10
L6	Create	-

#### Suggested Learning Resources:

##### Reference Books:

1. Anil Kumar Verma, "Scilab A Beginner'S Approach by Anil Kumar Verma, Cengage India", Books from same Publisher, ISBN:9789386858931. Cengage India.
2. Sandeep Nagar, "Introduction to Scilab: For Engineers and Scientists Paperback", Apress; ISBN: 1484231910

<b>OPTICAL COMMUNICATION USING OPTSIM</b>														
<b>Course Code</b>	<b>21ECL555</b>				<b>CIE Marks</b>				<b>50</b>					
<b>L:T:P:S</b>	<b>0:0:1:0</b>				<b>SEE Marks</b>				<b>50</b>					
<b>Hrs / Week</b>	<b>2</b>				<b>Total Marks</b>				<b>100</b>					
<b>Credits</b>	<b>01</b>				<b>Exam Hours</b>				<b>03</b>					
<b>Course outcomes:</b>														
At the end of the course, the student will be able to:														
21ECL555.1	Demonstrate analog and digital link, propagation loss, numerical aperture for optical fiber communication.													
21ECL555.2	Recognize the characteristics of Optical devices													
21ECL555.3	Design the receiver and amplifiers behavior for optical communication													
21ECL555.4	Analyze the optical system performance using Eye diagram, Q-factor & BER of optical signals													
<b>Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:</b>														
	<b>P01</b>	<b>P02</b>	<b>P03</b>	<b>P04</b>	<b>P05</b>	<b>P06</b>	<b>P07</b>	<b>P08</b>	<b>P09</b>	<b>P010</b>	<b>P011</b>	<b>P012</b>	<b>PS01</b>	<b>PS02</b>
21ECL555.1	3	3	2	2	3	-	-	-	1	-	-	2	3	3
21ECL555.2	3	3	2	2	3	-	-	-	1	-	-	2	3	3
21ECL555.3	3	3	2	3	3	-	-	-	1	-	-	2	3	3
21ECL555.4	3	3	2	3	3	-	-	-	1	-	-	2	3	3
<b>Exp. No. / Pgm. No.</b>	<b>List of Experiments / Programs</b>											<b>Hours</b>	<b>Cos</b>	
<b>Prerequisite Experiments / Programs / Demo</b>														
	<ul style="list-style-type: none"> <li>• Modulation and demodulation of ASK, PSK and FSK.</li> <li>• Working of LED &amp; LASER.</li> <li>• Types of optical fibres &amp; their losses.</li> </ul>											2	NA	
<b>PART-A</b>														
1	To design a basic optical fiber communication system using OptSim software.											2	21ECL555.1	
2	Measurement of numerical aperture and bending loss of optical fiber.											2	21ECL555.1	
3	Measurement of fiber characteristics, fiber damage and splice loss/connector loss by OTDR.											2	21ECL555.1	
4	To generate an intensity modulated signal at the transmitter and demodulate it at the receiver using direct detection scheme in OptSim software.											2	21ECL555.1	
5	Sketch Voltage vs. current(V-I) characteristics of LED.											2	21ECL555.2	
6	Sketch Voltage vs. current(V-I) characteristics of laser diode.											2	21ECL555.2	
<b>PART-B</b>														
7	To generate a PSK modulated signal at the transmitter and detect it at the receiver using homodyne and heterodyne demodulators in OptSim software											2	21ECL555.2	
8	To generate an intensity modulated signal at the transmitter and demodulate it at the receiver using direct detection scheme in OptSim software.											2	21ECL555.2	
9	Simulation and analysis of APD-HBT Receiver.											2	21ECL555.3	

10	Simulation and analysis of SLA (SOA) Amplifier and Raman Amplifier.	2	21ECL555.3
11	Simulation and analysis of WDM systems.	2	21ECL555.4
12	To modulate a continuous wave laser using external PRBS generator and analyze the BER, Q-factor and eye diagram obtained at the output.	2	21ECL555.4

**PART-C**  
**Beyond Syllabus Virtual Lab Content**  
**(To be done during Lab but not to be included for CIE or SEE)**

1. Study Of LED and Detector Characteristics

<https://vlab.amrita.edu/index.php?sub=59&brch=269&sim=1371&cnt=3512>

2. Numerical Aperture of Optical Fiber

<https://vlab.amrita.edu/?sub=1&brch=189&sim=343&cnt=2>

3. Fiber Optic Analog and Digital link

<https://vlab.amrita.edu/index.php?sub=59&brch=269&sim=1317&cnt=2780>

4. Fiber Optic Bi-directional Communication

<https://vlab.amrita.edu/index.php?sub=59&brch=269&sim=1372&cnt=3055>

5. Wavelength Division Multiplexing

<https://vlab.amrita.edu/index.php?sub=59&brch=269&sim=1373&cnt=3289>

**CIE Assessment Pattern (50 Marks - Lab)**

RBT Levels		Test (s)	Weekly Assessment
		20	30
L1	Remember	-	-
L2	Understand	-	5
L3	Apply	10	10
L4	Analyze	5	10
L5	Evaluate	5	5
L6	Create	-	-

**SEE Assessment Pattern (50 Marks - Lab)**

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	05
L3	Apply	20
L4	Analyze	15
L5	Evaluate	10
L6	Create	-

**Suggested Learning Resources:**

**Reference 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.
- 3) Fiber Optic Communication - Joseph C Palais: 4th Edition, Pearson Education, 2004

### MINI PROJECT

<b>Course Code</b>	<b>21ECE56</b>	<b>CIE Marks</b>	<b>50</b>
<b>L:T:P:S</b>	<b>0:0:1:0</b>	<b>SEE Marks</b>	<b>50</b>
<b>Hrs / Week</b>	<b>0</b>	<b>Total Marks</b>	<b>100</b>
<b>Credits</b>	<b>01</b>	<b>Exam Hours</b>	<b>03</b>

**Course outcomes:**

At the end of the course, the student will be able to:

21ECE56.1	Identify technical aspects of the chosen project with a comprehensive and systematic approach
21ECE56.2	Review the literature and develop solutions for problem statement
21ECE56.3	Work as an individual or in a team in development of technical projects
21ECE56.4	Experiment with state-of-the-art methods and analyze the available solutions
21ECE56.5	Implement the proposed solution utilizing the systematic approach
21ECE56.6	Extend or use the idea in mini project for major project

**Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
21ECE56.1	3	3	-	-	-	-	-	-	3	-	-	-	3	3
21ECE56.2	3	3	3	-	-	-	-	-	3	3	3	3	3	3
21ECE56.3	3	3	3	-	-	-	-	-	-	3	3	3	3	3
21ECE56.4	3	3	3	3	2	-	-	2	3	3	3	3	3	3
21ECE56.5	3	3	3	3	2	-	-	2	3	3	3	3	3	3
21ECE56.6	3	3	3	3	2	2	1	2	3	3	3	3	3	3

**CIE Assessment Pattern (50 Marks)**

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	-
L3	Apply	20
L4	Analyze	10
L5	Evaluate	10
L6	Create	10

**SEE Assessment Pattern (50 Marks)**

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	-
L3	Apply	20
L4	Analyze	10
L5	Evaluate	10
L6	Create	10

<b>RESEARCH METHODOLOGY AND IPR</b>															
<b>Course Code</b>	<b>21ECK57</b>								<b>CIE Marks</b>	<b>50</b>					
<b>L:T:P:S</b>	<b>1:0:0:0</b>								<b>SEE Marks</b>	<b>50</b>					
<b>Hrs / Week</b>	<b>02</b>								<b>Total Marks</b>	<b>100</b>					
<b>Credits</b>	<b>01</b>								<b>Exam Hours</b>	<b>02</b>					
<b>Course outcomes:</b> At the end of the course, the student will be able to:															
21ECK57.1	Characterize the significance and suitability of research in engineering applications														
21ECK57.2	Demonstrate the various processing techniques of research														
21ECK57.3	Evaluate the research in the development of engineering materials, process and tools														
21ECK57.4	Analyze criteria to fit own intellectual work in particular form of IPR														
21ECK57.5	Apply statutory provisions to protect particular form of research														
21ECK57.6	Develop the art of scholarly writing and evaluate its quality														
<b>Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:</b>															
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	
21ECK57.1	3	3	3	-	-	-	-	-	3	3	2	3	3	2	
21ECK57.2	3	3	3	1	2	-	-	-	3	3	2	3	3	2	
21ECK57.3	3	3	3	1	2	-	-	2	3	3	2	3	3	2	
21ECK57.4	3	3	-	-	-	-	-	2	3	3	2	3	3	2	
21ECK57.5	3	-	-	-	-	-	-	2	3	3	2	3	3	2	
21ECK57.6	3	3	3	1	2	-	-	1	3	3	2	3	3	2	
<b>MODULE-1 RESEARCH FORMULATION AND DESIGN</b>															
<b>MODULE-1</b>	<b>RESEARCH FORMULATION AND DESIGN</b>								<b>21ECK57.1, 21ECK57.2</b>				<b>3 Hours</b>		
Definition and objective of research, types of research, steps in research process, research design, concept and types of research design, defining and formulating the research problems, importance of literature review- primary and secondary sources, reviews, monographs, patent, research database, web sources, identifying gap areas from the literature and research data base, surveying synthesis, Interpretation.															
Self-study / Case Study / Applications			Explore how to align research questions and objectives with the appropriate research problem.												
Text Book			Text Book 1: Ch. 1, 2& 6												
<b>MODULE-2 SAMPLING &amp; DATA INTERPRETATION</b>															
<b>MODULE-2</b>	<b>SAMPLING &amp; DATA INTERPRETATION</b>								<b>21ECK57.2, 21ECK57.3</b>				<b>3 Hours</b>		
Mathematical tools for analysis, statistical analysis of data, regression analysis, correlation, concept of best fit and exact fit, exact fit, theory, examples from linear regression with one and more unknowns.															
Self-study / Case Study / Applications			Explore different data collection techniques associated with each methodology, including surveys, interviews, observations, and document analysis.												
Text Book			Text Book 1: Ch. 4& 7												
<b>MODULE-3 PATENT RIGHTS AND IPR</b>															
<b>MODULE-3</b>	<b>PATENT RIGHTS AND IPR</b>								<b>21ECK57.3, 21ECK57.4</b>				<b>3 Hours</b>		
Patents and its basics, process of filing patent at national and international level, Introduction and significance of intellectual property rights, commercialization, royalty, copyright, trade related aspects of IPR, Administration of patent system in India, licensing and transfer of technology, case studies.															

Self-study / Case Study / Applications	Examine how startups develop and implement intellectual property strategies to protect their innovations, considering patents, trademarks, copyrights, and trade secrets.			
Text Book	Text Book 2: Ch. 1 & 2/ IPR India website.			
<b>MODULE-4</b>	<b>RESEARCH AND PUBLICATION ETHICS</b>	<b>21ECK57.4, 21ECK57.5</b>	<b>3 Hours</b>	
Research and Integrity, Scientific mis conduct: Falsification, Fabrication and Plagiarism (FFP), Conflict of research, Predatory publishers and Journals, Open access publication, citation and acknowledgement, reproducibility and accountability, software tools for similarity check.				
Self-study / Case Study / Applications	Explore the ethical issues surrounding data fabrication and image manipulation in research publications.			
Text Book	Text Book 1: Ch. 14 & 15			
<b>MODULE-5</b>	<b>REPORT WRITING</b>	<b>21ECK57.5, 21ECK57.6</b>	<b>3 Hours</b>	
Structure and components of research report, types of report, layout of research report, mechanism of writing a research report, referencing in academic writing, Abstracting, Bibliography.				
Self-study / Case Study / Applications	Report Writing in a Emerging technology.			
Text Book	Text Book 1: Ch. 14			
<b>CIE Assessment Pattern (50 Marks - Theory) -</b>				
<b>RBT Levels</b>		<b>Marks Distribution</b>		
		<b>Test (s)</b>	<b>Qualitative Assessment (s)</b>	<b>MCQ's</b>
		<b>25</b>	<b>15</b>	<b>10</b>
<b>L1</b>	<b>Remember</b>	5	-	-
<b>L2</b>	<b>Understand</b>	5	-	-
<b>L3</b>	<b>Apply</b>	5	5	5
<b>L4</b>	<b>Analyze</b>	5	5	5
<b>L5</b>	<b>Evaluate</b>	5	5	-
<b>L6</b>	<b>Create</b>	-	-	-
<b>SEE Assessment Pattern (50 Marks - Theory)</b>				
<b>RBT Levels</b>		<b>Exam Marks Distribution (50)</b>		
<b>L1</b>	<b>Remember</b>	10		
<b>L2</b>	<b>Understand</b>	10		
<b>L3</b>	<b>Apply</b>	10		
<b>L4</b>	<b>Analyze</b>	10		
<b>L5</b>	<b>Evaluate</b>	10		
<b>L6</b>	<b>Create</b>	--		
<b>Suggested Learning Resources:</b>				
<b>Text Books:</b>				
1) Kothari, C.R., "Research Methodology: Methods and Techniques". New Age International, 2018, ISBN-13: 978-8122436235				
2) Ramakrishna Chintakunta, A Text book of Intellectual Property rights, Blue Hill Publication, ASIN: B09T6YDB5N, 2022				
<b>Reference Books:</b>				
1) Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K, An introduction to Research Methodology, RBSA				

Publishers. 2015, ISBN-13:978-8176111652

- 2) Ranjith Kumar, Research methodology, Saga publications, 4<sup>th</sup> edition, 2014, ISBN-13- 978-9351501336
- Anderson, T. W., "An Introduction to Multivariate Statistical Analysis", Wiley Eastern Pvt., Ltd., New Delhi, 2011, ISBN-13: 978-8126524488
- 3) Montgomery, Douglas C. & Runger, George C. (2016) 6/e, Applied Statistics & probability for Engineers (Wiley India) ISBN-13: 978-1118539712
- 4) Montgomery, Douglas C. (2012) 8th edition, Design and Analysis of Experiments (Wiley India) ISBN: 978-1-118-14692-7
- 5) Sinha, S.C. and Dhiman, A.K., 2012. Research Methodology, EssEss Publications. 2 volumes. ISBN : 81-7000-324-5, 81-7000-334-2

**Web links and Video Lectures (e-Resources):**

- [https://onlinecourses.nptel.ac.in/noc22\\_ge08/preview](https://onlinecourses.nptel.ac.in/noc22_ge08/preview)
- <https://www.youtube.com/watch?v=zY6Xf87GAvg>
- [https://guides.library.stanford.edu/qualitative\\_research](https://guides.library.stanford.edu/qualitative_research)
- [https://onlinecourses.nptel.ac.in/noc21\\_hs08/preview](https://onlinecourses.nptel.ac.in/noc21_hs08/preview)
- <https://mitxonline.mit.edu/courses/course-v1:MITxT+21A.819.2x/>

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Demonstration of LaTeX writing.
- Demonstration of design patent templates.
- Contents related activities (Activity-based discussions).
- Organizing Group wise discussions on ethics of research.

INNOVATION AND DESIGN THINKING															
<b>Course Code</b>	<b>21ECK58</b>									<b>CIE Marks</b>	<b>50</b>				
<b>L:T:P:S</b>	<b>1:0:0:0</b>									<b>SEE Marks</b>	<b>50</b>				
<b>Hrs / Week</b>	<b>01</b>									<b>Total Marks</b>	<b>100</b>				
<b>Credits</b>	<b>01</b>									<b>Exam Hours</b>	<b>01</b>				
<b>Course outcomes:</b> At the end of the course, the student will be able to:															
21ECK58.1	Articulate a comprehensive understanding of the concept of Design Thinking														
21ECK58.2	Apply Design Thinking methodologies to solve complex and ambiguous problems effectively														
21ECK58.3	Utilize design thinking tools for creative solutions														
21ECK58.4	Implement design thinking in IT that showcase the ability to drive meaningful innovation														
21ECK58.5	Develop strategic innovation for Business Model Design														
21ECK58.6	Create the Minimum Viable Product to solve societal needs using Design Thinking														
<b>Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:</b>															
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	
21ECK58.1	3	-	-	-	-	-	-	-	3	3	-	3	3	2	
21ECK58.2	3	3	2	-	-	-	-	-	3	3	-	3	3	2	
21ECK58.3	3	3	2	-	2	-	-	-	3	3	-	3	3	2	
21ECK58.4	3	3	2	2	2	-	-	-	3	3	-	3	3	2	
21ECK58.5	3	3	2	2	-	-	-	-	3	3	-	3	3	2	
21ECK58.6	3	3	2	2	2	1	1	1	3	3	1	3	3	2	
<b>MODULE-1</b>	<b>UNDERSTANDING DESIGN THINKING</b>									<b>21ECK58.1</b>			<b>3 Hours</b>		
Definition, Origin and features of Design Thinking, Design thinker in organization, Principles and stages of Design thinking. Design Shared model in team-based design, Theory and practice in Design thinking. Collaborative design thinking. Live examples of MVP or Prototyping.															
Self-study / Case Study / Applications	Study the importance of ethics in design and how to create products that are socially responsible.														
<b>MODULE-2</b>	<b>TOOLS FOR DESIGN THINKING</b>									<b>21ECK58.3</b>			<b>3 Hours</b>		
Visualization, Journey mapping, Value Chain Analysis, The mind map, Rapid Concept development, Assumption testing, Prototype, Co creation, Learning launches and Storytelling.															
Self-study / Case Study / Applications	Study the popular design thinking tools and software like Miro, Figma, and Adobe XD														
<b>MODULE-3</b>	<b>DESIGN THINKING IN IT</b>									<b>21ECK58.4</b>			<b>3 Hours</b>		
Business process modelling (BPM). Agile in Virtual collaboration environment. Scenario based Prototyping. Case studies on Design thinking.															
Self-study / Case Study / Applications	Analyze how a tech startup applied design thinking to create user-friendly and highly-rated mobile applications, driving user engagement and revenue growth.														
<b>MODULE-4</b>	<b>DESIGN THINKING FOR STRATEGIC INNOVATION</b>									<b>21ECK58.5</b>			<b>3 Hours</b>		
Strategic management and Innovation management, Types of Innovations, Features and Scope of strategic innovations, Design thinking and strategic innovation, Practices of integrating Design thinking in Strategic Innovation.															
Self-study / Case Study / Applications	Study the latest trends and developments in the field of innovation and design thinking.														



<b>MODULE-5</b>	<b>DESIGN THINKING WORK SHOP</b>	<b>21ECK58.6</b>	<b>3 Hours</b>
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Focus, Need and stages of Design thinking workshop. Empathize, Design, Ideate, Prototype and Test.

Case Study Remote health monitoring solutions to provide real-time data for patients and healthcare providers.

**CIE Assessment Pattern (50 Marks - Theory) -**

RBT Levels		Marks Distribution		
		Test (s)(15)	Assignment (10)	Seminar/ Activity (25)
		15	10	25
L1	Remember	5	-	-
L2	Understand	5	-	5
L3	Apply	5	5	5
L4	Analyze	-	5	10
L5	Evaluate	-	-	5
L6	Create	-	-	-

**SEE Assessment Pattern (50 Marks - Theory)**

RBT Levels		Exam Marks Distribution (50)
L1	Remember	10
L2	Understand	25
L3	Apply	15
L4	Analyze	--
L5	Evaluate	--
L6	Create	--

**Suggested Learning Resources:**

1. Christian Mueller-Roterberg, Handbook of Design Thinking - Tips & Tools for how to design thinking.
2. John.R.Karsnitz, Stephen O'Brien and John P. Hutchinson, "Engineering Design", Cengage learning (International edition) Second Edition, 2013.
3. Roger Martin, "The Design of Business: Why Design Thinking is the Next Competitive Advantage", Harvard Business Press, 2009.
4. Hasso Plattner, Christoph Meinel and Larry Leifer (eds), "Design Thinking: Understand - Improve - Apply", Springer, 2011
5. Yousef Haik and Tamer M.Shahin, "Engineering Design Process", Cengage Learning, Second Edition, 2011.
6. Book - Solving Problems with Design Thinking - Ten Stories of What Works (Columbia Business School Publishing) Hardcover - 20 Sep 2013 by Jeanne Liedtka (Author), Andrew King (Author), Kevin Bennett (Author).

**Web links and Video Lectures (e-Resources):**

- <https://www.ibm.com/design/thinking/>
- <https://www.ideo.com/pages/design-thinking>
- <https://www.youtube.com/watch?v=3RemkU4BH8U>

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

1. Problem Definition Through Observation.
2. Provide materials to create paper prototypes of a user interface or physical product.
3. Organizing the brainstorming sessions where students generate creative ideas to solve a specific problem.

**SIXTH SEMESTER**  
**(SYLLABUS)**

<b>OPERATIONS RESEARCH AND MANAGEMENT</b>															
<b>Course Code</b>	21ECE61					<b>CIE Marks</b>					50				
<b>L:T:P:S</b>	3:0:0:0					<b>SEE Marks</b>					50				
<b>Hrs / Week</b>	3					<b>Total Marks</b>					100				
<b>Credits</b>	03					<b>Exam Hours</b>					03				
<b>Course outcomes:</b>															
At the end of the course, the student will be able to:															
21ECE61.1	Apply basic principles of project management for real time problems														
21ECE61.2	Promote entrepreneurship as an individual or as a group by creating awareness on its needs and roles with respect to growth of economic development														
21ECE61.3	Develop solutions for barriers in small scale industries														
21ECE61.4	Calculate the interest rates, cash flows and costing materials, production and overheads														
21ECE61.5	Analyse the sequence of jobs on various machines														
21ECE61.6	Apply the game theory concepts to determine the optimal solution														
<b>Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:</b>															
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	
21ECE61.1	3	-	-	-	-	-	-	-	-	-	2	2	2	2	
21ECE61.2	3	-	-	-	-	1	1	1	-	-	2	2	2	2	
21ECE61.3	3	-	-	-	-	1	1	1	-	-	2	2	2	2	
21ECE61.4	3	2	2	1	-	-	-	-	-	-	2	2	2	2	
21ECE61.5	3	2	2	-	-	-	-	-	-	-	2	2	2	2	
21ECE61.6	3	2	2	-	1	-	-	-	-	-	2	2	2	2	
<b>MODULE 1 BASICS OF PROJECT MANAGEMENT</b>															
											<b>21ECE61.1</b>		<b>8 Hours</b>		
Introduction, Definition of project, characteristics of projects, types of projects, need for project management, phases of project life cycle management, impact of delays in project completions, roles and responsibilities of project leader.															
Self-study / Case Study / Applications			Create project management plan by taking any real time project as example.												
Text Book			Text Book 3: 1.1, 1.1, 1.8, 1.9, 1.10, 1.18, 1.16.												
<b>MODULE 2 ENTREPRENEUR AND SSI</b>															
											<b>21ECE61.2</b>		<b>21ECE61.3</b>		<b>8 Hours</b>
Meaning of Entrepreneur, Functions of an Entrepreneur, Types of Entrepreneur, Stages in entrepreneurial process; Role of entrepreneurs in Economic Development. Entrepreneurship in India; women entrepreneurs, Entrepreneurship - its Barriers, SSI Impact of Liberalization, Privatization, Globalization on SSI Effect of WTO/GATT Supporting Agencies of Government for SSI, Meaning, Nature of support. Objectives; Functions; Types of Help.															
Self-study / Case Study / Applications			List out some of the Small-Scale Industries which are mainly focused on women empowerment.												
Text Book			Text Book 4: 2.2, 2.3, 2.4 to 2.15												
<b>MODULE 3 INTEREST, CASH FLOW, ESTIMATION AND COSTING</b>															
											<b>21ECE61.4</b>		<b>8 Hours</b>		
Law of demand and supply, Law of returns, Interest and Interest factors: Interest rate, Simple interest, Compound interest, Cash - flow diagrams, Personal loans and EMI Payment, Exercises and Discussion. Components of costs such as Direct Material Costs, Direct Labor Costs, Fixed Over-Heads, Factory cost, Administrative Over-Heads, First cost, Marginal cost, Selling price, Estimation for simple components.															

Text Book	Text Book 5: 2.1 to 2.10			
<b>MODULE 4</b>	<b>SEQUENCING</b>	<b>21ECE61.5</b>	<b>8 Hours</b>	
Basic assumptions, sequencing 'n' jobs on single machine using priority rules, sequencing using Johnson's rule- 'n' jobs on 2 machines, 'n' jobs on 3 machines, 'n' jobs on 'm' machines. Sequencing 2 jobs on 'm' machines using graphical method.				
Case Study	Case study on sequencing by taking any real time examples.			
Text Book	Text Book 2 : Chapter 11			
<b>MODULE 5</b>	<b>GAME THEORY</b>	<b>21ECE61.6</b>	<b>8 Hours</b>	
Formulation of games, Two person-Zero sum game, games with and without saddle point, Graphical solution (2x n, m x 2 game), dominance property.				
Case Study	Case study on game theory by taking any real time examples.			
Text Book	Text Book 2: Chapter 14			
<b>CIE Assessment Pattern (50 Marks - Theory) -</b>				
<b>RBT Levels</b>		<b>Marks Distribution</b>		
		<b>Test (s)</b>	<b>Qualitative Assessment (s)</b>	<b>MCQ's</b>
		<b>25</b>	<b>15</b>	<b>10</b>
<b>L1</b>	<b>Remember</b>	<b>5</b>	<b>-</b>	<b>5</b>
<b>L2</b>	<b>Understand</b>	<b>10</b>	<b>-</b>	<b>5</b>
<b>L3</b>	<b>Apply</b>	<b>5</b>	<b>5</b>	<b>-</b>
<b>L4</b>	<b>Analyze</b>	<b>5</b>	<b>5</b>	<b>-</b>
<b>L5</b>	<b>Evaluate</b>	<b>-</b>	<b>5</b>	<b>-</b>
<b>L6</b>	<b>Create</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>SEE Assessment Pattern (50 Marks - Theory)</b>				
<b>RBT Levels</b>		<b>Exam Marks Distribution (50)</b>		
<b>L1</b>	<b>Remember</b>	<b>10</b>		
<b>L2</b>	<b>Understand</b>	<b>20</b>		
<b>L3</b>	<b>Apply</b>	<b>10</b>		
<b>L4</b>	<b>Analyze</b>	<b>10</b>		
<b>L5</b>	<b>Evaluate</b>	<b>-</b>		
<b>L6</b>	<b>Create</b>	<b>--</b>		
<b>Suggested Learning Resources:</b>				
<b>Text Books:</b>				
1. Operations Research: An Introduction, H A Taha, Pearson; 10th edition (17 January2017), ISBN-13: 978-1292165547				
2. Operation Research, S D Sharma, KedarNath RamNath publication, 2014 edition, ISBN-13: 1234567142552				
3. Contemporary Project Management, Timothy J Kloppenborg, Cengage Learning, 2 nd Edition, ISBN: 97881315187				
4. Project Management a System approach to Planning Scheduling & Controlling, Harold Kerzner, CBS Publishers and Distributors.2nd Ed., ISBN: 9788123908670				
5. Engineering Economy, Riggs J.L., 4 TH ed. , McGraw Hill, 2002				
6. Engineering Economy, Thuesen H.G. PHI , 2002				
<b>Web links and Video Lectures (e-Resources):</b>				
• <a href="https://onlinecourses.nptel.ac.in/noc22_ge24/preview">https://onlinecourses.nptel.ac.in/noc22_ge24/preview</a>				
• <a href="https://projectmanagement.berkeley.edu/project-managemenet-course/">https://projectmanagement.berkeley.edu/project-managemenet-course/</a>				
• <a href="https://www.youtube.com/watch?v=cwxXY9Qe8ss">https://www.youtube.com/watch?v=cwxXY9Qe8ss</a>				
• <a href="https://www.youtube.com/watch?v=V2GvOXvjhLA">https://www.youtube.com/watch?v=V2GvOXvjhLA</a>				

- [https://nsf.gov/resources/nsf.gov/2023-03/Bio-inspired%20Design%20Workshop%20Report 2232327 October%202022 Final.508.pdf](https://nsf.gov/resources/nsf.gov/2023-03/Bio-inspired%20Design%20Workshop%20Report%202232327%20October%202022%20Final.508.pdf)

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Demonstration of project management by taking any real time examples.
- Demonstration of implementation of game theory in industries.
- Demonstration of application of sequencing in the industries.
- Motivational videos from a women entrepreneur.
- Contents related activities (Activity-based discussions)
  - For active participation of students, instruct the students to prepare Flowcharts and Handouts.
  - Organizing Group wise discussions on issues.
  - Seminars.

<b>EMBEDDED SYSTEM DESIGN</b>															
<b>Course Code</b>	<b>21ECE62</b>								<b>CIE Marks</b>	<b>50</b>					
<b>L:T:P:S</b>	<b>3:0:0:0</b>								<b>SEE Marks</b>	<b>50</b>					
<b>Hrs / Week</b>	<b>3</b>								<b>Total Marks</b>	<b>100</b>					
<b>Credits</b>	<b>03</b>								<b>Exam Hours</b>	<b>03</b>					
<b>Course outcomes:</b> At the end of the course, the student will be able to:															
21ECE62.1	Apply the features of processors, Memory, I/O and communication interfaces in developing embedded system														
21ECE62.2	Use software development tools to design embedded systems														
21ECE62.3	Compare the programmer's model of Cortex M processors to give frugal solutions for real world problems														
21ECE62.4	Design computational models for hardware and software design														
21ECE62.5	Apply the concept of RTOS in embedded system applications														
21ECE62.6	Engage in self-learning in analyzing and carry out embedded projects														
<b>Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:</b>															
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	
21ECE62.1	3	-	-	-	-	-	-	-	-	-	-	3	3	2	
21ECE62.2	3	3	3	-	3	-	-	-	-	-	-	3	3	2	
21ECE62.3	3	3	3	2	3	2	2	-	-	-	-	3	3	2	
21ECE62.4	3	3	3	-	3	-	-	-	-	-	-	3	3	2	
21ECE62.5	3	-	-	-	-	-	-	-	-	-	-	3	3	2	
21ECE62.6	3	3	3	2	3	2	2	-	2	1	-	3	3	2	
<b>MODULE-1 INTRODUCTION TO EMBEDDED SYSTEMS 21ECE62.1 8 Hours</b>															
What is an Embedded System?, Embedded Systems Vs General Computing Systems, Classification of Embedded System, Major Application areas of Embedded System, Purpose Embedded System, The Innovative Bonding of lifestyle with Embedded Technologies. Core of the Embedded System, Sensors and Actuators, Memory, Communication Interface, Embedded Firmware.															
Self-study / Case Study / Applications		Discuss the role of embedded operating systems in smartphones and smart TVs.													
Text Book		Text Book 1: 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7,2.1, 2.2, 2.3.1, 2.3.2, 2.4, 2.4.1, 2.4.2, 2.5													
<b>MODULE-2 INTRODUCTION TO ARM CORTEX M PROCESSORS 21ECE62.2 8 Hours</b>															
What are ARM Cortex M Processors?, Features of Cortex M3 and M4, Advantages and Applications of Cortex M Processors.															
Introduction to Embedded Software Development: Software Development flow, Compiling the applications, software flow, Microcontroller interfaces.															
Self-study / Case Study / Applications		Discuss how embedded systems in gaming consoles manage tasks like rendering graphics, processing user input, and providing network connectivity for online gaming.													
Text Book		Text Book 1: 1.1, 1.2, 3.2, 1.3, 2.3, 2.4, 2.5, 2.8													
<b>MODULE-3 ARM- 32 BIT MICROCONTROLLER FAMILY 21ECE62.3, 21ECE62.4 8 Hours</b>															
Cortex M4 Basics Architecture of ARM Cortex-M4, Block diagram of ARM Cortex-M4, Operation modes and states, Registers, Special Registers, Data type, Memory System, Exceptions and interrupts ,Debug, Instruction Set Summary.															

Self-study / Case Study / Applications	Create a network of wireless sensors that monitor environmental parameters like temperature, humidity, and air quality.			
Text Book	Text Book -2: 4.1, 3.1.4, 4.2, 4.4, 4.5, 4.7, 5.6.1-5.6.15, 5.7.5			
<b>MODULE-4</b>	<b>HARDWARE SOFTWARE CO-DESIGN AND PROGRAM MODELING</b>	<b>21ECE62.5</b>	<b>8 Hours</b>	
Fundamental Issues in Hardware Software Co-Design, Computational Models in Embedded Design, Introduction to Unified Modelling Language, Hardware Software Trade-offs.				
Self-study / Case Study / Applications	Create a smart traffic management system and try to include the hardware-software co-design principles and program modelling.			
Text Book	Text Book 1: 7.1, 7.2, 7.3, 7.4			
<b>MODULE-5</b>	<b>REAL TIME OPERATING SYSTEM (RTOS) BASED EMBEDDED SYSTEM DESIGN</b>	<b>21ECE62.6</b>	<b>8 Hours</b>	
Operating system basics, Types of operating systems, Tasks, Process and threads, Multiprocessing and Multitasking, Task Scheduling. The embedded product development lifecycle.				
Self-study / Case Study / Applications	Build a home automation system that controls lights, temperature, and security using an RTOS.			
Text Book	Text Book 1: 15.1-15.4			
<b>CIE Assessment Pattern (50 Marks – Theory)</b>				
<b>RBT Levels</b>		<b>Marks Distribution</b>		
		<b>Test (s)</b>	<b>Qualitative Assessment (s)</b>	<b>MCQ's</b>
		<b>25</b>	<b>15</b>	<b>10</b>
<b>L1</b>	<b>Remember</b>	5	-	5
<b>L2</b>	<b>Understand</b>	5	-	5
<b>L3</b>	<b>Apply</b>	10	5	-
<b>L4</b>	<b>Analyze</b>	5	5	-
<b>L5</b>	<b>Evaluate</b>	-	5	-
<b>L6</b>	<b>Create</b>	-	-	-
<b>SEE Assessment Pattern (50 Marks – Theory)</b>				
<b>RBT Levels</b>		<b>Exam Marks Distribution (50)</b>		
<b>L1</b>	<b>Remember</b>	10		
<b>L2</b>	<b>Understand</b>	10		
<b>L3</b>	<b>Apply</b>	20		
<b>L4</b>	<b>Analyze</b>	10		
<b>L5</b>	<b>Evaluate</b>	-		
<b>L6</b>	<b>Create</b>	--		
<b>Suggested Learning Resources:</b>				
<b>Text Books:</b>				
1) Introduction to Embedded Systems, Shibu K V, 2 <sup>nd</sup> Edition 2017, McGRAW HILL.				
2) The Definitive Guide to ARM Cortex –M3 and Cortex-M4 Processors Joseph Yiu, 3rd Edition, 2014, Elsevier.				
<b>Reference Books:</b>				
1) Embedded Systems – A contemporary Design Tool, James K Peckol, 2014, John Wiley.				

- 2) Cortex M4 Technical Reference Manual, ARM.
- 3) M4 Programming manual, ST microelectronics.

**Web links and Video Lectures (e-Resources):**

- <https://archive.nptel.ac.in/courses/106/105/106105193/>
- <https://embeddedcomputing.com/technology/software-and-os/introduction-to-realtime-operating-systems-rtos>
- [https://www.youtube.com/watch?v=dOijuXYFMkE&list=PLqmN55CTOnLeArO1\\_td4vHkAY35h6GlHM](https://www.youtube.com/watch?v=dOijuXYFMkE&list=PLqmN55CTOnLeArO1_td4vHkAY35h6GlHM)
- <https://www.arm.com/resources/education/education-kits/efficient-embedded-systems>

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Visit to any ARM Company.
- Demonstration of STM ARM cortex M4.
- Complete the course available at <https://www.arm.com/resources/education/online-courses>.
- Contents related activities (Activity-based discussions).
  - For active participation of students, instruct the students to prepare Flowcharts and Handouts
  - Organizing Group wise discussions on issues.
  - Seminars.



<b>EMBEDDED SYSTEM DESIGN LAB</b>														
<b>Course Code</b>	<b>21ECL62</b>					<b>CIE Marks</b>					<b>50</b>			
<b>L:T:P:S</b>	<b>0:0:1:0</b>					<b>SEE Marks</b>					<b>50</b>			
<b>Hrs / Week</b>	<b>2</b>					<b>Total Marks</b>					<b>100</b>			
<b>Credits</b>	<b>01</b>					<b>Exam Hours</b>					<b>03</b>			
<b>Course outcomes:</b>														
At the end of the course, the student will be able to:														
21ECL62.1	Conduct experiments to understand data transfer, process and memory access instructions													
21ECL62.2	Conduct experiments using bit field and process control instructions													
21ECL62.3	Develop code for saturation and floating-point operations													
21ECL62.4	Use Embedded C code to demonstrate peripheral interfacing with ARM development kit													
<b>Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:</b>														
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>
21ECL62.1	3	3	1	2	3	-	-	-	2	-	-	1	3	3
21ECL62.2	3	3	1	2	3	-	-	-	2	-	-	1	3	3
21ECL62.3	3	3	1	2	3	-	-	-	2	-	-	1	3	3
21ECL62.4	3	3	1	2	3	-	-	-	2	-	-	1	3	3
<b>Exp. No. / Pgm. No.</b>														
<b>List of Experiments / Programs</b>														
<b>Hours</b>														
<b>COs</b>														
<b>Prerequisite Experiments / Programs / Demo</b>														
<ul style="list-style-type: none"> <li>Revisit to 8086 and 8051 programming basic programming</li> <li>Study of ARM- Cortex M4 processor development board</li> </ul>														
2														
NA														
<b>PART-A</b>														
1	Assembly Level Program (ALP) involving instructions for transferring data within the processor.											2	21ECL62.1	
2	ALP to demonstrate memory access instruction for various data sizes and addressing modes.											2	21ECL62.1	
3	ALP involving logic operations.											2	21ECL62.1	
4	ALP involving data conversion operations.											2	21ECL62.1	
5	ALP involving shift and rotate operations.											2	21ECL62.1	
6	ALP to illustrate bit field processing instruction.											2	21ECL62.2	
<b>PART-B</b>														
7	ALP to illustrate program flow instruction.											2	21ECL62.2	
8	ALP to illustrate saturation operation.											2	21ECL62.3	
9	ALP involving floating point operation.											2	21ECL62.3	
10	Interfacing LED with ARM STM32F401xx using Embedded C programming <ul style="list-style-type: none"> <li>a. With delay</li> <li>b. Without delay</li> </ul>											2	21ECL62.4	
11	Embedded C program to demonstrate serial communication (UART) using ARM Cortex development board.											2	21ECL62.4	
12	Design of stepper motor driver based on STM32.											2	21ECL62.4	
<b>PART-C</b>														

**Beyond Syllabus Virtual Lab Content**  
**(To be done during Lab but not to be included for CIE or SEE)**

1. Fixed Point Arithmetic Operations and Logical Operators  
<https://portal.coepvlab.ac.in/vlab/auth/home?dept=1&lab=1>
2. Temperature control using ATmega16  
<https://portal.coepvlab.ac.in/vlab/auth/home?dept=2&lab=9>
3. Interfacing 4x4 switch matrix with the microcontroller  
<http://vlabs.iitkgp.ac.in/rtes/exp12/index.html>
4. Floating Point Arithmetic Operations  
<https://portal.coepvlab.ac.in/vlab/auth/home?dept=1&lab=1>
5. Serial Communication between micro controller and PC  
<http://vlabs.iitkgp.ac.in/rtes/exp15/index.html>
6. Pulse Width Modulation (PWM) Generation Using FPGA  
<https://portal.coepvlab.ac.in/vlab/auth/home?dept=1&lab=1>

**CIE Assessment Pattern (50 Marks - Lab)**

RBT Levels		Test (s)	Weekly Assessment
		20	30
L1	Remember	-	-
L2	Understand	-	5
L3	Apply	10	10
L4	Analyze	5	10
L5	Evaluate	5	5
L6	Create	-	-

**SEE Assessment Pattern (50 Marks - Lab)**

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	05
L3	Apply	20
L4	Analyze	15
L5	Evaluate	10
L6	Create	-

**Suggested Learning Resources:**

**Reference Books (Arm Developer documents)**

1. The Definitive Guide to ARM Cortex –M3 and Cortex-M4 Processors Joseph Yiu, 3rd Edition, 2014, Elsevier.
2. Arm Developer documents
  - (a) <https://developer.arm.com/documentation/dui0068/b/ARM-Instruction-Reference>
  - (b) <https://developer.arm.com/documentation/ddi0403/d/Application-Level-Architecture/Application-Level-Programmers--Model/The-optional-Floating-point-extension/Floating-point-data-types-and-arithmetic?lang=en>

<b>COMMUNICATION SYSTEMS - II</b>															
<b>Course Code</b>	21ECE63								<b>CIE Marks</b>	50					
<b>L:T:P:S</b>	3:0:0:0								<b>SEE Marks</b>	50					
<b>Hrs / Week</b>	3								<b>Total Marks</b>	100					
<b>Credits</b>	03								<b>Exam Hours</b>	03					
<b>Course outcomes:</b>															
At the end of the course, the student will be able to:															
21ECE63.1	Solve the transmission line problems using analytical and graphical approach														
21ECE63.2	Analyze the behavior and characteristics of microwave active components														
21ECE63.3	Apply the knowledge of low frequency network to express Scattering parameter for microwave multiport junctions														
21ECE63.4	Interpret the relationships between antenna parameters														
21ECE63.5	Analyze the power radiated by different antennas and their radiation characteristics														
21ECE63.6	Use the modern mathematical techniques to the solutions of antenna problems and wave propagation mechanism at different frequencies														
<b>Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:</b>															
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	
21ECE63.1	3	3	2	-	2	-	-	-	-	-	-	3	3	3	
21ECE63.2	3	3	-	-	-	-	-	-	-	-	-	3	3	3	
21ECE63.3	3	-	-	-	2	-	-	-	-	-	-	3	3	3	
21ECE63.4	3	3	-	-	2	-	-	-	-	-	-	3	3	3	
21ECE63.5	3	3	-	-	2	-	-	-	-	-	-	3	3	3	
21ECE63.6	3	3	2	1	2	1	1	-	1	-	-	3	3	3	
<b>MODULE 1</b>															
<b>MICROWAVE SOURCES AND TRANSMISSION LINES</b>										<b>21ECE63.1, 21ECE63.2</b>		<b>8 Hours</b>			
<b>MICROWAVE SOURCES:</b> Introduction to Microwave System and Microwave frequencies. Generation of Microwaves- Reflex Klystron, TWT, Magnetron.															
<b>TRANSMISSION LINES:</b> Equivalent Circuit of a Transmission Line, Transmission Line equations and solutions, Analysis of Primary and Secondary Constants. Reflection and Transmission Coefficients, Standing Waves and SWR, Smith Chart, Single Stub matching.															
Self-study / Case Study / Applications			Radiation Hazards, Applications of Microwave System												
Text Book			Text Book 1: 9.1, 9.2, 9.3, 9.5 Text Book 2 – 0.1, 0.2, 0.3, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6												
<b>MODULE 2</b>															
<b>MICROWAVE NETWORK THEORY AND PASSIVE COMPONENTS</b>										<b>21ECE63.3</b>		<b>8 Hours</b>			
<b>MICROWAVE NETWORK THEORY:</b> Introduction, S matrix representation of multiport networks, Properties of S parameters, S- parameters of a Two-port network with mismatched load.															
<b>PASSIVE COMPONENTS:</b> Attenuators, Waveguide Tees, Magic Tees, Circulators and Isolators, Directional Couplers-Bethe Hole Coupler.															
Self-study			Analyze the S parameter of a microwave passive devices												
Text Book			Text Book 2: 6.1, 6.2, 6.3, 6.4.2, 6.4.14, 6.4.15, 6.4.16												

<b>MODULE 3</b>	<b>ANTENNA FUNDAMENTALS</b>	<b>21ECE63.4</b>	<b>8 Hours</b>	
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.				
Case Study	Simulation of Antenna Parameters			
Text Book	Text Book 3: 2.1 - 2.7, 2.9-2.11, 2.13			
<b>MODULE 4</b>	<b>POINT SOURCES AND ARRAYS AND ELECTRIC DIPOLES</b>	<b>21ECE63.4, 21ECE63.5</b>	<b>8 Hours</b>	
<b>POINT SOURCES AND ARRAYS:</b> Point Sources, Power Patterns, Power Theorem, Radiation Intensity, Arrays of two isotropic point sources, Linear Arrays of n Isotropic Point Sources of equal Amplitude and Spacing. <b>ELECTRIC DIPOLES:</b> Introduction, Short Electric Dipole, Fields of a Short Dipole, Radiation Resistance of a Short Electric Dipole, Thin Linear Antenna (Field Analyses)				
Self-study	Design of an Antenna			
Text Book	Text Book 3: 5.1- 5.6, 5.9, 5.13, 6.1 - 6.5			
<b>MODULE 5</b>	<b>RADIOWAVE PROPAGATION</b>	<b>21ECE63.5, 21ECE63.6</b>	<b>8 Hours</b>	
Introduction, Classification of Electromagnetic Waves, 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.				
Self-study	Guided wave concepts			
Text Book	Text Book 3: 22.1, 22.3, 25.4, 25.10			
<b>CIE Assessment Pattern (50 Marks - Theory)</b>				
<b>RBT Levels</b>		<b>Marks Distribution</b>		
		<b>Test (s)</b>	<b>Qualitative Assessment (s)</b>	<b>MCQ's</b>
		<b>25</b>	<b>15</b>	<b>10</b>
<b>L1</b>	<b>Remember</b>	5	-	<b>5</b>
<b>L2</b>	<b>Understand</b>	5	-	<b>5</b>
<b>L3</b>	<b>Apply</b>	10	5	-
<b>L4</b>	<b>Analyze</b>	5	5	-
<b>L5</b>	<b>Evaluate</b>	-	5	-
<b>L6</b>	<b>Create</b>	-	-	-
<b>SEE Assessment Pattern (50 Marks - Theory)</b>				
<b>RBT Levels</b>		<b>Exam Marks Distribution (50)</b>		
<b>L1</b>	<b>Remember</b>	<b>10</b>		
<b>L2</b>	<b>Understand</b>	<b>10</b>		
<b>L3</b>	<b>Apply</b>	<b>20</b>		
<b>L4</b>	<b>Analyze</b>	<b>10</b>		
<b>L5</b>	<b>Evaluate</b>	-		
<b>L6</b>	<b>Create</b>	-		
<b>Suggested Learning Resources:</b>				
<b>Text Books:</b>				
1. Microwave Engineering – Sushrut Das, Oxford Higher Education, 2nd Edn, 2015.				
2. Microwave Engineering - Annapurna Das, Sisir K Das, TMH, Publication, 2nd, 2010.				

3. Antennas and Wave Propagation-John D. Krauss, Ronald J Marhefka, Ahmad S Khan, 4th Edition, McGraw Hill Education, 2013.
4. Antennas and Wave Propagation - Harish and Sachidananda: Oxford University Press, 2007.

**Reference Books:**

1. Microwave Engineering - David M Pozar, John Wiley India Pvt. Ltd., 3<sup>rd</sup> Edn,2008.
2. Microwave Devices and circuits- Liao, Pearson Education.,2005
3. Antennas and Wave Propagation - Harish and Sachidananda: Oxford University Press, 2007

**Web links and Video Lectures (e-Resources):**

- <https://youtu.be/2SxSBMum4gc>
- <https://youtu.be/0NgWS9HvSDk>
- <https://youtu.be/lDBBrD6259A>
- [https://youtu.be/wx\\_tIvaajAI](https://youtu.be/wx_tIvaajAI)
- [https://youtu.be/IPwk9Cjjo\\_I](https://youtu.be/IPwk9Cjjo_I)
- [https://youtu.be/s4yTE2h\\_OYM](https://youtu.be/s4yTE2h_OYM)
- <https://youtu.be/bUsS5KUMLvw>

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Visit to any manufacturing/Assembling unit of Transmission Line or Antenna printed boards.
- Video demonstration of latest trends in Microwave System/ Antenna Design.
- Contents related activities (Activity-based discussions).
  - Group Discussion.
  - Case- Study.

<b>COMMUNICATION SYSTEMS - II LAB</b>														
<b>Course Code</b>	<b>21ECL63</b>					<b>CIE Marks</b>					<b>50</b>			
<b>L:T:P:S</b>	<b>0:0:1:0</b>					<b>SEE Marks</b>					<b>50</b>			
<b>Hrs / Week</b>	<b>2</b>					<b>Total Marks</b>					<b>100</b>			
<b>Credits</b>	<b>01</b>					<b>Exam Hours</b>					<b>03</b>			
<b>Course outcomes:</b>														
At the end of the course, the student will be able to:														
21ECL63.1	Calculate different microwave parameters for microwave circuits													
21ECL63.2	Demonstrate the working of various microwave components													
21ECL63.3	Model an optical communication system and analyze its characteristics													
21ECL63.4	Analyze the design of antenna parameters and radiation pattern of different antenna types													
<b>Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:</b>														
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>
21ECL63.1	3	3	-	-	-	-	-	-	2	-	-	3	3	2
21ECL63.2	3	3	2	-	2	-	-	-	2	-	-	3	3	2
21ECL63.3	3	3	2	1	-	-	-	-	2	-	-	3	3	2
21ECL63.4	3	3	2	1	2	-	-	-	2	-	-	3	3	2
<b>Exp. No. / Pgm. No.</b>														
<b>List of Experiments / Programs</b>														
<b>Hours</b>														
<b>COs</b>														
<b>Prerequisite Experiments / Programs / Demo</b>														
	<ul style="list-style-type: none"> <li>The ANSYS Electronics Desktop Environment: <a href="https://www.youtube.com/watch?v=oOH6hVP6vcA&amp;list=PL0lZXwHtV6Ol3KjVHLhOZF3q1Ey491LF7">https://www.youtube.com/watch?v=oOH6hVP6vcA&amp;list=PL0lZXwHtV6Ol3KjVHLhOZF3q1Ey491LF7</a></li> <li>Introduction to HFSS for antenna/microwave device design: <a href="https://www.youtube.com/watch?v=2ADK971gKKU&amp;list=PL4lHevQbRIlnAhw2BjIhiHDi2lkGaS9Xs">https://www.youtube.com/watch?v=2ADK971gKKU&amp;list=PL4lHevQbRIlnAhw2BjIhiHDi2lkGaS9Xs</a></li> </ul>											2	NA	
<b>PART-A</b>														
1	Measurement of frequency, guide wavelength, power, VSWR and attenuation in microwave test bench.											2	21ECL63.1	
2	To conduct an experiment to find out the insertion loss and coupling factor for the Magic Tee.											2	21ECL63.1 21ECL63.2	
3	Determination of Coupling and isolation characteristics of microstrip directional coupler.											2	21ECL63.2	
4	Determination of (a) Resonance characteristics of microstrip ring resonator and computation of dielectric constant of the substrate. (b) Power division and isolation of microstrip power divider.											2	21ECL63.2	
5	Measurement of propagation loss, bending loss and numerical aperture of an optical fiber.											2	21ECL63.3	
6	Measurement of directivity and gain of microstrip dipole and Yagi antennas											2	21ECL63.4	
<b>PART-B</b>														
7	To generate Electromagnetic Wave using MATLAB software.											2	21ECL63.3	

			21ECL63.4
8	To plot radiation pattern of dipole antenna using MATLAB software.	2	21ECL63.4
9	To plot radiation pattern of uniform linear Array using MATLAB software.	2	21ECL63.4
10	To design and simulate rectangular microstrip patch antenna with coaxial probe feeding technique for the frequency $f=3.5\text{GHz}$ using ANSYS HFSS software.	2	21ECL63.4
11	To design and simulate rectangular microstrip patch antenna for the frequency $3\text{GHz}$ using strip line feed using ANSYS HFSS software.	2	21ECL63.4
12	To design and simulate U-shaped Slot Rectangular Microstrip Patch Antenna with strip line feed working at operational frequency $5\text{GHz}$ using ANSYS HFSS software.	2	21ECL63.4

**PART-C**

**Beyond Syllabus Virtual Lab Content**

**(To be done during Lab but not to be included for CIE or SEE)**

1. Measurement of VSWR on a line: <http://eem-iitd.vlabs.ac.in/exp1.html>
2. Determination of unknown impedance: <http://eem-iitd.vlabs.ac.in/exp2.html>
3. Microwave Coupler: <http://eem-iitd.vlabs.ac.in/exp5.html>
4. Radiation Pattern of Horn Antenna: <http://eem-iitd.vlabs.ac.in/exp7.html>
5. Antenna Gain measurement: <http://eem-iitd.vlabs.ac.in/exp8.html>

**CIE Assessment Pattern (50 Marks - Lab)**

RBT Levels		Test (s)	Weekly Assessment
		20	30
L1	Remember	-	-
L2	Understand	-	5
L3	Apply	10	10
L4	Analyze	5	10
L5	Evaluate	5	5
L6	Create	-	-

**SEE Assessment Pattern (50 Marks - Lab)**

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	05
L3	Apply	20
L4	Analyze	15
L5	Evaluate	10
L6	Create	-

**Suggested Learning Resources:**

**Reference Books:**

- 1) Constantine A. Balanis, "Antenna Theory: Analysis and Design" 4th Edition, Publisher: Wiley, 2016, ISBN: 978-1-118-64206-1
- 2) David M. Pozar, "Microwave Engineering" 4th Edition, Publisher: Wiley, 2021, ISBN: 978-1-119-77062-6

<b>FIBER OPTIC COMMUNICATION</b>														
<b>Course Code</b>	21ECE641					<b>CIE Marks</b>			50					
<b>L:T:P:S</b>	3:0:0:0					<b>SEE Marks</b>			50					
<b>Hrs / Week</b>	3					<b>Total Marks</b>			100					
<b>Credits</b>	03					<b>Exam Hours</b>			03					
<b>Course outcomes:</b> At the end of the course, the student will be able to:														
21ECE641.1	Apply the fundamental concepts of optical fiber communication in modern digital communication systems													
21ECE641.2	Identify suitable optical fiber structures for specific applications													
21ECE641.3	Investigate the effects of channel impairments in optical fiber communication systems													
21ECE641.4	Evaluate the performance of optical receivers													
21ECE641.5	Utilize the theory of optical multiplexers for networking applications													
21ECE641.6	Deploy various concepts for creation of optical amplifiers													
<b>Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:</b>														
	P01	P02	P03	P04	P05	P06	P07	P08	P09	P010	P011	P012	PS01	PS02
21ECE641.1	3	-	-	-	-	-	-	-	-	-	-	-	3	3
21ECE641.2	3	3	3	-	-	-	-	-	-	-	-	-	3	3
21ECE641.3	3	3	3	3	2	-	-	-	-	-	-	-	3	3
21ECE641.4	3	3	3	3	2	-	-	-	-	-	-	-	3	3
21ECE641.5	3	3	-	-	-	-	-	-	-	-	-	-	3	3
21ECE641.6	3	3	3	3	-	-	-	-	-	-	-	-	3	3
<b>MODULE 1 OVERVIEW OF OPTICAL FIBER COMMUNICATION 21ECE641.1 8 Hours</b>														
Historical development, The General System, advantages, disadvantages, and applications of optical fiber communication, Ray theory, single mode fiber, cutoff wave length, mode field diameter.														
Self-study		Impact of the fiber optics revolution on communication and connectivity across various industries.												
Text Book		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												
<b>MODULE 2</b>	<b>OPTICAL SOURCES AND TRANSMISSION CHARACTERISTICS OF OPTICAL FIBERS</b>					<b>21ECE641.2, 21ECE641.3</b>					<b>8 Hours</b>			
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 modal dispersion.														
Self-study		Investigate optical sources and transmission characteristics of optical fibers.												
Text Book		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, 3.3.8, 3.9, 3.10												
<b>MODULE 3</b>	<b>OPTICAL RECEIVER</b>					<b>21ECE641.4, 21ECE641.6</b>					<b>8 Hours</b>			
Physical Principles of Photo diodes, PIN and APD, Photo detector noise. Optical Receiver Operation, receiver sensitivity, quantum limit, eye diagrams, coherent detection.														
Case Study		Investigate the principles of operations of photo diodes, PIN ,APD and explore the applications of optical receivers.												



Text Book	Text Book2: 6.1.1,6.1.2, 6.2, 7.1, 7.2.2, 7.2.3,7.3, 7.4		
<b>MODULE 4</b>	<b>OPTICAL AMPLIFIERS</b>	<b>21ECE641.4, 21ECE641.6</b>	<b>8 Hours</b>
Basic Applications and types of Optical amplifiers, types of Optical amplifiers, semiconductor optical amplifiers, EDFA, Amplifier Noise, Optical SNR.			
Self-study	Scrutinize the Different types of optical amplifiers and their applications.		
Text Book			
<b>MODULE 5</b>	<b>WDM CONCEPTS AND OPTICAL NETWORKS</b>	<b>21ECE641.5</b>	<b>8 Hours</b>
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.			
Case Study	Investigate the operating principles of WDM, SONET/SDH, Optical Add/Drop Multiplexing		
Text Book	Text Book2:10.1.1, 10.1.2,10.2.5,10.3,13.1,13.2,13.3,13.5		
<b>CIE Assessment Pattern (50 Marks - Theory)</b>			
<b>RBT Levels</b>		<b>Marks Distribution</b>	
		<b>Test (s)</b>	<b>Qualitative Assessment (s) (NPTEL)</b>
		<b>25</b>	<b>25</b>
<b>L1</b>	<b>Remember</b>	<b>5</b>	<b>-</b>
<b>L2</b>	<b>Understand</b>	<b>5</b>	<b>5</b>
<b>L3</b>	<b>Apply</b>	<b>10</b>	<b>10</b>
<b>L4</b>	<b>Analyze</b>	<b>5</b>	<b>10</b>
<b>L5</b>	<b>Evaluate</b>	<b>-</b>	<b>-</b>
<b>L6</b>	<b>Create</b>	<b>-</b>	<b>-</b>
<b>SEE Assessment Pattern (50 Marks - Theory)</b>			
<b>RBT Levels</b>		<b>Exam Marks Distribution (50)</b>	
<b>L1</b>	<b>Remember</b>	<b>10</b>	
<b>L2</b>	<b>Understand</b>	<b>10</b>	
<b>L3</b>	<b>Apply</b>	<b>20</b>	
<b>L4</b>	<b>Analyze</b>	<b>10</b>	
<b>L5</b>	<b>Evaluate</b>	<b>-</b>	
<b>L6</b>	<b>Create</b>	<b>-</b>	
<b>Suggested Learning Resources:</b>			
<b>Text Books:</b>			
1)"Optical Fiber Communications", John M. Senior, Pearson Education, Second edition,7th Impression, 2010.			
2)"Optical Fiber Communication", Gerd Keiser, 4th Ed., MGH,2008.			
<b>Reference Books:</b>			
1) Fiber Optic Communication - Joseph C Palais: 4th Edition, Pearson Education.			
<b>Web links and Video Lectures (e-Resources):</b>			
<ul style="list-style-type: none"> <li>• <a href="https://www.youtube.com/watch?v=ougKUUM3hIA">https://www.youtube.com/watch?v=ougKUUM3hIA</a></li> <li>• <a href="https://www.youtube.com/watch?v=2zZZc6RXVjo">https://www.youtube.com/watch?v=2zZZc6RXVjo</a></li> <li>• <a href="https://www.youtube.com/watch?v=XtXbPabLmU4">https://www.youtube.com/watch?v=XtXbPabLmU4</a></li> <li>• <a href="https://www.youtube.com/watch?v=5dIYNjWkzTc">https://www.youtube.com/watch?v=5dIYNjWkzTc</a></li> <li>• <a href="https://www.youtube.com/watch?v=8LAatT_wUuo">https://www.youtube.com/watch?v=8LAatT_wUuo</a></li> </ul>			

- <https://www.youtube.com/watch?v=4W7hieXDAmc>

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Video demonstration of latest trends in Optical Fiber Communication
- Contents related activities (Activity-based discussions)
- For active participation of students, conduct problem solving sessions
- Organizing Group wise discussions on issues
  - Seminars

<b>BIOMEDICAL SIGNAL PROCESSING</b>														
<b>Course Code</b>	<b>21ECE642</b>					<b>CIE Marks</b>					<b>50</b>			
<b>L:T:P:S</b>	<b>3:0:0:0</b>					<b>SEE Marks</b>					<b>50</b>			
<b>Hours / Week</b>	<b>3</b>					<b>Total Marks</b>					<b>100</b>			
<b>Credits</b>	<b>03</b>					<b>Exam Hours</b>					<b>03</b>			
<b>Course outcomes:</b> At the end of the course, the student will be able to:														
21ECE642.1	Describe the origin, properties and suitable models of biomedical signals such as ECG and EEG													
21ECE642.2	Apply signal processing methods to extract relevant information from biomedical signal measurements													
21ECE642.3	Develop the relevant mathematical and computational skills relevant in compression of biomedical signals													
21ECE642.4	Analyze the ECG Signal behavior using signal processing methods													
21ECE642.5	Analyze the rhythms and detection process in neurological signal processing													
21ECE642.6	Examine the quality of biomedical images acquired from Computed Tomographic Imaging and Ultrasound Imaging modalities													
<b>Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:</b>														
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PS01</b>	<b>PS02</b>
21ECE642.1	2	-	-	-	-	-	-	-	-	-	-	-	3	2
21ECE642.2	3	3	-	-	-	-	-	-	-	-	-	-	3	2
21ECE642.3	3	3	2	-	-	-	-	-	-	-	-	-	3	2
21ECE642.4	3	3	-	-	-	-	-	-	-	-	-	-	3	2
21ECE642.5	3	3	-	-	-	-	-	-	-	-	-	-	3	2
21ECE642.6	3	3	2	2	1	2	-	-	-	-	-	-	3	2
<b>MODULE-1 INTRODUCTION TO BIOMEDICAL SIGNALS 21ECE642.1, 21ECE642.2 8 Hours</b>														
The nature of Biomedical Signals, Examples of Biomedical Signals, Objectives and difficulties in Biomedical analysis, Simple signal conversion systems, Conversion requirements for biomedical signals, Signal conversion circuits, Basics of signal averaging, signal averaging as a digital filter, a typical averager, software for signal averaging, limitations of signal averaging.														
Self-Study Filtering and Frequency Analysis of 2D Images														
Text Book Text Book 1: 1.1,2.1-2.3,3.2-3.4; 9.1-9.5.														
<b>MODULE-2 NOISE CANCELLATION AND DATA COMPRESSION TECHNIQUES 21ECE642.2, 21ECE642.3 8 Hours</b>														
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.														
Self-Study Filtering and Frequency Analysis: ECG														
Text Book Text Book no 1: 8.1-8.3,10.1-10.4,11.1-11.4														
<b>MODULE-3 ELECTROCARDIOGRAPHY 21ECE642.4 8 Hours</b>														
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, Band-pass filtering techniques, Differentiation techniques, Template matching techniques, A QRS detection algorithm, Real-time ECG processing algorithm, ECG interpretation, ST segment analyzer, Portable arrhythmia monitor.														

Self-Study	Medical Image Segmentation		
Text Book	Text Book no 2 : 7.1-7.4 Text Book no 1: 12.1-12.6,13.1-13.3		
<b>MODULE-4</b>	<b>EEG SIGNAL</b>	<b>21ECE642.5</b>	<b>8 Hours</b>
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, Templatematching for EEG, spike and wave detection.			
Self-Study	Medical Image Analysis.		
Text Book	Text Book no 2: 4.1-4.4		
<b>MODULE-5</b>	<b>BIOMEDICAL IMAGE PROCESSING</b>	<b>21ECE642.6</b>	<b>8 Hours</b>
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.			
Case Study	Mini-project on Bio-Medical Imaging systems		
Text Book	Text Book no 3: 6.1-6.4, 11.1-11.8		
<b>CIE Assessment Pattern (50 Marks - Theory)</b>			
<b>RBT Levels</b>		<b>Marks Distribution</b>	
		<b>Test (s)</b>	<b>Qualitative Assessment (s) (NPTEL)</b>
		<b>25</b>	<b>25</b>
<b>L1</b>	<b>Remember</b>	<b>5</b>	<b>-</b>
<b>L2</b>	<b>Understand</b>	<b>5</b>	<b>5</b>
<b>L3</b>	<b>Apply</b>	<b>10</b>	<b>10</b>
<b>L4</b>	<b>Analyze</b>	<b>5</b>	<b>10</b>
<b>L5</b>	<b>Evaluate</b>	<b>-</b>	<b>-</b>
<b>L6</b>	<b>Create</b>	<b>-</b>	<b>-</b>
<b>SEE Assessment Pattern (50 Marks - Theory)</b>			
<b>RBT Levels</b>		<b>Exam Marks Distribution (50)</b>	
<b>L1</b>	<b>Remember</b>	<b>10</b>	
<b>L2</b>	<b>Understand</b>	<b>10</b>	
<b>L3</b>	<b>Apply</b>	<b>20</b>	
<b>L4</b>	<b>Analyze</b>	<b>10</b>	
<b>L5</b>	<b>Evaluate</b>	<b>-</b>	
<b>L6</b>	<b>Create</b>	<b>-</b>	
<b>Suggested Learning Resources:</b>			
<b>Text Books:</b>			
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.			

**Reference Books:**

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," 2<sup>nd</sup> Edition, Reed Elsevier Private Limited, New York, U.S.A., 2005.

**Web links and Video Lectures (e-Resources):**

- **Biomedical signal processing NPTEL course.**
- **Biomedical signal processing NPTEL lecture videos**  
<https://www.youtube.com/watch?v=ezfPl8kUdbg&list=PLVDPthxoc3INzu07X-CbQWPZNMboPXKtb>
- **Biomedical Signal processing lecture videos by Dr. Geetika Dua**  
<https://www.youtube.com/watch?v=R7WaykzESlg&list=PLeefXVKiX48rcnK0TentV2rXrQolhugpy>

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Game based learning – Kahoot Quizzes.
- Contents related activities (Activity-based discussions).
- For active participation of students, instruct the students to prepare Flowcharts and Handouts.
- Organizing Group wise discussions on issues.
- Seminars & Flip-classes.

<b>LOW POWER VLSI DESIGN</b>														
<b>Course Code</b>	21ECE643					<b>CIE Marks</b>					50			
<b>L:T:P:S</b>	3:0:0:0					<b>SEE Marks</b>					50			
<b>Hrs / Week</b>	3					<b>Total Marks</b>					100			
<b>Credits</b>	03					<b>Exam Hours</b>					03			
<b>Course outcomes:</b> At the end of the course, the student will be able to:														
21ECE643.1	Examine the sources of power dissipation in CMOS circuits													
21ECE643.2	Investigate the Impact of device and technology scaling on Low Power Electronics													
21ECE643.3	Inspect different low power circuit & Module techniques to design digital circuits													
21ECE643.4	Distinguish various architectural techniques for minimizing power in microprocessor & SRAM													
21ECE643.5	Analyze various energy recovery techniques in low power VLSI Design													
21ECE643.6	Compare research articles on low power design methodologies in VLSI Design													
<b>Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:</b>														
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>
21ECE643.1	3	3	-	-	2	-	-	-	-	-	-	1	3	2
21ECE643.2	3	3	2	-	2	-	-	-	-	-	-	1	3	2
21ECE643.3	3	3	2	-	2	-	-	-	-	-	-	1	3	2
21ECE643.4	3	3	2	-	2	-	-	-	-	-	-	1	3	2
21ECE643.5	3	3	2	-	2	-	-	-	-	-	-	1	3	2
21ECE643.6	3	3	2	-	2	-	-	-	-	-	-	1	3	2
<b>MODULE-1 INTRODUCTION TO LOW POWER VLSI DESIGN 21ECE643.1 8 Hours</b>														
Need for Low Power VLSI Chips, Charging and Discharging Capacitances, Short circuit current in CMOS Circuits (Inverter), CMOS Leakage Current. Sources of Dissipation in Digital Integrated Circuits, Degrees of Freedom, Emerging Low Power Approaches – An Overview.														
Self-study	Design Constraints in IC technology, Investigate the battery capacity trends, Different types of Leakage current in CMOS Circuits.													
Text Book	Text Book 1: 1.1, 1.2, 1.3.1, 1.4. Text Book 2: 1.2, 1.3, 1.5													
<b>MODULE-2 DEVICE AND TECHNOLOGY IMPACT ON LOW POWER ELECTRONICS 21ECE643.2 8 Hours</b>														
Introduction, 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 Innovation.														
Applications	<i>Simulation Power Analysis, SPICE Circuit Simulation TEXT 1: 2</i>													
Text Book	Text Book 2: 2.1to 2.7													
<b>MODULE-3 LOW POWER CIRCUIT AND MODULE TECHNIQUES 21ECE643.3 8 Hours</b>														
Introduction, Power Consumption in Circuits, Flipflops and Latches, Logic, High capacitance Nodes. Low Power Arithmetic Components, Adder.														
Self-study	Low Power Arithmetic Components, Multipliers, Division													
Text Book	Text Book 2:3.1-3.5, 7.3													
<b>MODULE-4 ARCHITECTURE AND SYSTEM 21ECE643.4 8 Hours</b>														
Power and Performance management, Switching activity reduction, Parallel architecture with voltage reduction, Low Power SRAM Architecture, MOS Static RAM Memory Cell, Banked Organization of SRAMs, Reducing Voltage Swing on Bit lines.														

Self-study /	Reducing Power in Write Driver Circuits, Reducing Power in Sense Amplifier Circuits.		
Text Book	Text Book 1:7.1.1,7.2,7.3 Text Book 3: 6.1-6.5		
<b>MODULE-5</b>	<b>LOW ENERGY COMPUTING USING ENERGY RECOVERY TECHNIQUES</b>	<b>21ECE643.5, 21ECE643.6</b>	<b>8 Hours</b>
Energy Dissipation in Transistor channel using an RC Model, Energy Recovery Circuit Design, Design with Partially reversible Logic, Supply Clock Generation.			
Self-study	Energy recovery SRAM Core, Energy Dissipation in Memory Core		
Text Book	Text Book 3: 7.1, 7.2, 7.3, 7.3.1, 7.3.2,7.3.3, 7.4		
<b>CIE Assessment Pattern (50 Marks – Theory)</b>			
<b>RBT Levels</b>		<b>Marks Distribution</b>	
		<b>Test (s)</b>	<b>Qualitative Assessment (s) (NPTEL)</b>
		<b>25</b>	<b>25</b>
<b>L1</b>	<b>Remember</b>	<b>5</b>	<b>-</b>
<b>L2</b>	<b>Understand</b>	<b>5</b>	<b>5</b>
<b>L3</b>	<b>Apply</b>	<b>10</b>	<b>10</b>
<b>L4</b>	<b>Analyze</b>	<b>5</b>	<b>10</b>
<b>L5</b>	<b>Evaluate</b>	<b>-</b>	<b>-</b>
<b>L6</b>	<b>Create</b>	<b>-</b>	<b>-</b>
<b>SEE Assessment Pattern (50 Marks – Theory)</b>			
<b>RBT Levels</b>		<b>Exam Marks Distribution (50)</b>	
<b>L1</b>	<b>Remember</b>	<b>10</b>	
<b>L2</b>	<b>Understand</b>	<b>10</b>	
<b>L3</b>	<b>Apply</b>	<b>20</b>	
<b>L4</b>	<b>Analyze</b>	<b>10</b>	
<b>L5</b>	<b>Evaluate</b>	<b>-</b>	
<b>L6</b>	<b>Create</b>	<b>-</b>	
<b>Suggested Learning Resources:</b>			
<b>Text Books:</b>			
1. Practical Low Power Digital Low Power VLSI Design, Gary Yeap, 4 <sup>th</sup> edition, 2014, Springer International Edition.			
2. Low Power Design Methodologies, Jan M. Rabaey, Massoud Pedram, 2 <sup>nd</sup> edition 2014, Springer Science + Business Media, LLC.			
3. Low Power CMOS VLSI Circuit Design, Kaushik Roy, Sharat C. Prasad, 2015, Wiley India Pvt.Ltd.			
<b>Reference Books:</b>			
1. CMOS VLSI Design: A Circuit and System perspective, Neil H.E. Weste, David Harris, 4th Edition 2015, Pearson.			
<b>Web links and Video Lectures (e-Resources):</b>			
• <a href="https://archive.nptel.ac.in/courses/106/105/106105034/">https://archive.nptel.ac.in/courses/106/105/106105034/</a>			
• <a href="https://archive.nptel.ac.in/courses/106/105/106105161/">https://archive.nptel.ac.in/courses/106/105/106105161/</a>			
<b>Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning</b>			
• SPICE Simulation of VLSI Circuits to estimate the Power.			
• Video demonstration of the latest trends in VLSI Technology.			
• Contents related activities (Activity-based discussions)			
➤ For active participation of students, instruct the students to prepare Flowcharts and Handouts.			
➤ Organizing Group wise discussions on issues and Seminars.			

<b>OBJECT ORIENTED PROGRAMMING USING C++</b>														
<b>Course Code</b>	<b>21ECE644</b>					<b>CIE Marks</b>					<b>50</b>			
<b>L:T:P:S</b>	<b>3:0:0:0</b>					<b>SEE Marks</b>					<b>50</b>			
<b>Hrs / Week</b>	<b>3</b>					<b>Total Marks</b>					<b>100</b>			
<b>Credits</b>	<b>03</b>					<b>Exam Hours</b>					<b>03</b>			
<b>Course outcomes:</b>														
At the end of the course, the student will be able to:														
21ECE644.1	Articulate the fundamental concepts of object-oriented programming with C++													
21ECE644.2	Analyse the working of different operators in C++ for the development of C++ programs													
21ECE644.3	Apply the concepts of classes and objects to solve real world problems													
21ECE644.4	Compare the implementation of different Inheritations and overloading concepts													
21ECE644.5	Analyze the exception handling mechanism to handle Real-time problems													
21ECE644.6	Develop applications for real time problems using object-oriented programming techniques													
<b>Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:</b>														
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>
21ECE644.1	3	-	-	-	-	-	-	-	-	-	-	-	2	-
21ECE644.2	3	3	1	-	3	-	-	-	-	-	-	3	2	2
21ECE644.3	3	-	-	-	3	-	-	-	-	-	-	3	2	2
21ECE644.4	3	3	1	-	3	-	-	-	-	-	-	-	2	2
21ECE644.5	3	3	1	-	3	-	-	-	-	-	-	-	2	2
21ECE644.6	3	3	1	-	3	-	-	-	-	-	-	3	2	2
<b>MODULE-1 INTRODUCTION TO OOP 21ECE644.1 8 Hours</b>														
Introduction, Procedural Approach, Object-Oriented approach, Features of object-oriented programming, Introduction to C++, Structure of the C++, Data types, Control structures, Arrays and Strings, User defined types.														
Self-study		Explore how OOP is used in real-world software development projects.												
TEXT BOOK		TEXT BOOK 1: Chapter 1,2												
<b>MODULE-2 OBJECTS AND CONSTRUCTORS 21ECE644.2 8 Hours</b>														
Class, Data members and Member functions, Creating Objects of Class, Access Specifier, Scope Resolution Operator, Friend Functions and Friend Classes, Static Members, Comparison of class with structure, Purpose of Constructors and Destructors, Types of Constructors, Constructor Overloading, Invoking Constructors and Destructors.														
Self-study		Study how encapsulation helps in data hiding and protecting data within objects.												
Text Book		Text Book 1: Chapter 3, 6												
<b>MODULE-3 OPERATOR OVERLOADING 21ECE644.3 8 Hours</b>														
Introduction and Fundamentals of overloading, overloading of binary and unary operators, overloading of prefix and postfix operators, Dynamic memory management.														
Case-study		Develop a custom container class (e.g., a stack, queue, or linked list) with operator overloads for common container operations (e.g., push, pop, enqueue, dequeue).												
Text Book		Text Book 1: Chapter 10												
<b>MODULE-4 EXCEPTION HANDLING 21ECE644.4 21ECE644.6 8 Hours</b>														



Introduction, handling an attempt to divide by zero, re-throwing an exception, stack unwinding, when to use exception handling, Uncaught exception, bad exception Classes, and Built-In Exceptions. Exception Vs Error Handling, Assertion in C++.			
Self-study	Analyze real-world examples of exceptional situations and how it handled in software projects.		
Text Book	Text Book 1: Chapter 17		
<b>MODULE-5</b>	<b>INHERITANCE</b>	<b>21ECE644.5</b> <b>21ECE644.6</b>	<b>8 Hours</b>
Defining derived classes, protected access specifier in Base class, public, private & protected inheritance, constructors and destructors in derived classes, Types of Inheritances, Virtual base class.			
Applications	Implement inheritance to create a hierarchy of geometric shapes.		
Text Book	Text Book 1: Chapter 11		
<b>CIE Assessment Pattern (50 Marks - Theory)</b>			
<b>RBT Levels</b>		<b>Marks Distribution</b>	
		<b>Test (s)</b>	<b>Qualitative Assessment (s) (NPTEL)</b>
		<b>25</b>	<b>25</b>
<b>L1</b>	<b>Remember</b>	<b>5</b>	<b>-</b>
<b>L2</b>	<b>Understand</b>	<b>5</b>	<b>5</b>
<b>L3</b>	<b>Apply</b>	<b>10</b>	<b>10</b>
<b>L4</b>	<b>Analyze</b>	<b>5</b>	<b>10</b>
<b>L5</b>	<b>Evaluate</b>	<b>-</b>	<b>-</b>
<b>L6</b>	<b>Create</b>	<b>-</b>	<b>-</b>
<b>SEE Assessment Pattern (50 Marks - Theory)</b>			
<b>RBT Levels</b>		<b>Exam Marks Distribution (50)</b>	
<b>L1</b>	<b>Remember</b>	<b>10</b>	
<b>L2</b>	<b>Understand</b>	<b>10</b>	
<b>L3</b>	<b>Apply</b>	<b>20</b>	
<b>L4</b>	<b>Analyze</b>	<b>10</b>	
<b>L5</b>	<b>Evaluate</b>	<b>-</b>	
<b>L6</b>	<b>Create</b>	<b>-</b>	
<b>Suggested Learning Resources:</b>			
<b>Text Books:</b>			
1. C++-How to program, Paul Deital and Harvey Deital, 9 <sup>th</sup> Edition,2014, Pearson.			
2. The Complete Reference C++, Herbert Schildt, 4 <sup>th</sup> Edition, 2003, Tata McGraw Hill.			
<b>Reference Books:</b>			
1. C++ Primer, Stanley B. Lippman, JoseeLajoie, Barbara E. Moo, 5 <sup>th</sup> Edition, 2012, Addison Wesley.			
2. The C++ programming language, Bjarne Stroustrup, 4 th Edition, 2013, Pearson.			
<b>Web links and Video Lectures (e-Resources):</b>			
• <a href="#">C++ Programming Language - GeeksforGeeks</a>			
• <a href="https://onlinecourses.nptel.ac.in/noc19_cs38/">https://onlinecourses.nptel.ac.in/noc19_cs38/</a>			
<b>Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning</b>			
• Conduct on spot problem solving based on C++			
• Develop simple GUI interfaces for a computer program to interact with users			

<b>BIO INSPIRED DESIGN AND INNOVATION</b>														
<b>Course Code</b>	<b>21ECE645</b>								<b>CIE Marks</b>			<b>50</b>		
<b>L:T:P:S</b>	<b>3:0:0:0</b>								<b>SEE Marks</b>			<b>50</b>		
<b>Hrs / Week</b>	<b>3</b>								<b>Total Marks</b>			<b>100</b>		
<b>Credits</b>	<b>03</b>								<b>Exam Hours</b>			<b>03</b>		
<b>Course outcomes:</b>														
At the end of the course, the student will be able to:														
21ECE645.1	Verify the biomimetics principles in relation to the needs at that moment													
21ECE645.2	Evaluate the bio-material properties for health care applications													
21ECE645.3	Investigate novel bioengineering initiatives by evaluating design and development principles													
21ECE645.4	Formulate bio-based solutions for socially vital issues with critical thought													
21ECE645.5	Comprehend the bio computing optimization through research and experiential learning													
21ECE645.6	Review the fundamental biological ideas through pertinent industrial applications and case studies													
<b>Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:</b>														
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>
21ECE645.1	3	3	3	3	2	-	-	-	1	1	-	2	2	1
21ECE645.2	3	3	3	3	2	-	-	-	1	1	-	2	2	1
21ECE645.3	3	3	3	3	2	-	-	-	1	1	-	2	2	1
21ECE645.4	3	3	3	3	2	-	-	-	1	1	-	2	2	1
21ECE645.5	3	3	3	3	2	-	-	-	1	1	-	2	2	1
21ECE645.6	3	3	3	3	2	-	-	-	1	1	-	2	2	1
<b>MODULE-1 BIO-INSPIRED DESIGN AND ENGINEERING 21ECE645.1 8 Hours</b>														
Bio-Inspired Engineering and design, History, Evolution, Basics of Biomimetics and other Disciplines, Rawling's Classifications, Need for Bio-Inspired Designs. Bio inspired Additive manufacturing techniques, (self-healing, self-assembly).														
Self-study / Case Study / Applications			Investigate the Challenges of Bio inspired design, Compare with traditional areas of science and engineering.											
Text Book			Text Book 1: 1.2, 1.3, 1.4, 1.13, 1.15, 1.16											
<b>MODULE-2 BIO MATERIALS AND BIO HEALTHCARE DESIGN 21ECE645.2 8 Hours</b>														
Biomaterials, Design of Forms- (Hexagonal unit cells, Intrinsic disorder, anisotropy), Design of materials- (Hierarchy, fracture tough materials, structural colours, Actuating Materials, Bio-Compatible Materials). Bio-Mechanics, Applications of Biomaterials and Bio systems in Health care design (Human Prosthetics, Parasitic Wasp-Inspired Needle, Octopus-Inspired Sucker for Tissue Grafting, Peacock-Inspired Biosensors, Gecko-Inspired Surgical Glue) Robotics, Marine and Aeronautical.														
Self-study / Case Study / Applications			Investigate Bio-Compatible alloys and polymers for human implants and health care applications.											
Text Book			Text Book 1: 2.2, 2.3, 2.4 to 2.15											
<b>MODULE-3 BIO SUSTAINABLE DEVELOPMENT 21ECE645.3, 21ECE645.4 8 Hours</b>														
Innovations in Energy (Termite mound inspired shopping malls), Innovations in Resource-Air (purification, filtration), Dew water collection systems, water purification, desalination, Management of spaces, designs for megastructures.														

Self-study / Case Study / Applications	Explore the Bio inspired environmental constructions and development.		
Text Book	Text Book 2: 3.1, 3.3, 3.5, 3.7, 3.10		
<b>MODULE-4</b>	<b>BIO COMPUTING AND OPTIMISATION</b>	<b>21ECE645.5</b>	<b>8 Hours</b>
No Free Lunch Theorem, Bat Algorithm, Flower Pollination Algorithm, Genetic Algorithm- Crossover and Mutation Operations. Bio-Inspired Optimisation, Ant Colony Optimisation (ACO), Swam Intelligence-Particle Swam Optimisation (PSO).			
Self-study / Case Study / Applications	Scrutinize the Different types of Optimization techniques, genetic research.		
Text Book	Text Book 1: 6.1, 6.3, 6.5, 6.7, Text Book 2: 10.1, 10.3, 10.5, 10.7		
<b>MODULE-5</b>	<b>APPLICATIONS OF BIO-INSPIRED INNOVATIONS</b>	<b>21ECE645.6</b>	<b>8 Hours</b>
Bioinspired innovations in– Automotive, Automation, Materials and Manufacturing, Sensors, Controllers, Communications, Healthcare, Agriculture, food production, and Sports, Environment infrastructure. Carbon Neutral Solutions (Coral Reefs, Eco-cements), Carbon Free Solutions (Lotus leaf inspired paints), eco-restorations (Eco-friendly pesticide).			
Self-study / Case Study / Applications	Survey on Bio inspired Innovations, design, applications and case studies of the same.		
Text Book	Text Book 2: 12.1 to 12.10		
<b>CIE Assessment Pattern (50 Marks - Theory)</b>			
<b>RBT Levels</b>		<b>Marks Distribution</b>	
		<b>Test (s)</b>	<b>Qualitative Assessment (s) (NPTEL)</b>
		<b>25</b>	<b>25</b>
<b>L1</b>	<b>Remember</b>	5	-
<b>L2</b>	<b>Understand</b>	5	5
<b>L3</b>	<b>Apply</b>	10	10
<b>L4</b>	<b>Analyze</b>	5	10
<b>L5</b>	<b>Evaluate</b>	-	-
<b>L6</b>	<b>Create</b>	-	-
<b>SEE Assessment Pattern (50 Marks - Theory)</b>			
<b>RBT Levels</b>		<b>Exam Marks Distribution (50)</b>	
<b>L1</b>	<b>Remember</b>	10	
<b>L2</b>	<b>Understand</b>	10	
<b>L3</b>	<b>Apply</b>	10	
<b>L4</b>	<b>Analyze</b>	10	
<b>L5</b>	<b>Evaluate</b>	10	
<b>L6</b>	<b>Create</b>	--	
<b>Suggested Learning Resources:</b>			
<b>Text Books:</b>			
1)Helena Hashemi Farzaneh, Udo Lindemann, “A Practical Guide to Bio-inspired Design”, Springer Vieweg, 1st edition 2019, ISBN-10 : 366257683X, ISBN-13 : 978-3662576830			
2)Torben A. Lenau, Akhlesh Lakhtakia,” Biologically Inspired Design: A Primer (Synthesis Lectures on Engineering, Science, and Technology)”, Publisher: Morgan & Claypool Publishers, 2021, ISBN-10: 1636390471, ISBN-13: 978-1636390475			

**Reference Books:**

- 1) French M, "Invention and evolution: Design in nature and engineering", Publisher: Cambridge University Press, 2020
- 2) Pan L., Pang S., Song T. and Gong F. eds, "Bio-Inspired Computing: Theories and Applications", 15th International Conference, BIC-TA 2020, Qingdao, China, October 23-25, 2020, Revised Selected Papers (Vol. 1363). Springer Nature, 2021
- 3) Wann D, "Bio Logic: Designing with nature to protect the environment", Wiley Publisher, 1994

**Web links and Video Lectures (e-Resources):**

- [https://onlinecourses.nptel.ac.in/noc22\\_ge24/preview](https://onlinecourses.nptel.ac.in/noc22_ge24/preview)
- <https://biodesign.berkeley.edu/bioinspired-design-course/>
- <https://www.youtube.com/watch?v=cwxXY9Qe8ss>
- <https://www.youtube.com/watch?v=V2GvOXvjhLA>
- <https://nsf-gov-resources.nsf.gov/2023-03/Bio-inspired%20Design%20Workshop%20Report%202232327%20October%202022%20Final.508.pdf>

**Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**

Contents related activities (Activity-based discussions)

- For active participation of students, instruct the students to prepare Flowcharts and Handouts.
- Organizing Group wise discussions on issues.
- Seminars.

<b>SOCIAL CONNECT &amp; RESPONSIBILITY</b>														
<b>Course Code</b>	<b>21ECK65</b>					<b>CIE Marks</b>			<b>50</b>					
<b>L:T:P:S</b>	<b>0:0:1:0</b>					<b>SEE Marks</b>			<b>50</b>					
<b>Hrs / Week</b>	<b>02</b>					<b>Total Marks</b>			<b>100</b>					
<b>Credits</b>	<b>01</b>					<b>Exam Hours</b>			<b>02</b>					
<b>Course outcomes:</b>														
At the end of the course, the student will be able to:														
21ECK65.1	Realize social responsibility through societal activities													
21ECK65.2	Review the history and culture of city through community interaction													
21ECK65.3	Develop responsible connection for societal benefits													
21ECK65.4	Cultivate the best practices for diverse scenarios													
21ECK65.5	Build planning and organizational skills													
21ECK65.6	Develop deep drive into societal challenges being addressed by NGO(s), social enterprises & the Government													
<b>Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:</b>														
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>
21ECK65.1	-	-	-	-	-	3	2	2	3	2	-	1	-	-
21ECK65.2	-	-	-	-	-	3	2	2	3	2	-	1	-	-
21ECK65.3	-	-	-	-	-	3	2	2	3	2	-	1	-	-
21ECK65.4	-	-	-	-	-	3	2	2	3	2	-	1	-	-
21ECK65.5	-	-	-	-	-	3	2	2	3	2	-	1	-	-
21ECK65.6	-	-	-	-	-	3	2	2	3	2	-	1	-	-
<b>MODULE-1</b>	<b>PLANTATION AND ADOPTION OF A TREE</b>					<b>21ECK65.1, 21ECK65.2</b>			<b>3 Hours</b>					
Plantation of a tree that will be adopted for four years by a group of B.E students. They will also execute a documentary or a photoblog describing the plant's origin, its usage in daily life, and its appearance in folklore and literature.														
<b>MODULE-2</b>	<b>HERITAGE WALK AND CRAFTS CORNER</b>					<b>21ECK65.1, 21ECK65.2, 21ECK65.3</b>			<b>3 Hours</b>					
Heritage tour, knowing the history and culture of the city, connecting to people around through their history, knowing the city and its craftsman, photoblog and documentary on evolution and practice of various craft forms.														
<b>MODULE-3</b>	<b>ORGANIC FARMING AND WASTE MANAGEMENT</b>					<b>21ECK65.4, 21ECK65.5</b>			<b>3 Hours</b>					
Usefulness of organic farming, wet waste management in neighboring villages, and implementation in the campus.														
<b>MODULE-4</b>	<b>WATER CONSERVATION</b>					<b>21ECK65.4, 21ECK65.5, 21ECK65.6</b>			<b>3 Hours</b>					
Knowing the present practices in the surrounding villages and implementation in the campus, documentary or photo blog presenting the current practices.														

Self-study / Case Study / Applications	Water Conservation in a Manufacturing Company.												
<b>MODULE-5</b>	<b>FOOD WALK</b>	<b>21ECK65.3, 21ECK65.4</b>	<b>3 Hours</b>										
City's culinary practices, food lore, and indigenous materials of the region used in cooking.													
Self-study / Case Study / Applications	Create Mobile app to provide a user-friendly platform for food walk enthusiasts, both residents and tourists in order to explore the city's diverse food culture.												
<b>CIE Assessment Pattern (50 Marks – Activity based)</b>													
<ul style="list-style-type: none"> <li>Each module is evaluated for 50 Marks and average of all the five modules will be the final marks.</li> </ul>													
<table border="1"> <thead> <tr> <th>CIE component for each module</th> <th>Marks</th> </tr> </thead> <tbody> <tr> <td>Planning and scheduling the social connect</td> <td>15</td> </tr> <tr> <td>Information/Data collected during the social connect</td> <td>15</td> </tr> <tr> <td>Analysis of the information/data and report writing</td> <td>20</td> </tr> <tr> <td><b>Total (each module)</b></td> <td><b>50</b></td> </tr> </tbody> </table>				CIE component for each module	Marks	Planning and scheduling the social connect	15	Information/Data collected during the social connect	15	Analysis of the information/data and report writing	20	<b>Total (each module)</b>	<b>50</b>
CIE component for each module	Marks												
Planning and scheduling the social connect	15												
Information/Data collected during the social connect	15												
Analysis of the information/data and report writing	20												
<b>Total (each module)</b>	<b>50</b>												
<b>SEE Assessment Pattern (50 Marks – Activity based)</b>													
<table border="1"> <thead> <tr> <th>SEE</th> <th>Marks</th> </tr> </thead> <tbody> <tr> <td>Presentation</td> <td>20</td> </tr> <tr> <td>Jamming session / Open Mic</td> <td>15</td> </tr> <tr> <td>Group discussion / debate</td> <td>15</td> </tr> <tr> <td><b>Total</b></td> <td><b>50</b></td> </tr> </tbody> </table>				SEE	Marks	Presentation	20	Jamming session / Open Mic	15	Group discussion / debate	15	<b>Total</b>	<b>50</b>
SEE	Marks												
Presentation	20												
Jamming session / Open Mic	15												
Group discussion / debate	15												
<b>Total</b>	<b>50</b>												
<b>Activity-Based Learning / Practical Based learning</b>													
<ul style="list-style-type: none"> <li>Platform to connect to others and share the stories with others: <ul style="list-style-type: none"> <li>Jamming session</li> <li>Open mic</li> <li>Poetry</li> </ul> </li> <li>Share the experience of Social Connect.</li> <li>Exhibit the talent like playing instruments, singing, one-act play, art-painting, and fine art.</li> </ul>													

**Pedagogy:**

- The students will be divided into groups. Each group will be handled by faculty mentor.
- Faculty mentor will design the activities (particularly Jamming sessions, open mic and poetry)
- The course is mainly activity-based that will offer a set of activities for the student that enables them to connect with fellow human beings, nature, society, and the world at large.
- The course will engage students for interactive sessions, open mic, reading group, storytelling sessions, and semester-long activities conducted by faculty mentors.
- Students should present the progress of the activities as per the schedule in the prescribed practical session in the field.
- There should be positive progress in the vertical order for the benefit of society in general through activities.

**Plan of Action:**

- Each student should do activities according to the scheme and syllabus.
- At the end of semester student performance has to be evaluated by the faculty mentor for the assigned activity progress and its completion.
- At last consolidated report of all activities from 1<sup>st</sup> to 5<sup>th</sup>, compiled report should be submitted as per the instructions and scheme.
- Practice Session Description:
  - Lecture session in field to start activities
  - Students Presentation on Ideas
  - Commencement of activity and its progress
  - Execution of Activity
  - Case study-based Assessment, Individual performance
  - Sector/ Teamwise study and its consolidation
  - Videobased seminar for 10 minutes by each student at the end of semester with Report.

<b>Module Name</b>	<b>Group Size</b>	<b>Location</b>	<b>Magnitude</b>	<b>Activity</b>	<b>Reporting</b>
Plantation and adoption of a tree	03-05	Farmers Land or Roadside or Community area or institution's campus, anyone location to be selected.	Students must monitor till end of B Tech degree	Site selection Select suitable species in consultation with horticulture, forest or agriculture department. Interact with NGO/Industry and community to plant Tag the plant for continuous monitoring	Report shall be hand written with paintings, sketches, poster, video

Heritage walk and crafts corner	03-05	Preferably Within the city where institution is located or home town of the student group	One or two: One can be a structure or a heritage building the other can be heritage custom or practice	Survey in the form of questioner by connecting to the people and asking. No standard questioner to be given by faculty and has to be evolved involving students. Questions during survey can be asked in local language but report language is English.	and/or photograph with Geotag.
Waste management	03-05 More than one group Can be assigned one task based on magnitude of task.	Preferably in the near by villages and within the campus.	One	Report on importance and benefits of Waste management. Report on segregation, collection, transportation and disposal. Suggestion for composting. Visit near by village/location to sensitize farmers and public about waste management and also document	
Water Conservation	03-05	Rain water harvesting demonstration available in the campus or surroundings	One	Visit lakes/pond/river/drywell to involve on rejuvenation activity. Or Assessment of Water budget in the campus / village Report on traditional water conservation practices(to minimize wastage)	
Food Walk	03-05	Within the city where institution is located  Food culture of student's resident region	One	Survey local food centers and identify the specialty Identify and study the food ingredients Report on the regional foods Report on Medicinal values of the local food grains, and plants.	



<b>INNOVATION / ENTREPRENEURSHIP / SOCIETAL INTERNSHIP</b>														
<b>Course Code</b>	21ECE66					<b>CIE Marks</b>	50							
<b>L:T:P:S</b>	0:0:3:0					<b>SEE Marks</b>	50							
<b>Hrs / Week</b>	3					<b>Total Marks</b>	100							
<b>Credits</b>	03					<b>Exam Hours</b>	03							
<b>Course outcomes:</b>														
At the end of the course, the student will be able to:														
<b>21ECE66.1</b>	Apply the problem-solving skills to provide creative solutions towards sustainable development													
<b>21ECE66.2</b>	Promote innovation and sustainable development in different parts of society													
<b>21ECE66.3</b>	Develop practical insights for effectively applying appropriate technology in innovation and Entrepreneurship													
<b>21ECE66.4</b>	Create a conceptual framework towards global issues													
<b>Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:</b>														
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>
21ECE66.1	3	-		-	2	2	2	2	3	2	1	3	3	3
21ECE66.2	3	3	1	-	2	2	2	2	3	2	1	3	3	3
21ECE66.3	3	3	1	-	2	2	2	2	3	2	1	3	3	3
21ECE66.4	3	3	1	-	2	2	2	2	3	2	1	3	3	3
<b>CIE Assessment Pattern (50 Marks - Lab)</b>														
<b>RBT Levels</b>		<b>Exam Marks Distribution (50)</b>												
<b>L1</b>	<b>Remember</b>	-												
<b>L2</b>	<b>Understand</b>	-												
<b>L3</b>	<b>Apply</b>	20												
<b>L4</b>	<b>Analyze</b>	10												
<b>L5</b>	<b>Evaluate</b>	10												
<b>L6</b>	<b>Create</b>	10												
<b>SEE Assessment Pattern (50 Marks - Lab)</b>														
<b>RBT Levels</b>		<b>Exam Marks Distribution (50)</b>												
<b>L1</b>	<b>Remember</b>	-												
<b>L2</b>	<b>Understand</b>	-												
<b>L3</b>	<b>Apply</b>	20												
<b>L4</b>	<b>Analyze</b>	10												
<b>L5</b>	<b>Evaluate</b>	10												
<b>L6</b>	<b>Create</b>	10												

### MINI PROJECT

<b>Course Code</b>	<b>21ECE67</b>	<b>CIE Marks</b>	<b>50</b>
<b>L:T:P:S</b>	<b>0:0:1:0</b>	<b>SEE Marks</b>	<b>50</b>
<b>Hrs / Week</b>	<b>0</b>	<b>Total Marks</b>	<b>100</b>
<b>Credits</b>	<b>01</b>	<b>Exam Hours</b>	<b>03</b>

**Course outcomes:**

At the end of the course, the student will be able to:

21ECE67.1	Identify technical aspects of the chosen project with a comprehensive and systematic approach
21ECE67.2	Review the literature and develop solutions for problem statement
21ECE67.3	Work as an individual or in a team in development of technical projects
21ECE67.4	Select appropriate tools/ technologies/ concepts to solve the problem
21ECE67.5	Write a report and communicate effectively through oral presentation in a team
21ECE67.6	Extend or use the idea in mini project for major project

**Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
21ECE67.1	3	3	-	-	-	-	-	-	3	-	-	-	3	3
21ECE67.2	3	3	3	3	2	-	-	-	3	3	3	3	3	3
21ECE67.3	3	3	3	-	-	-	-	-	-	3	3	3	3	3
21ECE67.4	3	3	3	-	-	-	-	3	3	3	3	3	3	3
21ECE67.5	3	3	3	-	-	-	-	3	3	3	3	3	-	-
21ECE67.6	3	3	3	3	-	3	1	3	3	3	3	3	3	3

**CIE Assessment Pattern (50 Marks)**

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	-
L3	Apply	20
L4	Analyze	10
L5	Evaluate	10
L6	Create	10

**SEE Assessment Pattern (50 Marks)**

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	-
L3	Apply	20
L4	Analyze	10
L5	Evaluate	10
L6	Create	10

<b>NATIONAL SERVICE SCHEME (NSS)</b>												
<b>Course Code</b>	<b>21NSS84</b>						<b>CIE Marks</b>	<b>50</b>				
<b>L:T:P:S</b>	<b>0:0:0:0</b>						<b>SEE Marks</b>	<b>50</b>				
<b>Hrs / Week</b>	<b>2</b>						<b>Total Marks</b>	<b>100</b>				
<b>Credits</b>	<b>00</b>						<b>Exam Hours</b>	<b>2</b>				
<b>Course outcomes:</b>												
At the end of the course, the student will be able to:												
21NSS84.1	Understand the importance of his / her responsibilities towards society											
21NSS84.2	Analyze the environmental and societal problems/issues and will be able to design solutions for the same.											
21NSS84.3	Evaluate the existing system and to propose practical solutions for the same for sustainable development.											
21NSS84.4	Implement government or self-driven projects effectively in the field.											
<b>Mapping of Course Outcomes to Program Outcomes:</b>												
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>
21NSS84.1	-	-	-	-	-	3	1	1	3	2	2	1
21NSS84.2	-	-	-	-	-	3	1	1	3	2	2	1
21NSS84.3	-	-	-	-	-	3	1	1	3	2	2	1
21NSS84.4	-	-	-	-	-	3	1	1	3	2	2	1
<b>Semester</b>	<b>CONTENT</b>										<b>HOURS</b>	
5 <sup>th</sup> to 8 <sup>th</sup>	<b><u>PART A</u></b>										Total 32 Hrs/ Semester  2 Hrs/week	
	ONENSS-CAMP @College/University/State or Central Govt Level/ NGO's/General Social Camps											
	<b><u>PART B</u></b>											
	1. Organic farming, Indian Agriculture (Past, Present and Future) Connectivity for marketing											
	2. Waste management–Public, Private and Govt organization,5R's.											
	3. Setting of the information imparting club for women leading to contribution in social and economic issues.											
	4. Water conservation techniques–Role of different stakeholders– Implementation.											
	5. Preparing an actionable business proposal for enhancing the village income and approach for implementation.											
	6. Helping local schools to achieve good results and enhance their enrolment in Higher/technical/vocational education.											
	7. Developing Sustainable Water management system for rural areas and implementation approaches.											

	<p>8. Contribution to any national level initiative of Government of India. For. eg. Digital India, Skill India, Swachh Bharat, Atmanirbhar Bharath, Make in India, Mudra scheme, Skill development programs etc.</p> <p>9. Spreading public awareness under rural outreach programs. (minimum 5 programs).</p> <p>10. Organize National integration and social harmony events/workshops / Seminars. (Minimum 02 programs).</p> <p>11. Govt. school Rejuvenation and helping them to achieve good infrastructure.</p>	
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**CIE Assessment Pattern (50 Marks - Practical) -**

1. **PART A:** Compulsorily students have to attend one camp.
2. **PART B:** Students have to take up anyone activity on the above said topics and have to prepare content for awareness and technical contents for implementation of the projects and have to present strategies for implementation of the same.
3. CIE will be evaluated based on their presentation, approach and implementation strategies.

CIE Components	Marks
Presentation 1-Selection of topic- (phase 1)	10
Experiential Learning Presentation 2 (phase 2)	10
Case Study-based Teaching-Learning	10
Sector-wise study & consolidation	10
Video based seminar (4-5 minutes per student)	10
<b>Total</b>	<b>50</b>

**SEE Assessment Pattern (50 Marks - Practical)**

- Implementation strategies of the project with report duly signed by the Dept's Coordinator, HoD and Principal.
- At last it should be evaluated by the NSS Coordinator.
- Finally consolidated report should be sent to the University.

**Suggested Learning Resources:**

**Reference Books:**

1. NSS Course Manual, Published by NSS Cell, VTU Belagavi.

**Pre-requisites to take this Course:**

1. Students should have a service-oriented mindset and social concern.
2. Students should have dedication to work at any remote place, anytime with available resources and proper time management for the other works.
3. Students should be ready to sacrifice some of the time and wishes to achieve service-oriented targets on time.

<b>PHYSICAL EDUCATION (PE) (SPORTS AND ATHLETICS)</b>												
<b>Course Code</b>	<b>21PES84</b>						<b>CIE Marks</b>			<b>50</b>		
<b>L:T:P:S</b>	<b>0:0:0:0</b>						<b>SEE Marks</b>			<b>50</b>		
<b>Hrs / Week</b>	<b>2</b>						<b>Total Marks</b>			<b>100</b>		
<b>Credits</b>	<b>00</b>						<b>Exam Hours</b>			<b>02</b>		
<b>Course outcomes:</b>												
At the end of the course, the student will be able to:												
21PES84.1	Demonstrate the starting and finishing positions of different track and jump events.											
21PES84.2	Demonstrate the holding and releasing stances in various throwing events, and takeoff and landing position in various jumping events of Athletics.											
21PES84.3	Demonstrate the specific skills and techniques of the selected game/event.											
21PES84.4	Demonstrate and describe the rules and regulations of specific games.											
<b>Mapping of Course Outcomes to Program Outcomes:</b>												
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>
21PES84.1	-	-	-	-	-	-	-	1	2	-	-	1
21PES84.2	-	-	-	-	-	-	-	1	2	-	-	1
21PES84.3	-	-	-	-	-	-	-	1	2	-	-	1
21PES84.4	-	-	-	-	-	-	-	1	2	-	-	1
<b>Semester</b>												
<b>CONTENT</b>												
<b>HOURS</b>												
<b>5th</b>	<p><b>Fitness Components:</b> Meaning and Importance, Fit India Movement, Definition of fitness, Components of fitness, Benefits of fitness, Types of fitness and Fitness tips.</p> <p><b>Practical Components:</b> Speed, Strength, Endurance, Flexibility, and Agility</p> <p><b>Athletics:</b></p> <ol style="list-style-type: none"> <li>Track -Sprints: <ul style="list-style-type: none"> <li>Starting Techniques: Standing start and Crouch start(its variations)use of Starting Block.</li> <li>Acceleration with proper running techniques.</li> <li>Finishing technique: Run Through, Forward Lunging and Shoulder Shrug.</li> </ul> </li> <li>Jumps- Long Jump: Approach Run, Take-off, Flight in the air (Hang Style/Hitch Kick)and Landing</li> <li>Throws- Shot Put: Holding the Shot, Placement, Initial Stance, Glide, Delivery Stance and Recovery (Perry O'Brien Technique)</li> </ol> <p style="text-align: center;"><b>Kabaddi OR Kho-Kho</b></p> <p><b>Kabaddi:</b></p> <ol style="list-style-type: none"> <li>Fundamental skills <ol style="list-style-type: none"> <li>Skills in Raiding: Touching with hands, Use of leg-toe touch, squat leg thrust, side kick, mule kick, arrow fly kick, crossing of baulk line. Crossing of Bonus line.</li> <li>Skills of holding the raider: Various formations, catching from particular position, different catches, catching formation and techniques.</li> <li>Additional skills in raiding: Escaping from various holds, techniques of escaping from chain formation, offense and defense.</li> <li>Game practice with application of Rules and Regulations.</li> </ol> </li> <li>Rules and their interpretations and duties of the officials.</li> </ol>											Total 32 Hrs/ Semester  2 Hrs/week

	<p><b>Kho-Kho:</b>  A Fundamental skills  1. Skills in Chasing: Sit on the box (Parallel &amp; Bullet toe method), Get up from the box (Proximal &amp; Distal foot method), Give Kho (Simple, Early, Late &amp; Judgment), Pole Turn, Pole Dive, Tapping, Hammering, Rectification of foul.  2. Skills in running: Chain Play, Ring play and Chain &amp; Ring mixed play.  3. Game practice with application of Rules and Regulations.</p> <p>B. Rules and their interpretations and duties of the officials.</p>	
6th	<p><b>Athletics:</b>  1. Track -110 Mtrs and 400Mtrs:  <ul style="list-style-type: none"> <li>• Hurdling Technique: Lead leg Technique, Trail leg Technique, Side Hurdling, Over the Hurdles</li> <li>• Crouch start (its variations) use of Starting Block.</li> <li>• Approach to First Hurdles, In Between Hurdles, Last Hurdles to Finishing.</li> </ul> 2. Jumps- High jump: Approach Run, Take-off, Bar Clearance (Straddle) and Landing.  3. Throws- Discus Throw: Holding the Discus, Initial Stance Primary Swing, Turn, Release and Recovery (Rotation in the circle).</p> <p style="text-align: center;"><b>Volleyball OR Throw Ball</b></p> <p><b>Volleyball:</b>  A. Fundamental skills  1. Service: Under arm service, Side arm service, Tennis service, Floating service.  2. Pass: Under arm pass, Over-head pass.  3. Spiking and Blocking.  4. Game practice with application of Rules and Regulations</p> <p>B. Rules and their interpretation and duties of officials.</p> <p><b>Throw Ball:</b>  A. Fundamental skills:  Over hand service, Side arm service, two hand catching, one hand over head return, side arm return.  B. Rules and their interpretations and duties of officials</p> <p style="text-align: center;"><b>Football OR Hockey</b></p> <p><b>Football:</b>  A. Fundamental Skills  1. Kicking: Kicking the ball with inside of the foot, Kicking the ball with Full Instep of the foot, Kicking the ball with Inner Instep of the foot, Kicking the ball with Outer Instep of the foot and Lofted Kick.  2. Trapping: Trapping- the Rolling ball, and the Bouncing ball with sole of the foot.  3. Dribbling: Dribbling the ball with Instep of the foot, Dribbling the ball with Inner and Outer Instep of the foot.  4. Heading: In standing, running and jumping condition.  5. Throw-in: Standing throw-in and Running throw-in.  6. Feinting: With the lower limb and upper part of the body.</p>	

	<p>7. Tackling: Simple Tackling, Slide Tackling.</p> <p>8. Goal Keeping: Collection of Ball, Ball clearance-kicking, throwing and deflecting.</p> <p>9. Game practice with application of Rules and Regulations.</p> <p>C. Rules and their interpretation and duties of officials.</p> <p><b>Hockey:</b></p> <p>A. Fundamental Skills</p> <ol style="list-style-type: none"> <li>1. Passing: Short pass, Longpass, pushpass, hit</li> <li>2. Trapping.</li> <li>3. Dribbling and Dozing</li> <li>4. Penalty stroke practice.</li> <li>5. Penalty corner practice.</li> <li>6. Tackling: Simple Tackling, Slide Tackling.</li> <li>7. Goal Keeping, Ball clearance- kicking, and deflecting.</li> <li>8. Game practice with application of Rules and Regulations.</li> </ol> <p>B. Rules and their interpretation and duties of officials.</p>	
7th	<p><b>Athletics:</b></p> <ol style="list-style-type: none"> <li>1. Track -Relay Race: <ul style="list-style-type: none"> <li>• Starting, Baton Holding/Carrying, Baton Exchange in between zone, and Finishing</li> <li>• Crouch start (its variations) use of Starting Block.</li> <li>• Approach to First Hurdles, In Between Hurdles, Last Hurdles to Finishing.</li> </ul> </li> <li>2. Jumps- Triple Jump: Approach Run, Take-off, Flight in the Hop, Step, Jump and Landing</li> <li>3. Throws- Javelin Throw: Grip, Carry, and Recovery (3/5 Impulse stride). Release</li> </ol> <p style="text-align: center;"><b>Cricket OR Baseball</b></p> <p><b>Cricket:</b></p> <p>A. Fundamental skills</p> <ol style="list-style-type: none"> <li>1. Batting- Forward Defense Stroke, Backward Defense Stroke, OffDrive, On Drive, Straight Drive, Cover Drive, Square Cut.</li> <li>2. Bowling-Out-swing, In-swing Off Break, Leg Break and Googly.</li> <li>3. Fielding: Catching - The High Catch, The Skim Catch, The Close Catch and throwing at the stumps from different angles. Long Barrier and Throw, Short Throw, Long Throw, Throwing on the Turn.</li> <li>4. Wicket Keeping</li> </ol> <p>B. Rules and their interpretation and duties of officials.</p> <p><b>Baseball:</b></p> <p>A. Fundamental skills:</p> <ol style="list-style-type: none"> <li>1. Player Stances – walking, extending walking, L stance, cat stance Grip – standard grip, choke grip</li> <li>2. Batting – swing and bunt.</li> <li>3. Pitching</li> <li>4. Baseball: slider, fast pitch, curve ball, drop ball, rise ball, change up, knuckle ball, screw ball</li> </ol> <p>B. Rules and their interpretations and duties of officials</p> <p style="text-align: center;"><b>Basketball OR Net Ball</b></p>	

	<p><b>Basketball:</b></p> <p>A. Fundamental Skills</p> <ol style="list-style-type: none"> <li>1. Passing: Two hand Chest Pass, Two hands Bounce Pass, One hand Baseball Pass, Side arm Pass, Overhead Pass, Hook Pass.</li> <li>2. Receiving: Two hand receiving, One hand receiving, Receiving in stationary position, Receiving while Jumping and Receiving while Running.</li> <li>3. Dribbling: How to start dribble, drop dribble, High Dribble, Low Dribble, Reverse Dribble, Rolling Dribble.</li> <li>4. Shooting: Lay-up shot and its variations, One hand set shot, Two hands jump shot, Hook shot, Free Throw.</li> <li>5. Rebounding: Defensive rebound and Offensive rebound.</li> <li>6. Individual Defence: Guarding the player with the ball and without the ball, Pivoting.</li> <li>7. Game practice with application of Rules and Regulations.</li> </ol> <p><b>Netball:</b></p> <p>A. Fundamental Skills</p> <ol style="list-style-type: none"> <li>1. Catching: one handed, two handed, with feet grounded and in flight.</li> <li>2. Throwing (Different passes and their uses): One hand passes (shoulder, high shoulder, underarm, bounce, lob), two hand passes (Push, overhead and bounce).</li> <li>3. Footwork: Landing on one foot, landing on two feet, Pivot, Running pass.</li> <li>4. Shooting: One hand, forward step shot, and backward step shot.</li> <li>5. Techniques of free dodge and sprint, sudden sprint, sprint and stop, sprinting with change at speed.</li> <li>6. Defending: Marking the player, marking the ball, blocking, inside the circle, outside the circle. Defending the circle edge against the passing.</li> <li>7. Intercepting: Pass and shot.</li> <li>8. Game practice with application of Rules and Regulations.</li> </ol> <p>B. Rules and their interpretation and duties of officials.</p>	
<p><b>8th</b></p>	<p><b>Athletics:</b></p> <p>A. Track -Combined Events:</p> <ol style="list-style-type: none"> <li>a. Heptathlon all the 7 events</li> <li>b. Decathlon: All 10 Events</li> </ol> <p>B. Jumps- Pole Vault: Approach Run, Planting the Pole, Take-off, Bar Clearance and Landing.</p> <p>C. Throws- Hammer Throw: Holding the Hammer, Initial Stance Primary Swing, Turn, Release and Recovery (Rotation in the circle).</p> <p style="text-align: center;"><b>Shuttle Badminton OR Table Tennis</b></p> <p><b>Shuttle Badminton:</b></p> <p>A. Fundamental skills</p> <p>D. Basic Knowledge: Various parts of the Racket and Grip.</p> <p>E. Service: Short service, Long service, Long-high service.</p> <p>F. Shots: Over head shot, Defensive clear shot, Attacking clear shot, Drop shot, Net shot, Smash.</p> <p>G. Game practice with application of Rules and Regulations.</p> <p>B. Rules and their interpretation and duties of officials.</p> <p><b>Table Tennis:</b></p> <p>A. Fundamental skills:</p> <ol style="list-style-type: none"> <li>1. Basic Knowledge: Various parts of the Racket and Grip(Shake Hand &amp; PenHold Grip).</li> <li>2. Stance: Alternate &amp; Parallel.</li> </ol>	



3. Push and Service: Backhand & Forehand.
  4. Chop: Backhand & Forehand.
  5. Receive: Push and Chop with both Backhand & Forehand.
  6. Game practice with application of Rules and Regulations.
- B. Rules and their interpretations and duties of officials

**Handball OR Ball Badminton**

**Handball:**

- A. Fundamental Skills
1. Catching, Throwing and Ball control,
  2. Goal Throws: Jumpshot, Centershot, Diveshot, Reverseshot.
  3. Dribbling: High and low.
  4. Attack and counter attack, simple counter attack, counter attack from two wings and center.
  5. Blocking, Goal Keeping and Defensive skills.
  6. Game practice with application of Rules and Regulations.
- B. Rules and their interpretations and duties of officials

**Ball badminton:**

- A. Fundamental Skills
1. Basic Knowledge: Various parts of the Racket and Grip.
  2. Service: Short service, Long service, Long-high service.
  3. Shots: Overhead shot, Defensive clearshot, Attacking clearshot, Dropshot, Netshot, Smash.
  4. Game practice with application of Rules and Regulations.
- B. Rules and their interpretation and duties of officials.

**CIE Assessment Pattern (50 Marks – Practical) –**

CIE to be evaluated every semester end based on practical demonstration of Sports and Athletics activities learnt in the semester.

CIE	Marks
5 <sup>th</sup> Semester	10
6 <sup>th</sup> Semester	10
7 <sup>th</sup> Semester	15
8 <sup>th</sup> Semester	15
<b>Total</b>	<b>50</b>

**SEE Assessment Pattern (50 Marks – Practical)**

SEE	Marks
Athletics	20
Kabaddi OR Kho-Kho	05
Volleyball / Throw ball	05
Football/Hockey	05
Netball/Basketball	05
Shuttle Badminton / Table Tennis	05
Handball/ Badminton	05
<b>Total</b>	<b>50</b>

**Suggested Learning Resources:**

**Reference Books:**

1. Saha, A.K. Sarir Siksher Ritiniti, Rana Publishing House, Kalyani.
2. Bandopadhyay, K. Sarir Siksha Parichay, Classic Publishers, Kolkata.

3. Petipus, etal. Athlete's Guide to Career Planning, Human Kinetics.
4. Dharma,P.N. Fundamentals of Track and Field, Khel Sahitya Kendra, NewDelhi.
5. Jain,R. Play and Learn Cricket, Khel Sahitya Kendra, New Delhi.
6. Vivek Thani, Coaching Cricket ,Khel Sahitya Kendra, NewDelhi.
7. Saha,A.K.Sarir SiksherRitiniti,RanaPublishingHouse,Kalyani.
8. Bandopadhyay,K. Sarir Siksha Parichay, Classic Publishers, Kolkata
9. Naveen Jain, Play and Learn Basketball, Khel Sahitya Kendra, NewDelhi.
10. Dubey,H.C. Basketball, Discovery Publishing House, NewDelhi.
11. RachanaJain, Teach Yourself Basketball, Sports Publication.
12. JackNagle,Power Pattern Offences for Winning basketball,ParkerPublishingCo.,NewYork.
13. RenuJain, Play and Learn Basketball, Khel Sahitya Kendra,NewDelhi.
14. SallyKus, Coaching Volleyball Successfully, HumanKinetics.
15. Saha, A. K. Sarir Siksher Ritiniti, Rana Publishing House, Kalyani.
16. Bandopadhyay, K.Sarir Siksha Parichay, Classic Publishers, Kolkata

YOGA												
Course Code	21YOG84						CIE Marks	50				
L:T:P:S	0:0:0:0						SEE Marks	50				
Hrs / Week	2						Total Marks	100				
Credits	00						Exam Hours	02				
<b>Course outcomes:</b>												
At the end of the course, the student will be able to:												
21YOG84.1	Use Yogasana practices in an effective manner											
21YOG84.2	Become familiar with an authentic foundation of Yogic practices											
21YOG84.3	Practice different Yogic methods such as Suryanamaskara, Pranayama and some of the Shat Kriyas											
21YOG84.4	Use the teachings of Patanjali in daily life.											
<b>Mapping of Course Outcomes to Program Outcomes:</b>												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
21YOG84.1	-	-	-	-	-	3	-	-	2	-	-	1
21YOG84.2	-	-	-	-	-	3	-	-	2	-	-	1
21YOG84.3	-	-	-	-	-	3	-	-	2	-	-	1
21YOG84.4	-	-	-	-	-	3	-	-	2	-	-	1
<b>Semester</b>												
<b>CONTENT</b>												
<b>HOURS</b>												
5th	<p><b>Introduction of Yoga:</b> Aim and Objectives of yoga, Prayer: Yoga, its origin, history and development. Yoga, its meaning, definitions. Different schools of yoga, importance of prayer</p> <p><b>Brief introduction of yogic practices for common man:</b> Yogic practices for common man to promote positive health</p> <p><b>Rules and regulations:</b> Rules to be followed during yogic practices by practitioner</p> <p><b>Misconceptions of yoga:</b> Yoga its misconceptions, Difference between yogic and non-yogic practices.</p> <p><b>Suryanamaskara:</b></p> <ol style="list-style-type: none"> <li>1. Suryanamaskar prayer and its meaning, Need, importance and benefits of Suryanamaskar.</li> <li>2. Suryanamaskar 12 count, 2 rounds</li> </ol> <p><b>Kapalabhati:</b> Meaning, importance and benefits of Kapalabhati - 40 strokes/min 3 rounds</p> <p><b>Different types of Asanas:</b></p> <ol style="list-style-type: none"> <li>1. Sitting: Padmasana, Vajrasana, Sukhasana</li> <li>2. Standing: Vrikshana, Trikonasana, Ardhakati Chakrasana</li> <li>3. Prone line: Bhujangasana, Shalabhasana</li> <li>4. Supine line: Utthitadvipadasana, Ardhalasana, Halasana</li> </ol> <p><b>Patanjali's Ashtanga Yoga:</b> Yama, Niyama</p> <p><b>Pranayama:</b> Suryanuloma - Viloma, Chandranuloma - Viloma</p>											Total 32 Hrs/ Semester  2 Hrs/week
	6th	<p><b>Suryanamaskara:</b> Suryanamaskar 12 count, 4 rounds</p> <p><b>Kapalabhati:</b> Revision of Kapalabhati - 60 strokes/min 3 rounds</p> <p><b>Different types of Asanas:</b></p> <ol style="list-style-type: none"> <li>1. Sitting: Paschimottanasana, Ardha Ushtrasana, Vakrasana, Aakarna Dhanurasana</li> <li>2. Standing: Parshva Chakrasana, Urdhva Hastothanasana, Hastapadasana</li> <li>3. Prone line: Dhanurasana</li> </ol>										

	<p>4. Supine line: Karna Peedasana, Sarvangasana, Chakraasana  <b>Patanjali's Ashtanga Yoga:</b> Asana, Pranayama  <b>Pranayama:</b> Chandra Bhedana, Nadishodhana, Surya Bhedana</p>	
<b>7th</b>	<p><b>Suryanamaskara:</b> Suryanamaskar 12 count,8rounds  <b>Kapalabhati:</b> Revision of Kapalabhati - 80strokes/min3rounds  <b>Different types of Asanas:</b></p> <ol style="list-style-type: none"> <li>1. Sitting: Yogamudra in Padmasana, Vibhakta Paschimottanasana, Yogamudra in Vajrasana</li> <li>2. Standing: Parivritta Trikonasana, Utkatasana, Parshvakonasana</li> <li>3. Prone line: Padangushtha Dhanurasana, Poorna Bhujangasana / Rajakapotasana</li> <li>4. Supine line: Navasana/Noukasana, Pavanamuktasana, Sarvangasana</li> </ol> <p><b>Patanjali's Ashtanga Yoga:</b> Pratyahara, Dharana  <b>Pranayama:</b> Ujjayi, Sheetal, Sheektari</p>	
<b>8th</b>	<p><b>Suryanamaskara:</b> Suryanamaskar 12 count,12rounds  <b>Kapalabhati:</b> Revision of Kapalabhati - 100strokes/min3rounds  <b>Different types of Asanas:</b></p> <ol style="list-style-type: none"> <li>1. Sitting: Bakasana, Hanumanasana, Ekapada Rajakapotasana</li> <li>2. Standing: Parivritta Trikonasana, Utkatasana, Parshvakonasana</li> <li>3. Prone line: Mayurasana</li> <li>4. Supine line: Setubandhasana, Shavasana (Relaxation posture)</li> <li>5. Balancing: Sheershasana</li> </ol> <p><b>Patanjali's Ashtanga Yoga:</b> Dhyana (Meditation), Samadhi  <b>Pranayama:</b> Bhastrika, Bhramari, Ujjai  <b>Shat Kriyas:</b> Jalaneti and sutraneti, Sheetkarma Kapalabhati</p>	

**CIE Assessment Pattern (50 Marks - Practical) -**

CIE to be evaluated every semester end based on practical demonstration of Yogasana learnt in the semester.

CIE	Marks
5 <sup>th</sup> Semester	10
6 <sup>th</sup> Semester	10
7 <sup>th</sup> Semester	15
8 <sup>th</sup> Semester	15
<b>Total</b>	<b>50</b>

**SEE Assessment Pattern (50 Marks - Practical)**

SEE	Marks
Suryanamaskara	10
Kapalabhati	10
Asanas	10
Patanjali's Ashtanga Yoga	10
Pranayama / Shat Kriyas	10
<b>Total</b>	<b>50</b>

**Suggested Learning Resources:**

**Reference Books:**

2. Swami Kuvulyananda: Asma (Kavalyadhama, Lonavala)
3. Tiwari, O P: Asana Why and How
4. Ajitkumar: Yoga Pravesha (Kannada)
5. Swami Satyananda Saraswati: Asana Pranayama, Mudra, Bandha (Bihar School of yoga, Munger)

6. Swami Satyananda Saraswati: Surya Namaskar (Bihar School of yoga, Munger)
7. Nagendra H R: The art and science of Pranayama
8. Tiruka: Shatkriyegalu (Kannada)
9. Iyengar B K S: Yoga Pradipika (Kannada)
10. Iyengar B K S: Light on Yoga (English)

## APPENDIX A

### List of Assessment Patterns

1	Assignments
2	Group Discussions
3	Case Studies/ Caselets
4	Practical Orientation on Design thinking
5	Participatory & Industry-integrated Learning
6	Practical activities / Problem solving exercises
7	Class Presentations
8	Analysis of Industry / Technical / Business Reports
9	Reports on Industrial Visit
10	Industrial / Social / Rural Projects
11	Participation in external seminars / workshops
12	Any other academic activity
13	Online / Offline Quizzes

## APPENDIX B

### 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.

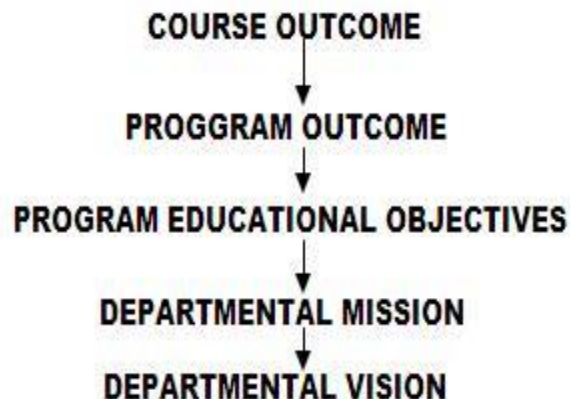
There are three educational Outcomes as defined by the National Board of Accreditation:

**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 C

### 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.

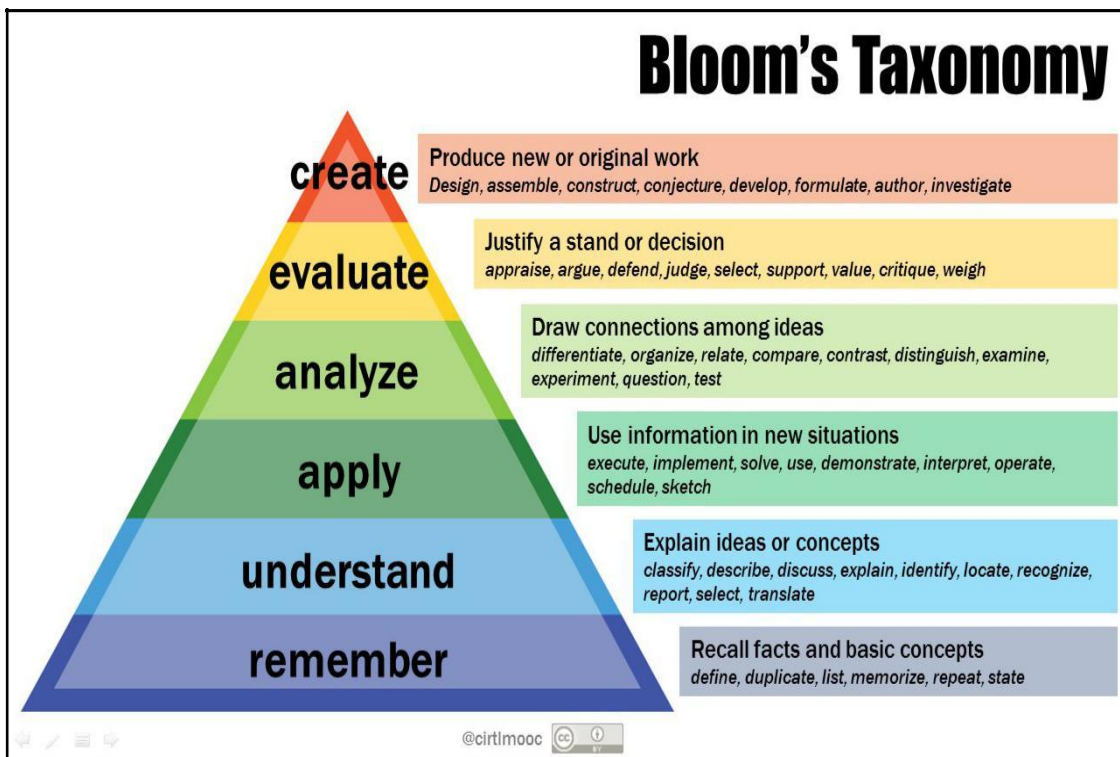
**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**Life-long learning:** 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.

## APPENDIX D

### 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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