SILVER HORIZONS 25 YEARS OF GLOBAL LEARNING

NEW HORIZON COLLEGE OF ENGINEERING

Department of Electronics and Communication Engineering

Academic Year: 2025-26
IV Year
Scheme and Syllabus

Batch 2022-26
Credits: 160

NEW HORIZON
COLLEGE OF ENGINEERING

Department of Electronics and Communication Engineering

Academic Year 2025-26

7th and 8th Semester Scheme & Syllabus

BATCH: 2022-26

CREDITS:160

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
- ❖ Innovation
- ❖ Integrity
- ❖ Professionalism
- ❖ Inclusiveness
- ❖ 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)

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

PEO to Mission Statement Mapping

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

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

Program Outcomes (PO) with Graduate Attributes

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

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

Program Specific Outcomes

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

Mapping of PEOs to POs & PSOs

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

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

NEW HORIZON COLLEGE OF ENGINEERING

B. E. in Electronics and Communication Engineering

Scheme of Teaching and Examinations for 2022- 2026 BATCH (2022 Scheme)

VII 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	22ECE71	Wireless Communication	EC	3	0	0	0	3	3	50	50	**100**
2	PCCL	22ECL71	Wireless Communication Lab	EC	0	0	1	0	1	2	50	50	**100**
3	PCC	22ECE72	Computer Vision	EC	3	0	0	0	3	3	50	50	**100**
4	PCCL	22ECL72	Computer Vision Lab	EC	0	0	1	0	1	2	50	50	**100**
5	PCC	22ECE73	Coding and Cryptography	EC	3	0	0	0	3	3	50	50	**100**
6	PROJ	22ECE74	Project Phase - II	EC	0	0	10	0	10	20	100	100	**200**
7	OEC	23NHOP7XX	Industrial Open Elective Course-II	Offering Dept.	3	0	0	0	3	3	50	50	**100**
								Total	**24**	**36**	**400**	**400**	**800**

PCC: Professional Core Course, **PCCL**: Professional Core Course laboratory, **PEC**: Professional Elective Course, **OEC**: Open Elective Course, **PROJ**: Project work**, L:** Lecture, **T**: Tutorial, **P**: Practical **S: SDA**: Self Study for Skill Development, C**IE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation.

Industrial Open Elective Courses-II:

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.

Project Phase-II:

The objective of the Project work is

(i) To encourage independent learning and the innovative attitude of the students.

(ii) To develop interactive attitude, communication skills, organization, time management, and presentation skills.

(iii) To impart flexibility and adaptability.

(iv) To inspire team working.

(v) To expand intellectual capacity, credibility, judgment and intuition.

(vi) To adhere to punctuality, setting and meeting deadlines.

(vii) To install responsibilities to oneself and others.

(viii) To train students to present the topic of project work in a seminar without any fear, face the audience confidently, enhance communication skills, involve in group discussion to present and exchange ideas.

CIE procedure for Project Work:

(1) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the project work, shall be based on the evaluation of the project work 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.

(2)Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable. The CIE marks awarded for the project work, shall be based on the evaluation of project work 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.

SEE procedure for Project Work: SEE for project work will be conducted by the two examiners appointed by the University. The SEE marks awarded for the project work shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the percentage ratio of 50:25:25.

Credit Definition: 1-hour Lecture (L) per week=1Credit 2-hoursTutorial(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

NEW HORIZON COLLEGE OF ENGINEERING

B. E. in Electronics and Communication Engineering

Scheme of Teaching and Examinations for 2022- 2026 BATCH (2022 Scheme)

VIII 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	PEC	22ECE81X	Professional Elective Courses -III	EC	3	0	0	0	3	3	50	50	**100**
2	PEC	22ECE82X	Professional Elective Courses -IV	EC	3	0	0	0	3	3	50	50	**100**
3	INT	22ECE83	Internship	EC	0	0	10	0	10	20	100	100	**200**
Total									**16**	**26**	**200**	**200**	**400**

PEC*: Professional Elective Course (Online/Hybrid), **L:** Lecture, **T**: Tutorial, **P**: Practical **S: SDA**: Self Study for Skill Development, **INT**: Industry Internship / Research Internship / Rural Internship, **CIE**: Continuous Internal Evaluation, **SEE**:Semester End Evaluation.

Professional Elective Course-III			
22ECE811	Satellite Communication	22ECE814	Wireless Sensor Networks
22ECE812	Statistical Signal Processing	22ECE815	Analog and Mixed mode VLSI Design
22ECE813	Automotive Electronics		

Professional Elective Course-IV			
22ECE821	Radar Networks	22ECE824	Quantum Computing
22ECE822	Multimedia Communication	22ECE825	Software Defined Radio
22ECE823	Nanoelectronics		

Elucidation:

At the beginning of IV years of the program i.e., after VI semester, VII semester classwork and VIII semester Internship shall be permitted to be operated simultaneously by the University so that students have ample opportunity for an internship. In other words, a good percentage of the class shall attend VII semester classwork and a similar percentage of others shall attend to Internship.

Internship: The mandatory Internship is for **14 to 20 weeks**. The internship shall be considered as a head of passing and shall be considered for the award of a degree. Those, who do not take up/complete the internship shall be declared to fail and shall have to complete it during the subsequent SEE examination after satisfying the internship requirements. If the students are opting for the 8th semester, the following internship options are available:

- Industry Internship
- Research Internship
- Skill Enhancement Courses
- Post-Placement Training as Internship
- Online Internship

Industry internship: It is an extended period of work experience undertaken by students to supplement their degree for professional development. It also helps them learn to overcome unexpected obstacles and successfully navigate organizations, perspectives, and cultures. Dealing with contingencies helps students recognize, appreciate, and adapt to organizational realities by tempering their knowledge with practical constraints. Students undertaking industry internships must ensure the organization is listed on the VTU Internship Portal. If not, request the organization to register on the portal.

Research internship: A research internship is intended to offer the flavor of current research going on in the research field. It helps students get familiarized with the field and imparts the skill required for carrying out research. Research internships must be carried out in recognized research centers. Ensure that these centers are registered on the portal.

Skill Enhancement Courses: Students can take Skill-based courses with credits totalling the same as those of the internship. Students must be taken from registered providers listed on the VTU Internship Portal.

Post-Placement Training as Internship: The post-placement training is also considered an internship. For students placed during their 6th/7th semester and willing to take the training during their final year, colleges must inform the recruiting companies in advance to register on the VTU Internship Portal.

Online Internship: Reputed online internship platforms, including those identified by NSDC, are already listed on the VTU Internship portal. If colleges come across other eligible organizations not yet listed, they are informed to ask the organization to register on the VTU Internship portal.

Credit Definition: 1-hour Lecture (L) per week=1 Credit 2-hoursTutorial(T) per week=1 Credit 2-hours Practical / Drawing (P) per week=1 Credit 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

SEVENTH SEMESTER

SYLLABUS

WIRELESS COMMUNICATION

Course Code	**22ECE71**	**CIE Marks**	**50**
L:T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hrs / Week	**3**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**3 Hrs**

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

22ECE71.1	Examine wireless signal propagation phenomena and assess their influence on transmission quality through relevant channel models
22ECE71.2	Analyze interference, system capacity, and grade of service in cellular networks
22ECE71.3	Apply knowledge of mobile communication standards to compare and analyse technological features across multiple generations
22ECE71.4	Compare the architectural principles and functional features of 3G and 4G wireless communication standards
22ECE71.5	Apply the concept of smart multi antenna systems for advanced wireless communication
22ECE71.6	Analyze multipath mitigation techniques and assess the integration and impact of AI in modern wireless communication infrastructure

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
22ECE71.1	3	-	-	-	-	-	-	-	-	-	-	3	3	2
22ECE71.2	3	3	1	-	-	-	-	-	-	-	-	3	3	2
22ECE71.3	3	-	-	-	-	-	-	-	-	-	-	3	3	2
22ECE71.4	3	-	-	-	-	-	-	-	-	-	-	3	3	2
22ECE71.5	3	3	-	-	-	-	-	-	-	-	-	3	3	2
22ECE71.6	3	-	-	-	-	-	-	1	-	-	-	3	3	2

MODULE-1	**Radio Signal Propagation**	**22ECE71.1**	**8 Hours**

Three Basic Propagation mechanism – Reflection (Ground Reflection - Two Ray model), Diffraction (knife-edge diffraction model) and Scattering, Propagation Models, Multipath propagation – Parameters of mobile multipath channels, Link Budget design using Path Loss model.

Self-study	Fading effects due to Multipath time delay spread and Fading effects due to Doppler spread - Rayleigh and Rician distribution.
Text Book	Text Book 1: 4.4-4.11, 5.4-5.6 (Pg No.: 107-157, 197-210)

MODULE-2	**Introduction to Cellular Communication Systems**	**22ECE71.2 22ECE71.3**	**8 Hours**

Overview of 1G, 2G, 3G, 4G and 5G cellular standards, Mobile Radio Systems, Cellular concept - Frequency reuse, hand off strategies, Interference & system capacity – trunking & grade of service, Improving coverage and capacity in cellular system.

Self-study	Comparison of different generations (1G to 6G) of Cellular Networks
Text Book	Text Book 1: 1.1,1.4, 3.1,3.2,3.3,3.4, 3.5, 3.6, 3.7 (Pg No.: 1-9, 57-86) Text Book 3: 1.2, 1.3, 1.4 (Pg No.: 1-12)

MODULE-3	**Network Evolution**	**22ECE71.3 22ECE71.4**	**8 Hours**

GSM-Architecture, 3GPP releases, Release 4 core Network Architecture, 4G Access Network Architecture, 4G-features and challenges.

Case Study	List the migration, architecture, and challenges to appreciate mobile communication systems today.
Text Book	Text Book 1: 11.3 (Pg No.: 551-565) Text Book 3: 4.4, 5.2, 5.3, 5.4 (Pg No.: 327-335, 417-423)

MODULE-4	**OFDM for Wireless Communication**	**22ECE71.5**	**8 Hours**

Basic principles of orthogonality, single Vs Multi-carrier systems, ODFM Block diagram, OFDM signal mathematical representation, pilot insertion and channel estimation, OFDM Peak to Average Power ratio.

Application	Derive cyclic prefix in OFDM for 64 sub-carriers.
Text Book	Text Book 2: 9.1, 9.2, 9.3, 9.4, 9.9 (Pg No.: 365-366, 373-375, 376-379, 388-393, 397-401)

MODULE-5	**Multipath Mitigation Techniques and AI-Driven Wireless Infrastructure**	**22ECE71.5 22ECE71.6**	**8 Hours**

Diversity – Types of Diversity – Diversity combining techniques: Selection, Feedback, Maximal Ratio Combining and Equal Gain Combining Introduction to MIMO, MIMO based system architecture, MIMO channel modeling, Advantages and applications of MIMO.
AI for the wireless world: Intelligent spectrum, pre-emptive network automation, ethics in using AI for wireless infrastructure.

Self-Study	Compare SISO and MIMO.
Text Book	Text Book 1: 7.10 (7.10.1-7.10.6) (Pg No.: 380-390) Text Book 2: 15.1, 15.4,15.8, 15.13 (Pg No.: 636, 645, 653-656, 667)

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		**Marks Distribution**		
		Test (s)	**AAT1**	**AAT2**
		25	**15**	**10**
L1	**Remember**	**5**	**-**	**-**
L2	**Understand**	**5**	**-**	**-**
L3	**Apply**	**10**	**10**	**5**
L4	**Analyze**	**5**	**5**	**5**
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. Rappaport T.S., "Wireless communications: Principles and Practices", Pearson Education,

2014, ISBN-13: 978-9332535794.
2. Wireless Communication — Upen Dalal, Oxford Univ. Press,2009, ISBN-13. 978- 019806066.
3. A. R. Mishra, Advanced Cellular Network Planning and Optimization: 2G/2.5G/3G... Evolution to 4G, 1st ed. Chichester, England: John Wiley & Sons, 2007.

Reference Books:

1. Lee, W.C.Y., Mobile Communication Engineering, McGraw Hill, 2.017, ISBN: 978- 0071810419.
2. David Tse and Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press, 2005, ISBN: 978-0521845274.
3. Andreas.F. Molisch, "Wireless Communications", John Wiley India, 2006, ISBN: 978- 8126511301.
4. Wireless Communications-Andrea Goldsmith, 2005 Cambridge University Press, ISBN: 978-0521837163.
5. Y. S. Cho, J. Kim, W. Y. Yang, and C. G. Kang, "MIMO-OFDM Wireless Communications with MATLAB", Hoboken, NJ, USA: John Wiley & Sons, Aug. 20, 2010, ISBN: 978-0-470-82563-1.

Web links and Video Lectures (e-Resources):

- **https://www.coursera.org/learn/wireless-communications**
- **https://www.youtube.com/watch?v=RrTmXIY3FbM**
- **https://wwrf.ch/wp-content/publications/outlook/Outlook24.pdf** - AI for future wireless world

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

- **Seminars**
- **Experiments for different Use cases.**
- **Contents related activities (Activity-based discussions)**
- **Group Discussion**
- **Case- Study**

WIRELESS COMMUNICATION LAB			
Course Code	**22ECL71**	**CIE Marks**	**50**
L:T:P:S	**0:0:1:0**	**SEE Marks**	**50**
Hrs / Week	**2**	**Total Marks**	**100**
Credits	**1**	**Exam Hours**	**3**

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

22ECL71.1	Simulate and analyse various wireless communication system models using MATLAB/Simulink tools
22ECL71.2	Evaluate the performance of wireless channel models, including fading, path loss, and BER
22ECL71.3	Implement and test advanced wireless systems like OFDM, MIMO, and CDMA
22ECL71.4	Demonstrate the working of hardware-based mobile communication systems and measure key performance parameters

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12	PSO 1	PSO 2
22ECL71.1	3	3	3	3	3	-	-	-	2	2	-	2	3	3
22ECL71.2	3	3	3	3	3	-	-	-	2	2	-	2	3	3
22ECL71.3	3	3	3	3	3	-	-	-	2	2	-	2	3	3
22ECL71.4	3	3	3	3	3	-	-	-	2	2	-	2	3	3

Exp. No. / Pgm. No.	List of Programs	Hours	COs
	Prerequisite Experiments / Programs / Demo		
	Basic operations of MATLAB and Simulink environments for signal generation, processing, and visualization.	2	NA
	PART-A		
1	Simulation of a basic wireless digital communication system using SIMULINK.	2	**22ECL71.1**
2	Simulation of Okumura, HATA models using MATLAB.	2	**22ECL71.1**
3	Simulation of log-normal shadowing models using MATLAB.	2	**22ECL71.2**
4	Simulation of link budget for satellite communication system using MATLAB.	2	**22ECL71.2**
5	Simulation of the free space loss and the power received (Free space Propagation – Path Loss Model) using MATLAB.	2	**22ECL71.2**
6	Simulation of the wireless channel including fading and doppler Effects using MATLAB.	2	**22ECL71.2**
	PART-B		
7	Study of CDMA (DS-SS) technique using analog signal as an input signal (trainer kit based).	2	**22ECL71.3**
8	Study and identify different blocks of mobile phone unit and sketch the waveforms of different sections, measure voltages at various test	2	**22ECL71.4**

	points in Mobile Communication Trainer board.		
9	Simulation of OFDM transmitter and receiver using MATLAB.	2	**22ECL71.3**
10	Simulation of 2x2 MIMO system using MATLAB.	2	**22ECL71.3**
11	Simulation of BER performance of modulation schemes over AWGN channel.	2	**22ECL71.2**
12	Simulation of BER performance of modulation schemes over Rayleigh/Rician fading channels.	2	**22ECL71.2**

PART-C

Beyond Syllabus Virtual Lab Content

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

1. 5G, LTE system simulations via MATLAB online

https://www.mathworks.com/help/5g/examples.html

https://www.mathworks.com/help/comm/examples.html

2. Discrete-event network simulator for internet systems and wireless protocols.

https://www.nsnam.org/

3. Tinkercad Circuits (for basic wireless, IoT, and RF module interfacing simulations)

https://www.tinkercad.com/circuits

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	10	10
L5	Evaluate	-	5
L6	Create	-	-

SEE Assessment Pattern (50 Marks – Lab)

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:

Reference Books:

1) T. S. Rappaport, Wireless Communications: Principles and Practice, 2nd Edition, Pearson. ISBN-13: 978-0130422323.

2) Andrea Goldsmith, Wireless Communications, Cambridge University Press,2005, ISBN-13: 978-0-521-83716-3 (9780521837163)

3) William C.Y. Lee, Mobile Cellular Telecommunications, McGraw-Hill, 2nd Edition, ISBN-13: 978-0070380899.

COMPUTER VISION

Course Code	**22ECE72**	**CIE Marks**	**50**
L:T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hrs / Week	**3**	**Total Marks**	**100**
Credits	**3**	**Exam Hours**	**3 hrs**

Course outcomes:

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

22ECE72.1	Apply image formation principles and color models for processing digital images
22ECE72.2	Make use of pixel-level operations, spatial and frequency domain transformation techniques for image enhancement
22ECE72.3	Implement image restoration methods and morphological operations for effective image segmentation under noise and distortion
22ECE72.4	Analyze geometric features such as edges, contours, and patches for object recognition and segmentation
22ECE72.5	Apply AI-based optimization techniques including sparse coding and combinatorial methods to solve vision-based recognition tasks
22ECE72.6	Develop a mini-project using basic computer vision techniques to solve a real-world problem

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
22ECE72.1	3	-	-	-	-	-	-	-	-	-	-	3	3	2
22ECE72.2	3	-	-	-	-	-	-	-	-	-	-	3	3	2
24ECE72.3	3	-	-	-	3	-	-	-	-	-	-	3	3	2
24ECE72.4	3	3	-	-	-	-	-	-	-	-	-	3	3	2
24ECE72.5	3	-	-	-	3	-	-	-	-	-	-	3	3	2
24ECE72.6	3	3	2	1	3	-	-	-	-	-	-	3	3	2

MODULE-1	**Introduction**	**22ECE72.1 , 22ECE72.6**	**8 Hours**

Introduction and Image formation: What is computer vision, Geometric primitives, Photometric image formation, Geometric Transformations.

Image Processing: What is Digital Image Processing, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Color image Fundamentals, Color Models.

Self-study	Pseudo Color Image Processing
Text Book	Text Book 1 : 1.1, 1.2; 2.1, 2.2;3.6; T2: 1.1, 1.4.1.5, 6.1–6.3

MODULE-2	**Image Enhancement and Transformations**	**22ECE72.2, 22ECE72.6**	**8 Hours**

Relationships Between points/Pixels, Point Operators, Linear Filtering, Non-Linear Filtering, Bilateral Filtering, Binary Image processing. 2D Image Transformations: 2D- DFT, Weiner Filtering, Discrete cosine transforms.

Self-study	Sharpening, blur, and noise removal
Text Book	Text Book 2: 2.5; Text Book 1: 3.2,3.3, 3.4.1

MODULE-3	**Image Region-Based Analysis**	**22ECE72.3, 22ECE72.6**	**8 Hours**

Image Restoration: Image Degradation/Restoration Model, Noise Models, Restoration in the Presence of Noise Only—Spatial Filtering, Periodic Noise Reduction Using Frequency Domain Filtering.

Morphological Processing: Erosion and Dilation, Opening and Closing, The Hit-or-Miss Transform, Some Basic Morphological Algorithms.			
Case Study	Image Reconstruction from Projections.		
Text Book	Text Book 2: 5.1–5.4; 9.1–9.5.		
MODULE-4	**Feature detection and matching**	**22ECE72.4, 22ECE72.6**	**8 Hours**
Points and patches, Edges and contours, Contour tracking, Lines and vanishing points, Segmentation- Graph-based segmentation, Mean shift, Normalized cuts.			
Application	Computer Vision in Robotics		
Text Book	Text Book 1: 7.1–7.5		
MODULE-5	**Intelligent Vision through Optimization Algorithms**	**22ECE72.5, 22ECE72.6**	**8 Hours**
Linear Least-Squares Methods, Nonlinear Least-Squares Methods, Sparse Coding and Dictionary Learning, Min-Cut/Max-Flow Problems and Combinatorial Optimization.			
Application	Implementation of sparse coding using Python/MATLAB		
Text Book	Text Book 3 : 22.1 – 22.4		

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	5	-	-
L2	Understand	5	-	-
L3	Apply	10	10	5
L4	Analyze	5	5	5
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. Richard Szeliski, Computer Vision: Algorithms and Applications, 2nd Ed., Springer, 2022, ISBN: **9783030343712**; https://doi.org/10.1007/978-3-030-34372-9; e Book: 978-3-030-34372-9.
2. Gonzalez, R. C., Woods, R. E., & Eddins, S. L. (2019). *Digital image processing* (4th ed.). Pearson. ISBN: **9780133356724.**
3. David Forsyth & Jean Ponce, Computer Vision: A Modern Approach, Pearson, 2015, ISBN: 9780136085928.

Reference Books:

1. Reinhard Klette, Concise Computer Vision, Springer, 2014. ISBN: 9781447163190.
2. Rajesh G., Sandeep Butt., Saroja B., Durga Prasad T., Image Processing, GCS Publishers, 2022, ISBN:

9789394304048
Web links and Video Lectures (e-Resources): • https://cse19-iiith.vlabs.ac.in/ • https://onlinecourses.nptel.ac.in/noc19_cs58/preview • https://www.youtube.com/watch?v=tY2gczObpfU • https://www.cse.iitm.ac.in/~vplab/computer_vision.html
Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning ➢ Mini Projects based on Image Processing.

COMPUTER VISION LAB

Course Code	**22ECL72**	**CIE Marks**	**50**
L:T:P:S	**0:0:1:0**	**SEE Marks**	**50**
Hrs / Week	**02**	**Total Marks**	**100**
Credits	**01**	**Exam Hours**	

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

22ECL72.1	Apply basic image processing operations using MATLAB for grayscale and color images to manipulate and visual data
22ECL72.2	Implement spatial and frequency domain filtering techniques for effective image enhancement and restoration
22ECL72.3	Analyse image segmentation techniques, including edge detection, thresholding, and morphological operations
22ECL72.4	Extract meaningful image features and perform basic pattern classification using MATLAB-based prototype matching techniques

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12	PSO1	PSO2
22ECL72.1	3	-	-	-	2	-	-	-	-	-	-	-	3	2
22ECL72.2	3	3	-	-	2	-	-	-	-	-	-	-	3	2
22ECL72.3	3	3	3	2	2	-	-	-	-	-	-	-	3	2
22ECL72.4	3	3	3	2	2	-	-	-	-	-	-	3	3	2

Pgm. No.	List of Programs	Hours	COs
	Prerequisite Experiments / Programs / Demo		
	Basics of Digital Image Processing	-	NA
	PART-A		
1	To perform basic Image Handling and processing operations on the image. Image Reading, Displaying, and Basic Manipulations.	2	**22ECL72.1**
2	To perform Point Operations and Histogram Processing including image negative, contrast stretching, and histogram equalization.	2	**22ECL72.1**
3	Implement spatial domain filtering techniques such as image smoothing and sharpening using average, Gaussian, and Laplacian filters.	2	**22ECL72.1**
4	To perform Geometric Transformations including image scaling, rotation, and translation on images.	2	**22ECL72.1**
5	To perform Frequency Domain Analysis using DFT and visualize magnitude spectrum.	2	**22ECL72.2**
6	Perform image restoration by adding noise (Gaussian and salt-and-pepper) and applying denoising filters such as mean and median filters.	2	**22ECL72.2**
	PART-B		
7	To perform Edge Detection and Thresholding using Sobel, Prewitt, and Canny edge detectors. Use global thresholding.	2	**22ECL72.3**
8	Implementation of region-based segmentation techniques including region growing and splitting & merging methods.	2	**22ECL72.3**

9	To perform Color Model Conversion and Enhancement. Convert RGB to HSV, YCbCr, and apply enhancement.	2	**22ECL72.3**
10	To perform Color-based Segmentation. Segment images based on color thresholds in HSV space.	2	**22ECL72.3**
11	To Perform morphological operations including erosion, dilation, opening, closing, and hit-or-miss transformation for shape-based processing.	2	**22ECL72.3**
12	To extract shape-based features and perform basic pattern classification using minimum distance classifier.	2	**22ECL72.4**

PART-C

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

1. Face Detection using Viola-Jones Algorithm.
   https://github.com/cheeyi/matlab-viola-jones/tree/master/trainHaar
2. Harris & Shi-Tomasi Corner Detection
   https://www.geeksforgeeks.org/python/python-corner-detection-with-shi-tomasi-corner-detection-method-using-opencv/
3. Panorama Stitching Using Harris Corners and SIFT
   https://in.mathworks.com/matlabcentral/fileexchange/51125-panorama-stitching-using-harris-corners-and-sift

CIE Assessment Pattern (50 Marks – Lab)

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

Suggested Learning Resources:

Reference Books:

1. Richard Szeliski, Computer Vision: Algorithms and Applications, 2nd Ed., Springer, 2022, ISBN: 9783030343712; e Book: 978-3-030-34372-9.
2. Gonzalez, R. C., Woods, R. E., & Eddins, S. L. (2019). Digital image processing (4th ed.). Pearson. ISBN: 9780133356724.

Reference Books:

1) David Forsyth & Jean Ponce, Computer Vision: A Modern Approach, Pearson, 2015
2) Reinhard Klette, Concise Computer Vision, Springer, 2014.
3) Rajesh G., Image Processing, GCS Publishers, 2022, ISBN: 9789394304048

Learning Resources:

1. MathWorks MATLAB Tutorials – Image Processing.
https://matlabacademy.mathworks.com/details/image-processing-with-matlab/mlip
2. NPTEL Course: Digital Image Processing – by Prof. P.K. Biswas, IIT Kharagpur.
https://nptel.ac.in/courses/117105135

CODING AND CRYPTOGRAPHY

Course Code	**22ECE73**	**CIE Marks**	**50**
L:T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hrs / Week	**3**	**Total Marks**	**100**
Credits	**3**	**Exam Hours**	**3**

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

22ECE73.1	Apply the fundamental concepts and principles of information theory and its role in coding and Cryptography
22ECE73.2	Analyze the Source Coding Techniques for Data Compression and Error Management
22ECE73.3	Evaluate the performance of convolutional codes compared to block codes in different noise environments
22ECE73.4	Use symmetric cryptography algorithms to encrypt and decrypt the information
22ECE73.5	Analyze secure systems and protocols using public key cryptographic methods
22ECE73.6	Design a file encryption system for secure communication

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12	PSO 1	PSO 2
22ECE73.1	3	-	-	-	-	-	-	-	-	-	-	2	3	2
22ECE73.2	3	3	-	-	-	-	-	-	-	-	-	2	3	2
22ECE73.3	3	3	1	-	-	-	-	-	-	-	-	2	3	2
22ECE73.4	3	-	-	-	-	-	-	-	-	-	-	2	3	2
22ECE73.5	3	3	1	-	2	-	-	-	-	-	-	2	3	2
22ECE73.6	3	3	1	1	2	1	1	-	-	-	-	2	3	2

MODULE-1	**Information Theory and Source Coding**	**22ECE73.1 22ECE73.2**	**8 Hours**

Introduction to Information Theory, Uncertainty and Information, Entropy, Relative entropy, Mutual information.

Source Coding Techniques: Shannon-Fano-Elias coding. Huffman Coding, Arithmetic coding, Lempel-Ziv Coding, Run length coding.

Self-study	Study the measure of uncertainty in a random variable and its properties.
Text Book	Text Book 2: Chapter 1(1.1,1.2,1.3,1.5,1.7,1.8,1.9,1.10,1.11). Text Book 1: Chapter 2(2.1,2.3), Chapter 5(5.6,5.10).

MODULE-2	**Error-Correcting Codes**	**22ECE73.1 22ECE73.2**	**8 Hours**

Channel models, channel capacity, channel coding.

Linear Block Codes: matrix description of Linear Block Codes, Decoding of a linear block, Hamming codes.

Binary Cyclic Codes: Algebraic Structure of Cyclic Codes, Encoding using an (n-k) Bit Shift register, Syndrome Calculation, Error Detection and Correction.

Self-study	Study the principles behind lossy compression algorithms, including JPEG and MPEG for images and videos, and MP3 for audio
Text Book	Text Book 2: Chapter 2 (2.2, 2.3, 2.4). Chapter 3(3.3, 3.6, 3.7, 3.8, 3.10), Chapter 4(4.1-4.4)

MODULE-3	Codes on Graph	22ECE73.1 22ECE73.3	8 Hours
Introduction to Convolutional Codes, Tree Codes and Trellis Codes, Description of Convolutional Codes (Analytical Representation), The Generating Function, Matrix Description of Convolutional Codes. Viterbi Decoding of Convolutional Codes. Turbo codes (Overview)			
Case Study	Error control coding, essential for designing reliable communication systems		
Text Book	Text Book 2: Chapter 7 (7.1, 7.2, 7.3, 7.5, 7.6, 7.7, 7.11, 7.12).		
MODULE-4	**Symmetric (Secret Key) Cryptography**	**22ECE73.4**	**8 Hours**
Introduction to Cryptography, An Overview of Encryption Techniques, Operations used by Encryption Algorithms. Symmetric (Secret Key) Cryptography: Block Cipher, Feistel Cipher, Stream Cipher, Data Encryption Standard (DES), Advanced Encryption Standard.			
Application	Design a file encryption system for a cloud storage service to ensure that only authorized users can access the files.		
Text Book	Text Book 2: Chapter 9(9.1 , 9.2, 9.3, 9.4, 9.5).		
MODULE-5	**Public-Key Cryptography**	**22ECE73.5 22ECE73.6**	**8 Hours**
Principles Public key crypto Systems, Diffie Hellman Key Exchange, RSA algorithm. **MESSAGE AUTHENTICATION AND HASH FUNCTIONS:** Authentication Requirement, Authentication Function, Message Authentication Code, Two simple Hash Function, Secure Hash Algorithm, security of MACs. Overview of Digital Signature, AI Cryptography.			
Application	1. Public key cryptography in securing communications for a messaging app. 2. Public key cryptography for secure online transactions in an e-commerce platform.		
Text Book	Text Book 3: Chapter 9 (9.1, 9.2). Chapter 10(10.1), Chapter 11(11.2,11.5), Chapter 12(12.1, 12.2, 12.3, 12.4). Chapter 13(13.1), e-resources		

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	5	-	-
L2	Understand	5	-	-
L3	Apply	10	10	5
L4	Analyze	5	5	5
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. Thomas M.Cover, Joy A Thomas, Elements of Information Theory, 2nd Edition, Wiley, 2015, ISBN: 978-1118585771
2. Bose, Ranjan. Information theory, coding and cryptography, 3rd Edition, Tata McGraw-Hill Education, 2015, ISBN: 978-9332901257
3. William Stallings, "Cryptography and Network Security Principles and Practice", Pearson Education Inc., 6th Edition, 2014, ISBN: 978-93- 325-1877-3

Reference Books:

1. K. Deergha Rao, Channel coding Techniques for wireless communications, 2nd edition, Springer, 2019, ISBN: 978-9811337383.

2. Simon Haykin, Communication Systems, 4th edition, Wiley Publications, 2001, ISBN:978-0471178699

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/108102117
- https://www.youtube.com/watch?v=U4dzerJHIFw&t=3s
- https://cse29-iiith.vlabs.ac.in/
- https://medium.com/@singularitynetambassadors/ai-cryptography-enhancing-security-and-privacy-in-the-digital-age-db5c1bbf5fdb

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

- Implementing encryption algorithms and protocols in programming languages like Python.
- Hands-on in encode and decode messages using various coding techniques.
- Contents related activities (Activity-based discussions).
  - Group Discussion.
  - Case- Study.

PROJECT PHASE - II

Course Code	**22ECE74**	**CIE Marks**	**100**
L:T:P:S	**0:0:10:0**	**SEE Marks**	**100**
Hrs / Week	**20**	**Total Marks**	**200**
Credits	**10**	**Exam Hours**	**03**

Course outcomes:

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

22ECE74.1	Demonstrate the ability to independently identify, formulate, and define real-world engineering problems and select suitable methodologies for their solution
22ECE74.2	Apply appropriate engineering concepts and modern tools to develop effective design solutions for identified engineering problems
22ECE74.3	Analyze experimental data from the developed design solutions to derive valid and insightful conclusions
22ECE74.4	Evaluate the societal and environmental implications of engineering solutions in a global and sustainability context
22ECE74.5	Demonstrate the ability to plan, allocate, and analyze project budgets through efficient resource management
22ECE74.6	Exhibit team collaboration skills, leadership qualities, and uphold professional ethics while contributing effectively in multidisciplinary teams

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

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
22ECE74.1	3	3	-	3	-	-	-	-	-	-	-	3	3	3
22ECE74.2	3	3	3	-	3	-	-	-	-	-	-	3	3	3
22ECE74.3	3	3	3	3	3	-	-	-	-	-	-	3	3	3
22ECE74.4	3	3	-	-	-	3	3	-	-	-	-	-	3	3
22ECE74.5	3	3	-	-	-	-	-	-	-	-	3	3	3	3
22ECE74.6	3	3	-	-	-	-	-	-	-	-	3	3	3	3

This project-based course offers students an opportunity for hands-on learning aimed at strengthening their practical knowledge and technical abilities. Through the development of small applications or systems, students will gain experience in applying theoretical concepts to real-world challenges.

Students are encouraged to identify problems that reflect societal needs across various disciplines and address them using current tools and technologies. Based on the student's skills and the guide's recommendations, a multidisciplinary project may be assigned to a team consisting of up to four members.

The progress of the project will be continuously assessed by a panel of experts over the duration of the semester. Continuous Internal Evaluation (CIE) will consider the quality of work completed, the effectiveness of the project presentation, and the student's ability to respond during evaluation sessions.

Any form of plagiarism will lead to an automatic 'F' grade, and students involved will be subject to disciplinary measures.

At the end of the project, a final report must be submitted. This report will be evaluated by examiners.

Project Work: Roadmap, activities, and deliverables

Goal Selection and Project Planning:

- Select a relevant project topic aligned with the Sustainable Development Goals (SDGs).
- Form project teams based on shared interests and complementary skill sets.
- Engage teams in drafting detailed project proposals that include objectives, strategies, and expected outcomes.

Research and Needs Assessment:

- Conduct in-depth research on the selected SDG topic, examining both global and local contexts, challenges, and opportunities.
- Perform needs assessments to identify specific problems or gaps that the project aims to address.

Interdisciplinary Approaches:

- Utilize interdisciplinary knowledge and creative problem-solving methods to develop effective solutions for sustainability challenges.

Deployment:

- Implement the project using appropriate hardware and software platforms, with attention to scalability, security, and performance.
- Set up necessary infrastructure such as servers, databases, and other system components.
- Perform deployment testing to ensure a seamless transition from development to live operation.

Knowledge Sharing and Communication:

- Encourage students to present their project outcomes and share key learnings through reports, presentations, and social media platforms.
- Promote peer-to-peer collaboration and learning through knowledge-sharing forums or platforms.

CIE Assessment Pattern (100 Marks)

RBT Levels		Marks Distribution	
		Review 1 (50 Marks)	Review 2 (50 Marks)
L1	Remember	-	-
L2	Understand	10	10
L3	Apply	10	10
L4	Analyze	10	10
L5	Evaluate	10	10
L6	Create	10	10

SEE Assessment Pattern (100 Marks)

RBT Levels		Exam Marks Distribution (100)
L1	Remember	-
L2	Understand	20
L3	Apply	20
L4	Analyze	20
L5	Evaluate	20
L6	Create	20

EIGHTH SEMESTER

SYLLABUS

SATELLITE COMMUNICATION

Course Code	**22ECE811**	**CIE Marks**	**50**
L:T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hrs / Week	**8**	**Total Marks**	**100**
Credits	**3**	**Exam Hours**	**3 Hrs**

Course outcomes:

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

22ECE811.1	Apply the fundamentals of satellite communication in propagation impairments such as atmospheric losses, ionospheric effects, and rain attenuation in signal transmission
22ECE811.2	Interpret satellite orbital parameters using Kepler's laws and compute key metrics for different satellite orbits
22ECE811.3	Compare the space segment and perform link budget calculations using parameters such as EIRP, system noise, and carrier-to-noise ratio
22ECE811.4	Analyze the working of satellite subsystems and their roles
22ECE811.5	Analyze international satellite communication regulations, frequency allocation frameworks, and the role of ITU in ensuring interference-free operations
22ECE811.6	Integrate AI techniques for managing satellite-ground operations and specialized services

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

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
22ECE811.1	3	-	-	-	-	-	-	-	-	-	-	-	3	2
22ECE811.2	3	2	-	-	-	-	-	-	-	-	-	-	3	2
22ECE811.3	3	2	1	-	-	-	-	-	-	-	-	-	3	2
22ECE811.4	3	-	-	-		-	-	-	-	-	-	-	3	2
22ECE811.5	3	2	1	-	1	1	1	-	-	-	-	-	3	2
22ECE811.6	3	2	1	-	1	-	-	-	-	-	-	3	3	2

MODULE-1	**INTRODUCTION TO SATELLITE SYSTEMS AND PROPAGATION IMPAIRMENTS**	**22ECE811.1**	**8 Hours**

Fundamentals: Introduction, frequency allocation, INTELSAT, Indian Satellite systems.
Propagation impairments: Introduction, atmospheric loss, ionospheric effects, rain attenuation, other propagation impairments.

Self-study	Evolution of Launch Vehicles
Text Book	Text Book 1; 1.1 – 1.3; 4.1 -4.5 (Pg No.: 1-4, 103-106)

MODULE-2	**ORBITAL MECHANICS**	**22ECE811.2**	**8 Hours**

Introduction, Kepler laws, definitions, orbital element, apogee and perigee heights, orbit perturbations, inclined orbits, calendars, universal time, sidereal time, orbital plane and sun synchronous orbits.
Geostationary orbit: Introduction, antenna look angles, polar mount antenna, limits of visibility, earth eclipse of satellite, sun transit outage.

Self-study	Study the 6 orbital elements and their corresponding apogee/perigee
Text Book	Text Book 1; 2.1 – 2.8, 2.9.1, 2.9.2, 2.9.4, 2.9.5, 3.1 -3.4, 3.6, 3.7 (Pg No.: 29-38, 45-50, 77-87, 92-94) Text Book 2; 2.1,2.3,2.5, 3.3, 3.5 (Pg No.: 31-39, 60, 94, 100)

<table>
<tr><td>MODULE-3</td><td>SPACE SEGMENT AND SPACE LINK</td><td>22ECE811.4
22ECE811.5</td><td>8 Hours</td></tr>
<tr><td colspan="4">Space Segment: Introduction, power supply units, altitude control, station keeping, thermal control, TT&C Subsystem, transponders, antenna subsystem.
Space link: Introduction, EIRP, transmission losses, link power budget Equation, system noise, CNR, uplink and downlink, combined CNR.</td></tr>
<tr><td>Case Study</td><td colspan="3">Demonstrate Link Budget and Signal Quality Analysis for a Ku-Band DTH Broadcast System (e.g., Tata Sky via GSAT-10)</td></tr>
<tr><td>Text Book</td><td colspan="3">Text Book 1; 7.1 – 7.8, 12.1 -12.8, 12.10 (Pg No.: 199-225, 351-371, 380)
Text Book 2; 4.4-4.5, 4.7, 4.9 (Pg No.: 130-134, 145, 152)</td></tr>
<tr><td>MODULE-4</td><td>EARTH SEGMENT & SATELLITE ACCESS TECHNIQUES</td><td>22ECE811.4
22ECE811.5</td><td>8 Hours</td></tr>
<tr><td colspan="4">Introduction, receive only home TV system, outdoor unit, indoor unit, MATV, CATV, Tx–Rx earth station.
Satellite Access Techniques: Bandwidth-Limited and Power- Limited, TDMA Downlink analysis for digital transmission, Comparison of uplink power requirements for FDMA and TDMA, On-Board Signal Processing for FDMA/TDM Operation, Satellite switched TDMA.</td></tr>
<tr><td>Application</td><td colspan="3">Simulate and compare the uplink power efficiency, downlink C/N ratio, and the impact of on-board signal processing for a satellite communication system serving multiple ground stations.</td></tr>
<tr><td>Text Book</td><td colspan="3">Text Book 1: 8.1 – 8.5 (Pg No.: 239-250)
Text Book 1: 14.6, 14.7.11-12, 14.8-14.9 (Pg No.: 432, 459-461, 463-467)
Text Book 2: 6.1-6.2 (Pg No.: 221-223)</td></tr>
<tr><td>MODULE-5</td><td>SATELLITE-BASED SERVICES AND AI-DRIVEN APPLICATIONS</td><td>22ECE811.3
22ECE811.4
22ECE811.6</td><td>8 Hours</td></tr>
<tr><td colspan="4">Introduction, orbital spacing, power ratio, frequency and polarization, transponder capacity, bit rates for digital TV, satellite mobile services, VSAT, Radar Sat.
GPS: Introduction, GPS position and location principles, GPS receiver and codes, Orbcomm.
AI in satellite communication: Telemetry analysis and anomaly detection, space debris tracking and earth station management.</td></tr>
<tr><td>Application</td><td colspan="3">Simulate and calculate the transponder capacity utilization when multiple digital video streams (e.g., MPEG-4) are being broadcast.</td></tr>
<tr><td>Text Book</td><td colspan="3">Text Book 1; 16.1 -16.6 , 17.2 -17.6 (Pg No.: 531-534, 562-572)T2; 10.11 (Pg No.: 455-469)</td></tr>
<tr><td colspan="4">CIE Assessment Pattern (50 Marks – Theory)
<table>
<tr><th colspan="2" rowspan="2">RBT Levels</th><th colspan="3">Marks Distribution</th></tr>
<tr><th>Test (s)</th><th>AAT1</th><th>AAT2</th></tr>
<tr><th colspan="2"></th><th>25</th><th>15</th><th>10</th></tr>
<tr><td>L1</td><td>Remember</td><td>5</td><td>-</td><td>-</td></tr>
<tr><td>L2</td><td>Understand</td><td>5</td><td>-</td><td>-</td></tr>
<tr><td>L3</td><td>Apply</td><td>10</td><td>10</td><td>5</td></tr>
<tr><td>L4</td><td>Analyze</td><td>5</td><td>5</td><td>5</td></tr>
<tr><td>L5</td><td>Evaluate</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>L6</td><td>Create</td><td>-</td><td>-</td><td>-</td></tr>
</table></td></tr>
<tr><td colspan="4">SEE Assessment Pattern (50 Marks – Theory)</td></tr>
</table>

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 Dennis Roddy, "Satellite Communications", 4th Edition, McGraw-Hill International edition, 2006, ISBN-13: 978-0071462983.

2.RAnil K. Maini, Varsha Agrawal, Satellite Communications, Wiley India Pvt. Ltd., 2015, ISBN: 978-81-265-2071-8.

Reference Books:

1. Timothy Pratt, Charles Bostian and Jeremy Allnutt, "Satellite Communications", 2nd Edition, John Wiley Pvt. Ltd & Sons, 2008.
2. W. L. Pitchand, H. L. Suyderhoud, R. A. Nelson, "Satellite Communication Systems Engineering", 2nd Ed., Pearson Education., 2007.
3. W. L. Pritchart, H. G. Suyderhoud and R. A. Nelson, "Satellite Communication Systems Engineering," 2nd Edition, Pearson Education, 2012.
4. K. Singh, R. Setia, and S. Kumar, "*Artificial Intelligence and Machine Learning in Satellite Data Processing and Services: Proceedings of the International Conference on Small Satellites*", ICSS 2022. Singapore: Springer Nature Singapore, 2023. ISBN: 978-981-1976-98-8.

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=dt4Ce8gQPns&list=PL2_fd4bcaOT0b9XOmQfu389QlgOmcrFml
- https://www.youtube.com/watch?v=rw0qSxm9jwI
- https://www.youtube.com/watch?v=n70zjMvm8L0&t=46s- How Satellite Works
- https://www.youtube.com/watch?v=dP5ygLT8g30- The Future of Satellite Communication: AI's Impact on Global Networks
- https://www.intersputnik.int/member-directory/?post=artificial-intelligence-and-modern-satellite-communications

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

- Content related discussions
- Group activity to explain GPS pseudo range and position estimation based on satellite placement (GDOP).
- Ground-based Link Design.
- Research paper presentation on recent applications and launchings.

STATISTICAL SIGNAL PROCESSING			
Course Code	**22ECE812**	**CIE Marks**	**50**
L:T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hrs / Week	**3**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

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

22ECE812.1	Analyze statistical properties of discrete-time random signals and their impact on signal processing operations
22ECE812.2	Develop signal models using Least Squares estimation techniques for effective signal representation
22ECE812.3	Make use of non-parametric spectral estimation methods for analyzing signal frequency components
22ECE812.4	Evaluate signal characteristics using parametric spectral estimation methods for enhanced spectral resolution
22ECE812.5	Interpret the principles of adaptive filtering techniques for optimal estimation and noise reduction in discrete-time signals
22ECE812.6	Apply the role and potential of AI in the context of modern signal processing applications

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

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
22ECE812.1	3	3	-	-	-	-	-	-	-	-	-	-	3	2
22ECE812.2	3	3	2	1	2	-	-	-	-	-	-	-	3	2
22ECE812.3	3	3	-	-	-	-	-	-	-	-	-	-	3	2
22ECE812.4	3	3	2	1	-	-	-	-	-	-	-	-	3	2
22ECE812.5	3	3	-	-	-	-	-	-	-	-	-	-	3	2
22ECE812.6	3	-	-	-	2	1	-	-	-	-	-	3	3	2

MODULE-1	**DISCRETE RANDOM SIGNAL PROCESSING**	**22ECE812.1**	**8 Hours**
Discrete Random Processes- Ensemble Averages, Stationary processes, Bias and Estimation, Autocovariance, Autocorrelation, Parseval's theorem, Wiener-Khintchine relation, White noise, Power Spectral Density, Spectral factorization, Filtering Random Processes			
Self-study	Random process		
Text Book	Text 1 3.2, 3.3, 3.4, 3.5		

MODULE-2	**DIGITAL FILTER DESIGN**	**22ECE812.2**	**8 Hours**
Digital Filter design using least-square method: Least Square error criterion in the design of Pole-zero filters, Shanks method, All pole modelling, Linear prediction, FIR least squares inverse filters.			
Self-study	Digital filter techniques		
Text Book	Text 1 4.1, 4.2, 4.4		

MODULE-3	**SPECTRAL ESTIMATION AND ANALYSIS NON-PARAMETRIC**	**22ECE812.3**	**8 Hours**

Spectral Estimation and Analysis -Non parametric methods: Periodogram, Bartlett and Welch modified periodogram, Blackman-Tukey Methods, performance comparisons, minimum variance spectrum estimation

Case Study	Comparative study of non-parametric spectral estimation
Text Book	Text 1 8.2, 8.3

MODULE-4	**SPECTRAL ESTIMATION AND ANALYSIS PARAMETRIC**	**22ECE812.4**	**8 Hours**

Parametric methods: wide sense stationary random process, rational power spectra: Auto Regressive (AR) Process, Moving Average (MA) Process, ARMA Process, Relationship between the Filter Parameters and the auto correlation sequence. Frequency estimation: Eigen decomposition of the autocorrelation matrix

Application	Studying biomedical signals such as ECG and EEG for diagnosing
Text Book	Text 1 8.5 8.6

MODULE-5	**AI FOR STATISTICAL SIGNAL PROCESSING**	**22ECE812.5 22ECE812.6**	**8 Hours**

Linear Mean square error estimation, Algorithms of Levinsion, Levinsion-Durbin and Schur, Wiener filtering and Kalman filtering. Classifiers and Detectors, Signals are Different, Machine Learning for Signals.

Application	Audio and Video Processing
Text Book	Text 1 5.1, 5.2, 7.2, 7.3 e-Resources

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember		-	-
L2	Understand	5	-	-
L3	Apply	10	10	5
L4	Analyze	5	5	5
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. Statistical signal processing and Modelling, Monson H. Hayes, Wiley, 2009 ISBN 9788126516100, 8126516100.

2. Fundamentals of statistical signal processing, Estimation Theory, S.M.Kay, Prentice Hall, 2009 ISBN-13 : 978-8131728994.

Reference Books:

1. Digital Signal Processing, Principles, Algorithms, and Applications, Proakis, John G., Dimitris G. Manolakis, and D. Sharma, Pearson Education, 2006.
2. Digital Signal Processing a computer Based approach, Mitra Sanjit.K, Tata McGraw Hill, 2001.
3. Adaptive Signal Processing, B. Widrow & S Stearns, PHI, 1985.
4. Statistical and Adaptive Signal Processing, Dimitris, Manolakis, McGraw Hill, 2000.

Web links and Video Lectures (e-Resources):

- https://ieeexplore.ieee.org/document/9591548
- https://www.renesas.com/en/document/whp/ai-service-signal-processing?srsltid=AfmBOorE148wtnqVyeeQB6hOGP10SuUe2KFgKYd7nE4yZrTg-qXzRUfF

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

- Journals and conference-based activity learning.

AUTOMOTIVE ELECTRONICS

Course Code	**22ECE813**	**CIE Marks**	**50**
L:T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hrs / Week	**3**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

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

22ECE813.1	Identify the basic concepts and building blocks of automotive electronic systems
22ECE813.2	Interpret the control system approaches and analyze the features of digital control systems used in automotive applications
22ECE813.3	Analyze the working principles and characteristics of sensors and actuators used in automotive electronic control systems
22ECE813.4	Compare automotive networks and communication buses work in vehicle motion control systems
22ECE813.5	Develop diagnostic procedures and fault identification methods in automotive electronic systems
22ECE813.6	Design new technologies used in modern and future automotive electronic systems

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12	PSO 1	PSO 2
22ECE813.1	3	-	-	-	-	-	-	-	-	-	-	-	3	1
22ECE813.2	3	3	2	1	2	-	-	-	-	-	-	-	3	1
22ECE813.3	3	3	-	-	-	-	-	-	-	-	-	-	3	1
22ECE813.4	3	3	-	-	-	-	-	-	-	-	-	-	3	1
22ECE813.5	3	3	2	1	2	-	-	-	-	-	-	-	3	1
22ECE813.6	3	3	2	1	2	2	-	-	-	2	2	2	3	1

MODULE-1	**Fundamentals of Automotive**	**22ECE813.1**	**8 Hours**

Evolution of Automotive Electronics, Automobile Physical Configuration, Survey of Major Automotive Systems, The Engine – Engine Block, Cylinder Head, Four Stroke Cycle, Engine Control, Ignition System - Spark plug, High voltage circuit and distribution, Spark pulse generation, Ignition Timing, Diesel Engine, Drive Train - Transmission, Drive Shaft, Differential, Suspension, Brakes, Steering System.

Self-study	Integration and Evolution of Electronic Control Systems in Modern Powertrain and Vehicle Dynamics
Text Book	Text book 1: Chapter 1

MODULE-2	**Electronic Engine Control Systems and Digital Performance Management**	**22ECE813.2**	**8 Hours**

Control System approach in Automotive: Concept of an electronic engine control system, Definition of general terms and Engine performance terms, Engine mapping, Control strategy, Electronic fuel control system.

Digital Engine control systems: Digital Engine control features, Control modes for fuel Control (Seven Modes), EGR Control, Variable valve timing control, Electronic Ignition control

Self-study	Control Strategies and Digital Implementation of Integrated Electronic Engine Management Systems
Text Book	Text book 1: Chapters 5 and 7

MODULE-3	**Sensors & Actuators**	**22ECE813.3**	**8 Hours**

Sensors: Airflow rate sensor, Strain Gauge MAP sensor, Engine Crankshaft Angular Position Sensor, Magnetic Reluctance Position Sensor, Hall effect Position Sensor, Shielded Field Sensor, Optical Crankshaft Position Sensor, Engine Coolant Temperature (ECT) Sensor, Exhaust Gas Oxygen sensor, Knock Sensors
Actuators: Automotive Engine Control Actuators, Fuel Injection, Exhaust gas recirculation actuator

Case Study	Case study on Integrated Sensor and Actuator Systems for Closed-Loop Engine Control in Modern Automobiles
Text Book	Text book 1: Chapter 6

MODULE-4	**Automotive Networking**	**22ECE813.4**	**8 Hours**

Vehicle Motion Control: Typical Cruise Control System, Digital Cruise Control System, Digital Speed Sensor, Throttle Actuator, Digital Cruise Control configuration, Cruise Control Electronics, Antilock Brake System
Automotive Buses: CAN Bus, LIN Bus, MOST Bus, Bluetooth, Flex Ray, Diagnostic Interfaces.

Application	Simulation of Digital Cruise Control and CAN Bus Communication Using MATLAB/Simulink
Text Book	Text book 1: Chapter 8, Text book 2: Pg. 92- 151

MODULE-5	**AI-Based Advanced Driver-Assistance Systems**	**22ECE813.5** **22ECE813.6**	**8 Hours**

Diagnostics: Timing Light, Engine Analyzer, On-board diagnostics, Offboard diagnostics, Expert Systems, Occupant Protection Systems – Accelerometer based Air Bag systems
Future Automotive Electronic Systems: Electric & Hybrid Vehicles, Fuel cell powered cars, Transmission control, Collision Avoidance Radar warning systems, AI- and Deep Learning-Powered Driver Drowsiness Detection Method Using Facial Analysis.

Application	Advanced Diagnostic and Safety Systems in Modern and Future Automobiles
Text Book	Text book 1: Chapter 10 and 11,E resource Link (3)

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	5	-	-
L2	Understand	5	-	-
L3	Apply	10	10	5
L4	Analyze	5	5	5
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) Understanding automotive Electronics: An Engineering Perspective, Willaim B. Ribbens, 6th edition, Elsevier Science 2003, ISBN: 978-0128104347.
2) Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, Robert Bosch Gmbh (Ed.), 5th edition, John Wiley& Sons Inc., 2007, ISBN: 978-3-658-01784-2

Reference Books:

1) Automotive Electronics Hand book – Ronald K. Jurgen, 2nd edition, 1999, ISBN: 978-0070344532.

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=etDnfS6REWc
- https://www.udemy.com/course/basics-of-automotive-electronics/?srsltid=AfmBOortYLcxWjESJ5SDmucu0hdf7Y7MWEvAuK2QxjBvFKXP2T6ILS50&couponCode=IND21PM
- https://www.mdpi.com/2076-3417/15/3/1102

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

- Industrial Visit to Automotive Manufacturing Plants
- Organizing Group wise discussions on issues
- Seminars

WIRELESS SENSOR NETWORKS

Course Code	**22ECE814**	**CIE Marks**	**50**
L:T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hrs / Week	**2**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course outcomes:

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

22ECE814.1	Understand the fundamental concepts and structural design aspects of Wireless Sensor Networks
22ECE814.2	Analyze different network architectures, classifications, and protocol stack layers of WSNs
22ECE814.3	Evaluate routing strategies and data dissemination protocols in WSNs, addressing energy efficiency, mobility, and scalability challenges
22ECE814.4	Apply various query processing and data aggregation techniques in WSNs
22ECE814.5	Examine sensor network and their relevance in modern applications
22ECE814.6	Analyze the integration of Artificial Intelligence in WSNs through a case study approach for optimizing network performance in consumer electronics and e-commerce

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

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
22ECE814.1	2	-	-	-	-	-	-	-	-	-	-	-	2	2
22ECE814.2	3	-	-	-	-	-	-	-	-	-	-	-	2	3
22ECE814.3	3	2	-	-	-	-	-	-	-	-	-	-	2	3
22ECE814.4	3	-	-	-	-	-	-	-	-	-	-	-	2	2
22ECE814.5	3	2	3	-	-	-	-	-	-	-	-	-	2	3
22ECE814.6	3	2	2	1	3	2	2	-	2	2	-	3	2	3

MODULE-1	**Introduction to Wireless Sensor Networks**	**22ECE814.1**	**8 Hours**

Overview of Wireless Sensor Networks, Network Characteristics, Network Applications, Network Design Objectives, Network Design Challenges, MEMS Technology, Wireless Communication Technology, Hardware and Software Platforms, Wireless Sensor Network Standards.

Self-study	A comprehensive understanding of WSNs, which consist of spatially distributed autonomous sensors to monitor physical or environmental conditions.
Text Book	Text Book 1: 1.1, 1.1.1,1.1.2, 1.1.3,1.1.4, 1.2.1, 1.2.2, 1.2.3, 1.2.4 (pp. 1-13)

MODULE-2	**Network Architectures and Protocol Stack**	**22ECE814.2**	**8 Hours**

Introduction, Network Architectures for Wireless Sensor Networks, Classifications of Wireless Sensor Networks, Protocol Stack for Wireless Sensor Networks, Fundamentals of MAC Protocol, The IEEE 802.15.4 MAC protocol.

Self-study	Fundamentals of Wireless Sensor Networks, including their architectures, classifications, protocol stack, and MAC layer principles, with a focused understanding of the IEEE 802.15.4 MAC protocol.
Text Book	Text Book 1: 2.1, 2.2, 2.3,2.4 (pp.19-31), Text Book 2: 5.1 (pp. 112-119), 5.5 (pp.139-145)

MODULE-3	Routing and Data Dissemination	22ECE814.3	8 Hours
Introduction, Fundamentals and Challenges, Taxonomy of Routing and Data Dissemination Protocols, Overview of Routing and Data Dissemination Protocols, Location-Aided Protocols, Geographic Adaptive Fidelity, Geographic and Energy-Aware Routing, Coordination of Power Saving with Routing, Mobility-Based Protocols.			
Text Book	Text Book 1: 4.1,4.2,4.3,4.4, 4.4.1, 4.4.5 (pp. 67-117)		
MODULE-4	**Query Processing and Data Aggregation**	**22ECE814.4**	**8 Hours**
Introduction, Query Processing in Wireless Sensor Networks, Query Characteristics, Challenges in Query Processing, Sensor Selection for Query Processing, Query Processing Techniques, Snapshot Querying, Data Aggregation in Wireless Sensor Networks, Challenges in Data Aggregation, Data Aggregation Techniques.			
Application	The concepts of query processing in Wireless Sensor Networks, including query characteristics, sensor selection, and techniques like snapshot querying, have been thoroughly studied.		
Text Book	Text Book 1: 7.1, 7.2, 7.2.1, 7.2.2,7.2.3, 7.2.4, 7.3, 7.3.1,7.3.2 (pp. 215-237)		
MODULE-5	**Sensor Network Standards**	**22ECE814.5, 22ECE814.6**	**8 Hours**
Introduction, IEEE 802.15.4 Standard, Data-Transfer Models, MAC Layer Services, ZigBee Standard, Wireless Multimedia Sensor Networks, Wireless Sensor and Actor Networks, Application of AI in Wireless Sensor Network for Consumer Electronics.			
Case Study	Implementation of an AI-Based Decision Support System for Optimizing Wireless Sensor Networks in Consumer Electronics for E-Commerce Applications.		
Text Book	Text Book 1: 13.1, 13.2, 13.2.3, 13.2.4, 13.3 (pp. 407-431), 14.2, 14.3 (pp. 433-447), Reference Article 1.		

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	Qualitative Assessment (s)	MCQ's
		25	15	10
L1	Remember	5	-	-
L2	Understand	5	-	-
L3	Apply	10	10	5
L4	Analyze	5	5	5
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. Wireless Sensor Networks: A Networking Perspective, Edited by Jun Zheng Abbas Jamalipour, Wiley, 2009.
2. Protocols and Architectures for Wireless Sensor Networks, Holger Karl, Andreas Willig, Hasso-Plattner-Institute at the University of Potsdam, GERMANY, John Wiley & Sons Ltd., 2005.

Reference Article:

1. M. S. Basingab, H. Bukhari, S. H. Serbaya, G. Fotis, V. Vita, S. Pappas, and A. Rizwan, "AI-based decision support system optimizing wireless sensor networks for consumer electronics in e-commerce," *Applied Sciences*, vol. 14, no. 12, p. 4960, Jun. 2024. [Online]. Available: https://doi.org/10.3390/app14124960.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/106105160
- https://www.youtube.com/playlist?list=PLbxBGRRnuvJffhUV5eo7LJq4-k8EPZle
- https://www.geeksforgeeks.org/wireless-sensor-network-wsn/

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

- Sensor node simulation using Arduino/Proteus
- Zigbee/LoRa communication setup between nodes
- In-network data aggregation and filtering code
- Packet analysis using Wireshark
- Energy consumption measurement in sensor nodes
- Localization technique implementation using MATLAB or Python

ANALOG AND MIXED MODE VLSI DESIGN

Course Code	**22ECE815**	**CIE Marks**	**50**
L:T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hrs / Week	**3**	**Total Marks**	**100**
Credits	**3**	**Exam Hours**	**3 Hrs**

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

22ECE815.1	Use efficient analytical tools for quantifying the behavior of basic MOS circuits by inspection
22ECE815.2	Design high-performance, stable operational amplifiers with the tradeoffs between speed, precision and power dissipation
22ECE815.3	Analyze the behavior of phase-locked-loops for specific applications
22ECE815.4	Identify the critical parameters that affect the analog and mixed-signal VLSI circuits design
22ECE815.5	Perform calculations in the digital or discrete time domain and use the data converters to translate the digital data to and from inherently analog world
22ECE815.6	Explore real-world applications of SCCs and data converters in communication systems, sensor interfaces, audio processing, and other areas

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12	PSO 1	PS O2
22ECE815.1	3	-	-	-	-	-	-	-	-	-	-	-	2	2
22ECE815.2	3	2	-	-	-	-	-	-	-	-	-	-	2	2
22ECE815.3	3	2	-	-	-	-	-	-	-	-	-	-	2	2
22ECE815.4	3	-	-	-	-	-	-	-	-	-	-	-	2	2
22ECE815.5	3	-	-	-	-	-	-	-	-	-	-	-	2	2
22ECE815.6	3	2	-	-	1	1	-	-	-	-	-	2	2	2

MODULE-1	**Basic MOS Device Physics**	**22ECE815.1**	**8 Hours**

Basic MOS Device Physics: General considerations, MOS I/V Characteristics, second order effects, MOS device models.
Single stage Amplifier: Basic Concepts, Common Source stage (Text 1)

Self-study	Fabrication of MOS Devices, Short channel effects, scaling theory MOSFET as an Amplifier.
Text Book	Text Book 1: Chapter 2.1-2.4, 3.1-3.2

MODULE-2	**Single stage and Differential Amplifier**	**22ECE815.2**	**8 Hours**

Single stage Amplifier: Source follower, common-gate stage, Cascode Stage, choice of device models.
Differential Amplifiers: Single ended and differential operation, Basic differential pair, Common mode response, Differential pair with MOS loads, Gilbert cell (Text 1)

Self-study	Noises in Single stage and differential amplifier Chapter 7.
Text Book	Text Book 1: Chapter 3.3-3.6, 4.1-4.5.

MODULE-3	**Current Mirrors and Op-Amp**	**22ECE815.3**	**8 Hours**

Passive and Active Current Mirrors: Basic current mirrors, Cascode Current mirrors, Active Current mirrors.
Operational Amplifiers (part-1): General Considerations, One Stage OP-Amp, Two Stage OP-Amp, Gain boosting (Text 1)

Case Study	Stability and frequency compensation in CMOS Circuits.
Text Book	Text Book 1: Chapter 5.1-5.3.2, 9.1-9.4.

MODULE-4	**Op-Amp and Phased Lock Loop**	**22ECE815.4**	**8 Hours**

Operational Amplifiers (part-2): Common Mode Feedback, Slew rate, Power Supply Rejection.

Phase Locked Loops: Simple PLL, Charge pump PLLs, Non-ideal effects in PLLs, Delay-Locked Loops, Applications (Text 1)

Application	Designing of Oscillators
Text Book	Text Book 1:Chapter 9.6-9.9,15.1-15.4

MODULE-5	**Data Converter Architectures**	**22ECE815.5, 22ECE815.6**	**8 Hours**

Data Converter Architectures: DAC & ADC Specifications, Current Steering DAC, Charge Scaling DAC, Cyclic DAC, Pipeline DAC, Flash ADC, Pipeline ADC, Integrating ADC, Successive Approximation ADC, Applications of Artificial Intelligence on the Modeling and Optimization for Analog and Mixed-Signal Circuits.

Application	Implementing data converters Text 2: Chapter 30
Text Book	Text Book 1: Chapter 28.4-28.5,29.1.4-29.1.7,29.2.1-29.2.5 Reference 2: Research paper

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	5	-	-
L2	Understand	5	-	-
L3	Apply	10	10	5
L4	Analyze	5	5	5
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. Behzad Razavi, "Design of Analog CMOS Integrated Circuits", TMH, 2007, ISBN: 9789325983274
2. R. Jacob Baker, "CMOS Circuit Design, Layout, and Simulation", Second Edition, Wiley,

ISBN: 007029158

Reference Books:

1. Phillip E. Allen, Douglas R. Holberg, "CMOS Analog Circuit Design", Second Edition, Oxford University Press, ISBN: 9780199937424.
2. Applications of Artificial Intelligence on the Modeling and Optimization for Analog and Mixed-Signal Circuits: A Review, IEEE Transactions On Circuits And Systems—I: Fundamental Theory And Applications. https://doi.org/10.1109/TCSI.2021.3065332

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=IyLrppKoKvk&list=PLm_MSClsnwm9JOsP-NzAER0nwyvsa7veq
- https://www.youtube.com/watch?v=yQDfVJzEymI&list=PLyYrySVqmyVPzvVlPW-TTzHhNWg1J_0LU

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

- Analyzing the Data sheets of Analog circuits and evaluation of the specifications.
- Designing Analog circuits and Data converter circuits with the help of SPICE tools.

RADAR NETWORKS

Course Code	22ECE821	CIE Marks	50
L:T:P:S	3:0:0:0	SEE Marks	50
Hrs / Week	3	Total Marks	100
Credits	03	Exam Hours	03

Course outcomes:

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

22ECE821.1	Apply the basic principles of radar systems to analyse their operation under various conditions and configurations
22ECE821.2	Analyse the effectiveness of radar in detecting, locating, and identifying objects in different scenarios
22ECE821.3	Select appropriate radar systems for detecting and tracking various types of moving targets.
22ECE821.4	Analyse radar tracking techniques to interpret the motion patterns and behaviour of moving targets
22ECE821.5	Investigate the effect of noise on automatic detection accuracy in radar systems
22ECE821.6	Examine radar signal components to assess their suitability for real-time applications

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12	PSO1	PSO2
22ECE821.1	3	-	-	-	-	-	-	-	-	-	-	2	3	2
22ECE821.2	3	3	-	-	-	-	-	-	-	-	-	2	3	2
22ECE821.3	3	-	-	-	-	-	-	-	-	-	-	2	3	2
22ECE821.4	3	3	2	-	-	-	-	-	-	-	-	2	3	2
22ECE821.5	3	3	-	-	-	-	-	-	-	-	-	2	3	2
22ECE821.6	3	3	2	1	1	2	-	-	-	-	-	2	3	2

MODULE-1	Introduction to Radar Systems and Radar Parameters	22ECE821.1, 22ECE821.2	8 Hours

Introduction to Radar System: Radar Block Diagram and Operation, Radar Frequencies, Applications of Radar, Simple form of the Radar Equation, Illustrative Problems.

Radar Transmitter and Receiver Parameters: PRF, PRI, Duty Cycle, Peak Transmitter Power, Average transmitter Power, Receiver noise, MDS, Range, Range accuracy, Range resolution, Maximum Unambiguous Range and RCS.

Case Study	Analyzing the Design and Performance Parameters of a Ground-Based Weather Radar System
Text Book	Text Book 1: Chapters 1.1, 1.2, 1.3, 1.4, 1.6

MODULE-2	CW and FMCW Radar	22ECE821.2, 22ECE821.3	8 Hours

Introduction to CW Radar: Basic principle and block diagram of a CW Radar, Limitations, Applications of CW Radar.

Frequency Modulated Continuous Wave (FMCW) Radar: Principle of operation, Block diagram and waveform analysis, Derivation of range and velocity measurement, Linear FM (chirp) signal analysis.

Case Study	FMCW in automotive radar (ADAS systems), Altimeters and drone-based height sensing		
Text Book	Text book 1: Chapter 3.1, 3.2, 3.4, 3.5		
MODULE-3	**Pulse Doppler Radar and MTI**	**22ECE821.3, 22ECE821.4**	**8 Hours**
Introduction to Doppler Effect in Radar: Principle, Doppler effect in radar, Doppler Frequency Shift, Coherent vs Non-Coherent radar systems. **Moving Target Indicator (MTI) Radar:** MTI Radar with- Power Amplifier Transmitter, Delay Line Cancelers- Frequency Response of Single Delay- Line Canceler, Blind Speeds, Clutter Attenuation, N- Pulse Delay-Line Canceler, Digital MTI Processing-Blind phases, I and Q Channels, Digital MTI Doppler signal processor.			
Applications	Perform Simulation and synthesis of digital circuits		
Text Book	Text Book 1: 4.1, 4.2, 4.3, 4.6, 4.10, 4.11, 4.12		
MODULE-4	**Tracking Radar**	**22ECE821.4, 22ECE821.5**	**8 Hours**
Tracking with Radar- Types of Tracking Radar Systems, Mono pulse Tracking- Amplitude Comparison Mono pulse (one-and two- coordinates), Phase Comparison Mono pulse. Sequential Lobing, Conical Scan Tracking, Block Diagram of Conical Scan Tracking Radar, Tracking in Range, Comparison of Trackers.			
Case Study	Integration in modern fighter aircraft and missile systems		
Text Book	Text Book 1: 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8		
MODULE-5	**Advanced Radar Signal Detection and AI-based Tracking**	**22ECE821.6**	**8 Hours**
Detection of Signals in Noise: Introduction, Detection Criteria, Detectors, Automatic Detection. **Target Recognition and Signal Processing:** Target Recognition, Land Clutter, Sea Clutter, Weather Clutter Waveform and Signal Processing –Range Measurements. **AI Applications of Radar Networks:** AI for Target Detection and Tracking, Classification of airborne, ground-based, and maritime targets, Multi-target tracking using deep learning, AI-based clutter suppression			
Self-Study	Analyse performance under different noise and clutter conditions		
Text Book	Text Book 1: 4.5, 4.6, 11.1, 11.2, 11.4, 13.1, 13.2, 13.3, 13.4, 13.5, 13.6, 13.7, 13.8		

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	5	-	-
L2	Understand	5	-	-
L3	Apply	10	10	5
L4	Analyze	5	5	5
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. Introduction to Radar Systems – Merrill I. Skolnik, TMH Special Indian Edition, 2nd Edition, Tata McGraw-Hill, 2007, ISBN 0-07-066572 .9.
2. Habibur Rahman, "Fundamental Principles of RADAR", CRC Press, 2019, ISBN: 978-1-138-38779-9

Reference Books:

1. Byron Edde, Radar: Principles, Technology, Applications, Pearson Education, 2004, ISBN: 9780137523467.

2. Mark A Richards, James A. Scheer, William A. Holm, "Principles of Modern RADAR", Yesdee Publishing Private Ltd, 2012, ISBN: 978-93-80381-29-9

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/108105154
- https://www.youtube.com/watch?v=-YyfN8vM04g
- https://ocw.mit.edu/courses/res-ll-003-build-a-small-radar-system-capable-of-sensing-range-doppler-and-synthetic-aperture-radar-imaging-january-iap-2011/
- https://www.youtube.com/watch?v=fphkkCTPwqA

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

- Seminars
- Class Presentation
- Flip Classroom Activity
- Practical activity using MATLAB

MULTIMEDIA COMMUNICATION

Course Code	**22ECE822**	**CIE Marks**	**50**
L:T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hrs / Week	**3**	**Total Marks**	**100**
Credits	**3**	**Exam Hours**	**3**

Course outcomes:

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

22ECE822.1	Understand the fundamentals and system components of multimedia communication
22ECE822.2	Analyze various multimedia data representation and compression techniques
22ECE822.3	Apply different networking protocols and streaming methods for multimedia communication
22ECE822.4	Examine the performance requirements of multimedia networking with QoS parameters
22ECE822.5	Evaluate contemporary standards and multimedia transport protocols
22ECE822.6	Explore emerging trends in multimedia applications

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12	PSO 1	PSO 2
22ECE822.1	-	-	-	-	-	-	-	-	-	-	-	-	3	2
22ECE822.2	3	3	-	-	-	-	-	-	-	-	-	-	3	2
22ECE822.3	3	-	-	-	-	-	-	-	-	-	-	-	3	2
22ECE822.4	3	3	1	-	-	-	-	-	-	-	-	-	3	2
22ECE822.5	3	3	1	-	-	-	-	-	-	-	-	-	3	2
22ECE822.6	3	3	-	-	1	1	-	-	-	-	-	2	3	2

MODULE-1	**Introduction to Multimedia**	**22ECE822.1**	**8 Hours**

Components of Multimedia, Multimedia: Past and Present, Multimedia Software Tools: A Quick Scan, Multimedia in the Future, Multimedia Media and Data Streams, Main properties of a Multimedia system, Traditional Data Stream characteristics, Data Stream characteristics for Continuous Media

Self-study	Explore real-time multimedia applications like YouTube, Netflix, Zoom.
Text Book	Text Book 1: 1.1,1.2,1.3 (Pg. no. 3-20) Text Book 2: 2.1,2.2,2.4,2.5 (Pg. no. 10-16,18-23)

MODULE-2	**Multimedia Data Representation and Compression Techniques**	**22ECE822.2**	**8 Hours**

Basic sound concepts, speech, Images, and graphics, Video, and animation
Multimedia Data Compression, Lossless Compression Algorithms, Lossy Compression Algorithms

Self-study	Implement image/audio compression techniques using MATLAB
Text Book	Text Book 2: 3.1,3.3,4.1,4.2,5.1,5.3 (Pg. no.28-31, 42-51,56-78,81-91,104-111) Text Book 1: 7.1,7.2,7.3,7.4,8.1,8.2,8.3,8.4,8.5(Pg. no. 185-196,225-249)

MODULE-3	**Multimedia Networking and Transport Protocols**	**22ECE822.3, 22ECE822.5**	**8 Hours**

Local Area Network (LAN) and Access Networks, Internet Technologies and Protocols, Protocols for Multimedia Transmission, and Interaction

Case Study	Simulation of a real-time audio/video stream using GStreamer		
Text Book	Text Book 1: 15.2,15.3,15.6 (Pg. no. 486-501,516-521)		
MODULE-4	**Multimedia Networking Performance and QoS**	**22ECE822.4**	**8 Hours**
Quality-of-Service for Multimedia Communications, Characteristics of Wireless Channels, Multimedia over Wireless Channels, Multimedia over Wireless Channels, Error Detection, Error Correction, Error Resilient Coding, Error Concealment.			
Application	Analyze network delay and jitter in a simulated multimedia network.		
Text Book	Text Book 1: 15.5,17.1,17.3 (Pg. no. 506-515,573-576,589-604)		
MODULE-5	**Multimedia Applications**	**22ECE822.6**	**8 Hours**
Media preparation, Media Composition, Media Entertainment, Representatives of Social Media Services, User-Generated Media Content Sharing, Media Propagation in Online Social Networks.			
Application	Project on cloud-based media delivery systems		
Text Book	Text Book 2: 17.1,17.3,17.7 (Pg. no. 713-724,756-762) Text Book 1: 18.1,18.2,18.3 (Pg. no. 618-638)		

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	-	-	-
L2	Understand	10	-	-
L3	Apply	10	10	5
L4	Analyze	5	5	5
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. Ze-Nian Li and Mark S. Drew, Fundamentals of Multimedia, 2nd Edition, Springer, 2014, ISBN: 978-3-319-05289-0

2. Ralf Steinmetz and Klara Nahrstedt, Multimedia: Computing, Communications and Applications, Pearson, 2012, ISBN-13: 978-0133244359.

Reference Books:

1. Yao Wang, Joern Ostermann, and Ya-Qin Zhang, Video Processing and Communication, 1st Edition, Prentice Hall, 2001

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/117105083
- https://wiki.wireshark.org/RTP
- https://gstreamer.freedesktop.org/documentation/?gi-language=c
- https://ffmpeg.org/documentation.html

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

- Hands-on session implementing basic image compression using MATLAB or Python (PIL library).
- Compress an image using JPEG compression in FFmpeg and analyze size reduction vs. quality loss.
- Implement Huffman coding for a given text file and compute compression ratio.
- Demonstration of RTP/UDP-based video streaming using GStreamer or VLC Media Player.
- Simulation of network congestion and QoS parameter changes using Cisco Packet Tracer or NS-3.

NANOELECTRONICS			
Course Code	**22ECE823**	**CIE Marks**	**50**
L:T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hrs / Week	**03**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course outcomes:

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

22ECE823.1	Classify nanostructures based on their dimensional properties and applications
22ECE823.2	Evaluate the electronic properties of nanomaterials
22ECE823.3	Apply various characterization techniques to analyze the properties of nanomaterials
22ECE823.4	Compare nanostructure fabrication processes using advanced lithographic, epitaxial and self-assembly techniques
22ECE823.5	Examine the properties and mutual relationships of carbon nanostructures
22ECE823.6	Analyze artificial intelligence and machine learning approaches in nanotechnology research and nanomanufacturing processes

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12	PSO 1	PSO 2
22ECE823.1	3	3	-	-	-	-	-	-	-	-	-	-	2	1
22ECE823.2	3	3	-	-	-	-	-	-	-	-	-	-	2	1
22ECE823.3	3	-	-	-	-	-	-	-	-	-	-	-	2	1
22ECE823.4	3	3	-	-	-	-	-	-	-	-	-	-	2	1
22ECE823.5	3	3	-	-	-	-	-	-	-	-	-	-	2	1
22ECE823.6	3	3	2	2	1	-	-	-	-	-	-	2	2	1

MODULE-1	**Introduction to Nanotechnology**	**22ECE823.1 22ECE823.2**	**8 Hours**

Introduction and classification: What is nanotechnology? Classification of Nanostructures, 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.

Case study	Electronic properties
Text Book	Textbook 1: 1.1, 1.2, 1.3, 1.4

MODULE-2	**Characterization Methodologies & Inorganic Semiconductor Nanostructures**	**22ECE823.3**	**8 Hours**

Characterization: Classification, Electron Microscopy, Microscopic techniques, Field ion microscopy, scanning probe techniques, diffraction techniques: bulk and surface diffraction techniques

Inorganic semiconductor nanostructures: overview of semiconductor physics. Quantum confinement in semiconductor nanostructures: quantum wells, quantum wires, quantum dots,

super-lattices, band offsets, electronic density of states			
Case study	Multi-Scale Characterization of Silicon Nanowires		
Text Book	Textbook 1: 2.1, 2.2, 2.3,2.4, 2.5, 2.6; 3.2, 3.3, 3.4		
MODULE-3	**Fabrication techniques and Physical Processes**	**22ECE823.4**	**8 Hours**
Requirements of ideal semiconductor, epitaxial growth of quantum wells, lithography and etching, cleaved-edge over growth, growth of vicinal substrates, strain induced dots and wires, electrostatically induced dots and wires, Quantum well width fluctuations, thermally annealed quantum wells, semiconductor nanocrystals, colloidal quantum dots, self-assembly techniques. Physical Processes in semiconductor nanostructures.			
Case Study	From Laboratory to Manufacturing of few approaches		
Text Book	Textbook 1: 3.5, 3.6.1-3.6.7		
MODULE-4	**Carbon Nanostructures**	**22ECE823.5**	**8 Hours**
Introduction, carbon molecules, Carbon Clusters, Carbon Nanotubes, application of Carbon Nanotubes, applications of carbon nanotubes			
Text Book	Textbook 2: 5.1, 5.2, 5.3, 5.4, 5.5		
MODULE-5	**AI in Nanotechnology**	**22ECE823.6**	**8 Hours**
Interdependency of Nanomaterials, Nanomanufacturing, Digital Manufacturing and Artificial Intelligence, Artificial Intelligence in Nanomanufacturing, Machine Learning and Deep Learning in Nanomanufacturing, Challenges and Prospects in Implementing AI in Nanomanufacturing. ML-assisted design strategies for nanomaterials, ML-assisted characterization strategies for nanomaterials			
Case study	AI in Nanomedicine Manufacturing		
Text Book	Reference 1: 1.5, 2, 3, 4 Reference 2: 3.1, 3.2		

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test(s)	AAT1	AAT2
		25	15	10
L1	Remember	-	-	-
L2	Understand	10	-	-
L3	Apply	10	10	5
L4	Analyze	5	5	5
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. Robert W. Kelsall, Ian W. Hamley, Mark Geoghegan, Nanoscale Science and Technology, John Wiley & Sons, Ltd, 2005, 9780470020876 (online)
2. Charles P. Poole Jr., Frank J. Owens, Introduction to Nanotechnology, 1st edition, Wiley-Interscience, 2003, ISBN: 9780471079354,0471079359

Reference Books:

1. Nandipati, M.; Fatoki, O.; Desai, S. Bridging Nanomanufacturing and Artificial Intelligence—A Comprehensive Review. Materials 2024, 17, 1621. https://doi.org/10.3390/ma17071621
2. Liang Yang, Hong Wang, Deying Leng, Shipeng Fang, Yanning Yang, Yurun Du, Machine learning applications in nanomaterials: Recent advances and future perspectives, Chemical Engineering Journal, Volume 500, 2024, 156687, ISSN 1385-8947, https://doi.org/10.1016/j.cej.2024.156687

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/117/108/117108047/
- https://www.youtube.com/watch?v=9ysm03dybr4
- https://www.youtube.com/watch?v=I7DWfXBL-bc&t=209s
- https://mitnano.mit.edu/

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

- Case studies
- Demo of fabrication technique using online videos

QUANTUM COMPUTING

Course Code	**22ECE824**	**CIE Marks**	**50**
L:T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hrs / Week	**3**	**Total Marks**	**100**
Credits	**3**	**Exam Hours**	**3**

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

22ECE824.1	Understand the fundamental concepts of quantum mechanics, quantum computing and quantum information Theory
22ECE824.2	Apply the concepts from linear algebra to model the quantum systems from a computational perspective
22ECE824.3	Analyze the fundamental differences between classical and quantum computational models
22ECE824.4	Construct quantum circuits using standard quantum gates and implement core quantum algorithms
22ECE824.5	Compare the principles of quantum information theory and apply it for real world use cases like quantum cryptography
22ECE824.6	Develop simple quantum machine learning model to solve real-world problems

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12	PSO 1	PSO 2
22ECE824.1	2	-	-	-	-	-	-	-	-	-	-	-	3	2
22ECE824.2	3	-	-	-	-	-	-	-	-	-	-	-	3	2
22ECE824.3	3	3	-	-	-	-	-	-	-	-	-	-	3	2
22ECE824.4	3	3	2	-	3	-	-	-	-	-	-	2	3	2
22ECE824.5	3	3	2	-	-	1	1	-	-	-	-	2	3	2
22ECE824.6	3	3	2	2	3	-	-	-	-	3	-	2	3	2

MODULE-1	**Introduction to Quantum computing**	**22ECE824.1**	**8 Hours**

Need of Quantum computing, prehistory of Quantum computing, Quantum Principles, Superposition, entanglement, measurement, Quantum bits, multiple qubits, Blosch sphere mapping.

Self-study	Qubit Touchdown- A quantum computing board game.
Text Book	Text Book 1 - 2.2, 2.3,2.4, Text book 2 -1.2, Reference book 1-1.1,1.2,1.6.

MODULE-2	**Quantum Mechanics for computing**	**22ECE824.2**	**8 Hours**

Linear algebra: matrices, vectors, tensor products, The postulates of quantum mechanics, density operator, Schmidt decomposition and purifications, Bell inequality.

Self-study	Super dense coding
Text Book	Text Book 2 :2.1, 2.2,2.4,2.5,2.6

MODULE-3	**Quantum Gates and Algorithms**	**22ECE824.3, 22ECE824.4**	**8 Hours**

Quantum gates: X, Y, Z, H, S, T, CNOT, SWAP.
Quantum circuit design, Universal gates and circuit equivalence, Deutsch's algorithm, Deutsch–Jozsa algorithm, Grover's Search Algorithm, Quantum Fourier Transform (QFT),

Self- Study	Quantum teleportation

Text Book	Text Book 1:2,6. Text Book 2: 1.3, 4.5.1,4.5.2, 6.1.2, 5.1		
MODULE-4	**Quantum Information Theory**	**22ECE824.1 22ECE824.5**	**8 Hours**
Quantum Error Correction: Decoherence, Bit flip code, Phase flip code, Shor code. Quantum Information Theory: Von Neumann entropy, Quantum information over noisy quantum channels. Quantum Key Distribution: Encryption, Classical solution, Quantum solution.			
Case Study	Quantum Information Theory in Secure Communication.		
Text Book	Text Book 1:4.7, 6.6 Text Book 2:11.3,12.4.		
MODULE-5	**AI in Quantum Computing**	**22ECE824.6**	**8 Hours**
Quantum machine learning, Types in QML, Quantum K means clustering, variational Quantum circuits, QSVM.			
Case Study	Quantum Machine Learning for Handwritten Digit Recognition		
Text Book	Text Book 3: Page no: 32,313, 332,368		

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	5	-	5
L2	Understand	5	-	5
L3	Apply	10	10	-
L4	Analyze	5	5	-
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. Thomas G Wong, Introduction to classical and Quantum computing,1st edition, Rooted Grove publisher, 2022, ISBN: 979-8-9855931-1-2.
2. Michael A Nielsen, Isaac L Chuang, Quantum Computation and Quantum Information, 10th edition, Cambridge University Press, 2010, ISBN 978-1-107-00217-3.
3. Santanu Ganguly, Quantum Machine Learning: An Applied Approach: The Theory and Application of Quantum Machine Learning in Science and Industry, 1st edition, Apress Publisher,2021, ISBN: 978-1-4842-7097-4

Reference Books:

1. Jozef Gruska, Quantum Computing, McGraw-Hill Book Co Ltd, 2000, ISBN 978-0077095031.
2. Phillip Kaye, An Introduction to Quantum Computing, Oxford University Press, 2007, ISBN 978-0-19-857049-3.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/106106232
- https://nptel.ac.in/courses/106106241
- https://www.youtube.com/watch?v=30U2DTfIrOU

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

- Simulated QKD using dice or coins to visualize key exchange and eavesdropping detection.
- Implement quantum algorithms using Qiskit.
- Contents related activities (Activity-based discussions)
  - Problem solving worksheets
  - Interactive Game: "Qubit Touchdown"
  - Group Discussion

SOFTWARE DEFINED RADIO

Course Code	**22ECE825**	**CIE Marks**	**50**
L:T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hrs / Week	**3**	**Total Marks**	**100**
Credits	**3**	**Exam Hours**	**3**

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

22ECE825.1	Understand the concepts of software defined radio and its implementation issues
22ECE825.2	Apply the Multi rate signaling technique for sample rate conversion
22ECE825.3	Illustrate the various digital synthesis approaches
22ECE825.4	Examine the various data converter architectures and their performance
22ECE825.5	Analyze the basics of designing smart antenna systems to accommodate the needs of software defined radio
22ECE825.6	Implement system-level decisions to develop and optimize software-defined radio systems and applications

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12	PSO 1	PSO 2
22ECE825.1	2	-	-	-	-	-	-	-	-	-	-	1	3	2
22ECE825.2	3	2		-	-	-	-	-	-	-	-	1	3	2
22ECE825.3	3	2	1	-	-	-	-	1	-	-	-	1	3	2
22ECE825.4	3	2	-	-	1	-	-	-	-	-	-	1	3	2
22ECE825.5	3	2	-	-	-	-	-	-	-	-	-	1	3	2
22ECE825.6	3	2	1	-	1	1	-	-	-	-	-	1	3	2

MODULE-1	**Introduction to Software Defined Radio (SDR)**	**22ECE825.1**	**8 Hours**

Introduction to SDR: What is a Software Radio? The need for Software Radios, Characteristics and benefits of a Software Radio, Design principles of Software Radio.
Radio frequency implementation issues: The purpose of the RF Front-End, Dynamic range: The principal challenge of receiver design. RF receiver front-end topologies, Enhanced flexibility of the RF Chain with Software Radios.

Self-study	Study of the basic parts of SDR system, Design principles of SDR.
Text Book	Text Book 1: Chapter 1 (1.1, 1.2, 1.3, 1.4). Chapter 2 (2.1, 2.2, 2.3, 2.4).

MODULE-2	**RF System Performance and Multirate Signal Processing Techniques**	**22ECE825.2 22ECE825.3**	**8 Hours**

Importance of the components to Overall performance, Transmitter architectures and their Issues, noise and distortion in the RF Chain, ADC and DAC distortion.
Multirate Signal Processing: Introduction to sample rate conversion principles, poly phase filters, digital filter banks.

Self-study	Modulation schemes used in SDR and channel models.
Text Book	Text Book 1: Chapter 2(2.5, 2.6, 2.7, 2.8). Text Book 1: Chapter 3(3.1, 3.2,3.3,3.4).

MODULE-3	**Digital generation of signals.**	**22ECE825.3**	**8 Hours**

Comparison of direct digital synthesis with analog signal synthesis, Approaches to direct digital synthesis, Analysis of spurious signals, Spurious components due to periodic jitter, Bandpass signal generation, Performance of direct digital synthesis systems, Hybrid DDS-PLL Systems, Applications of direct digital synthesis.

Case Study	Hybrid DDS-PLL Systems in Wireless Communication.		
MODULE-4	**Fundamentals and Architectures of Data Converters**	**22ECE825.3 22ECE825.4**	**8 Hours**

Analog to digital and digital to analog conversion, Parameters of ideal data converters, Parameters of practical data converters, Techniques to improve data converter performance, Common ADC and DAC Architectures, Neural ADCs.

Application	Analyze the effect of Quantization Error on signal quality.
Text Book	Text Book 1: Chapter 5(5.1,5.2,5.3,5.4,5.5).

MODULE-5	**Smart Antenna Systems**	**22ECE825.5 22ECE825.6**	**8 Hours**

Smart antennas designing issues, Vector channel modelling, Benefits of smart antennas, Structures for beamforming systems, Smart antenna algorithms, Diversity and space-time adaptive signal processing.

Application	Design and Simulation of an Adaptive Beamforming System.
Text Book	Text Book 1: Chapter 6(6.1,6.2,6.3,6.4,6.5,6.6).

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	Qualitative Assessment (s)	MCQ's
		25	15	10
L1	Remember	5	-	5
L2	Understand	10	-	5
L3	Apply	5	10	-
L4	Analyze	5	5	-
L5	Evaluate	-	-	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1. Jeffrey H Reed, Software Radio- A modern approach to Radio Engineering, Prentice Hall PTR, 2002, ISBN 0-13-081158-0.

Reference Books:

1. C. Richard Johnson Jr., William A. Sethares, Telecommunication Breakdown, Prentice Hall, 2003, ISBN 10: 0131430475.
2. K. Fazel, S. Kaiser, John Wiley and Sons, Multi-carrier and Spread Spectrum Systems, Ltd. Publication, 2010, ISBN 978-0-470-99821-2.
3. N.J. Fliege, "Multirate Signal Processing" John Wiley and Sons, 1994, SBN 0-13-146511-2.

Web links and Video Lectures (e-Resources):

- http://www.digimat.in/nptel/courses/video/108107107/L02.html
- https://www.youtube.com/watch?v=tYzYok3Vo9c
- https://www.youtube.com/watch?v=ppiIvlLiXsA
- https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=10517940

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

- Contents related activities (Activity-based discussions).
  - Group Discussion.
  - Case- Study.

INTERNSHIP

Course Code	**22ECE83**	**CIE Marks**	**100**
L:T:P:S	**0:0:10:0**	**SEE Marks**	**100**
Hrs / Week	**20**	**Total Marks**	**200**
Credits	**10**	**Exam Hours**	**03**

Course outcomes:

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

22ECE83.1	Identify the Research/industry and their products/expertise/domain, and interact with the authorities there
22ECE83.2	Understand their operations, applications, and maintenance; the research/ industry's business model; and industry innovations/achievements
22ECE83.3	Interact with industrial personnel and follow engineering practices and discipline prescribed in industry
22ECE83.4	Communicate effectively through technical presentations, reports, and interactions, and identify career goals and paths based on individual attributes such as affinity, aptitude, strengths and challenges, and inputs from the in-plant training
22ECE83.5	Develop awareness about general workplace behavior and build interpersonal and team skills
22ECE83.6	Demonstrate excellent control of personal behaviour, ethics, and attitudes, and adhere to ethical norms relevant to the Research/Industrial internship location

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

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
22ECE83.1	3	3	-	-	-	-	-	-	-	-	-	3	2	2
22ECE83.2	3	-	-	-	-	-	-	-	3	-	-	3	2	2
22ECE83.3	3	3	2	-	-	-	-	-	-	3	-	-	2	2
22ECE83.4	3	3	2	-	-	-	-	-	3	3	3	3	2	2
22ECE83.5	3	3	2	-	2	-	-	-	3	3	3	3	2	2
22ECE83.6	3	3	2	-	2	3	3	3	3	-	3	3	2	2

Evaluation Procedure

Assessment of CIE (Continuous Internal Evaluation) Marks

(i) Single Discipline Internships

The CIE marks for a single-discipline internship will be awarded by a committee comprising the Head of the concerned Department and two faculty members, one of whom will be the internship guide.

The evaluation will be based on the following components:

- Internship diary – 50%
- Internship report – 25%
- Presentation skills and Q&A session – 25%

Note: The marks awarded for the internship report will be identical for all members of the same group.

(ii) Interdisciplinary Internships

For interdisciplinary internships, CIE marks will be awarded at the institution level, considering group-wise performance. The evaluation will involve all guides associated with the internship.

Participation of external guides, if available, is encouraged.
The assessment will be based on the same components and weightage:

- Internship diary – 50%
- Internship report – 25%
- Presentation skills and Q&A session – 25%

Assessment of SEE (Semester-End Examination) Marks

(i) Single Discipline Internships

Each student's individual contribution and performance in the internship will be evaluated during the department-level semester-end examination. The assessment will be based on:

- Internship diary – 50%
- Internship report – 25%
- Presentation skills and Q&A session – 25%

(ii) Interdisciplinary Internships

Students will be individually assessed in the SEE, which will be conducted separately by each department the student is affiliated with. The evaluation will consider:

- Internship diary – 50%
- Internship report – 25%
- Presentation skills and Q&A session – 25%

CIE Assessment Pattern (100 Marks)

RBT Levels		Internship
		100
L1	Remember	20
L2	Understand	20
L3	Apply	20
L4	Analyze	20
L5	Evaluate	20
L6	Create	-

SEE Assessment Pattern (100 Marks)

RBT Levels		Exam Marks Distribution (100)
L1	Remember	20
L2	Understand	20
L3	Apply	20
L4	Analyze	20
L5	Evaluate	20
L6	Create	-

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.

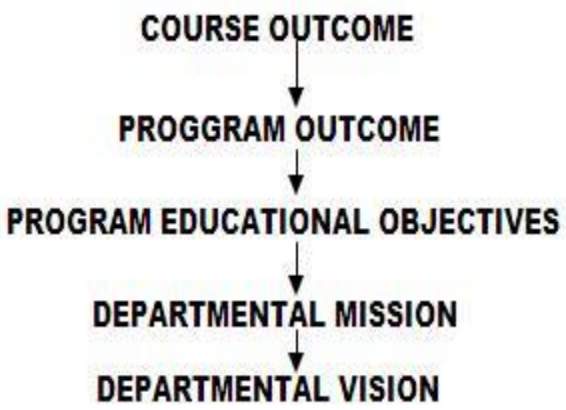
There are three educational Outcomes as defined by the National Board of Accreditation:

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.

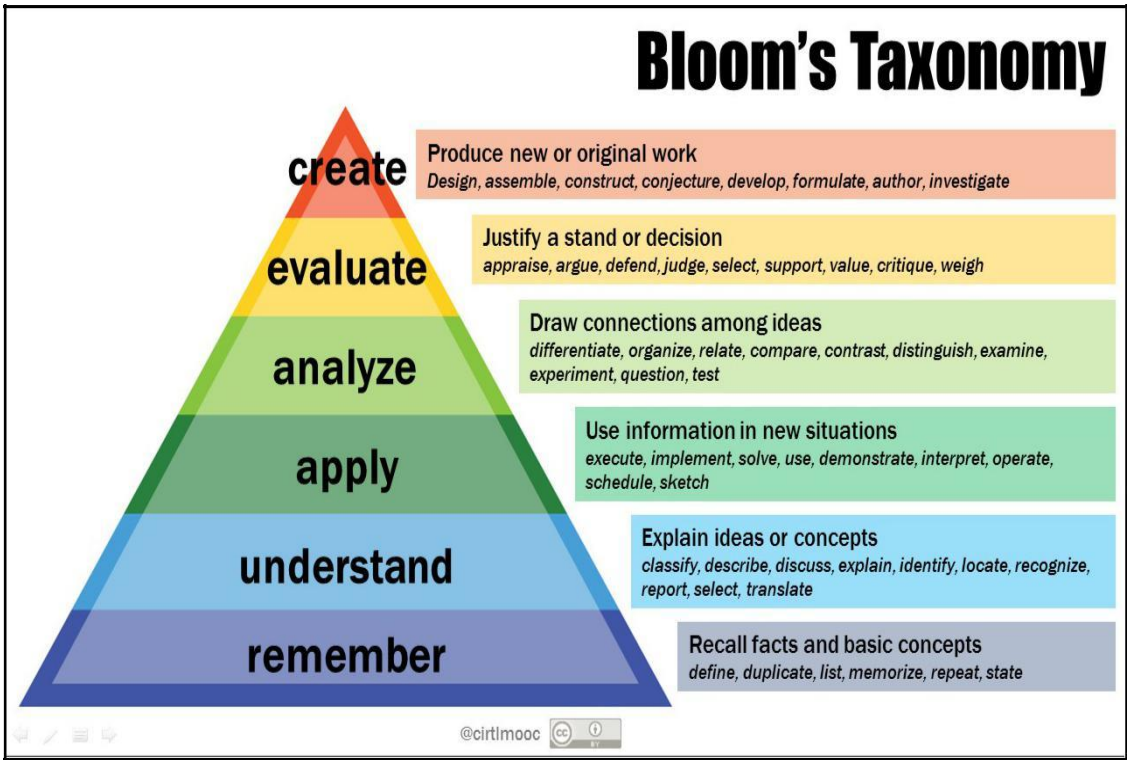
Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

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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