SILVER HORIZONS 25 YEARS OF GLOBAL LEARNING

NEW HORIZON COLLEGE OF ENGINEERING

Department of
Electronics and Communication Engineering

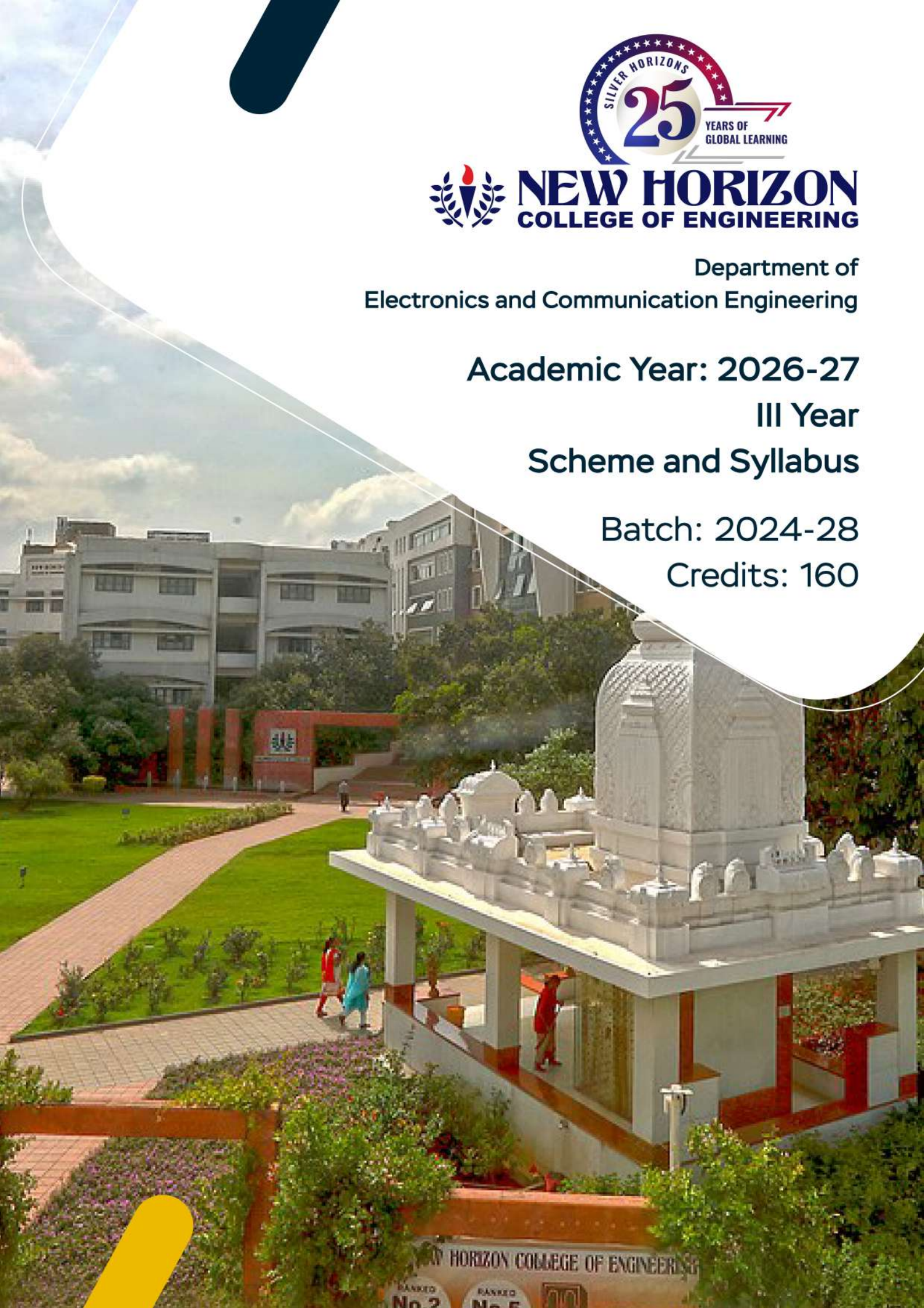
Academic Year: 2026-27

III Year

Scheme and Syllabus

Batch: 2024-28

Credits: 160



NEW HORIZON
COLLEGE OF ENGINEERING

Department of
Electronics and Communication Engineering
Academic Year 2026-27

5th and 6th Semester Scheme & Syllabus

BATCH: 2024-28

CREDITS: 160

NEW HORIZON
COLLEGE OF ENGINEERING

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

5th and 6th Semester Scheme & Syllabus

Academic Year 2026-27

BATCH:2024-28 (CREDITS:160)

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NEW HORIZON COLLEGE OF ENGINEERING

INSTITUTION

Vision

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

Mission

1. 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.
2. To encourage long-term interaction between the academia and industry through their involvement in the design of curriculum and its hands-on implementation.
3. 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 Engineering
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

KNOWLEDGE AND ATTITUDE PROFILE (WK)

S. No	Knowledge and Attitude Profile (WK)
1	WK1: A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.
2	WK2: Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.
3	WK3: A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline
4	WK4: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.
5	WK5: Knowledge, including efficient resource use, environmental impacts, whole-life cost, re use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.
6	WK6: Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.
7	WK7: Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.
8	WK8: Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.
9	WK9: Ethics, inclusive behaviour and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

PROGRAM OUTCOMES (POs)

S. No	Graduate Attributes	Program Outcomes (POs)
1	Engineering Knowledge	PO1: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
2	Problem Analysis	PO2: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
3	Design/Development of Solutions	PO3: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

4	Conduct Investigations of Complex Problems	PO4: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
5	Engineering Tool Usage	PO5: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
6	The Engineer and The World	PO6: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
7	Ethics	PO7: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
8	Individual and Collaborative Team work	PO8: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
9	Communication	PO9: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.
10	Project Management and Finance	PO10: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
11	Life-Long Learning	PO11: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8).

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 2024-2028 BATCH (2024 Scheme)

V Semester														
S. No.	**Course and Course Code**		**Course Title**	**BoS**	**Credit Distribution**				**Overall Credits**	**Contact Hours**	**Marks**		
					L	**T**	**P**	**S**			**CIE**	**SEE**	**Total**
1	HSMS	24ECE51	Operations Research and Management	EC	3	0	0	0	3	3	50	50	**100**
2	PCC	24ECE52	Communication Systems - I	EC	3	0	0	0	3	3	50	50	**100**
3	PCCL	24ECL52	Communication Systems - I Lab	EC	0	0	1	0	1	2	50	50	**100**
4	PCC	24ECE53	CMOS VLSI Design	EC	3	0	0	0	3	3	50	50	**100**
5	PCCL	24ECL53	CMOS VLSI Design Lab	EC	0	0	1	0	1	2	50	50	**100**
6	AEC*	24ECE54	Object Oriented Programming using Java	EC	3	0	0	0	3	3	50	50	**100**
7	AEC	24RMK55	Research Methodology and IPR	EC	1	0	0	0	1	1	50	50	**100**
8	AEC	24SDK56	Problem Solving Methodologies	-	0	0	1	0	1	2	50	-	**50**
9	PROJ**	24ECE57	Societal Based Mini Project	EC	0	0	1	0	1	2	50	50	**100**
10	OEC*	26NHOP5XX	Industrial Open Elective Course – I	Offering dept.	3	0	0	0	3	3	50	50	**100**
11	NCMC	24NSS50	National Service Scheme	-	0	0	0	0	0	2	50	--	**50**
		24PED50	Physical Education and Sports	-									
		24YOG50	Yoga	-									
								Total	**20**	**26**	**550**	**450**	**1000**

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

AEC* (Skill Based Core Course):
Credit for AEC* with 03 (L: T: P: S) credits can be considered as (3: 0: 0: 0). The teaching and learning of these Courses will be based on hands-on. The Course content will be from Industry Certification Course Content. The Course Assessment will be based on CIE and SEE in practical mode.

Societal Based Mini Project **:
The Mini project can be done in any lab across college. A common slot in time table can be allotted across all departments.
Mini Project is a laboratory-oriented/hands on course that will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications etc. Based on the ability/abilities of the student/s and recommendations of the mentor. A student can do mini project as

(i) A group of 2 if mini project work is single discipline (applicable to all IT allied branches)
(ii) A group of 3- 4 if mini project work is single discipline (applicable to all Core Branches)
(iii) A group of 3 - 4 students if the Mini Project work is a multidisciplinary (Applicable to all Branches)

CIE procedure for Mini-project:
(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two faculty members of the Department, one of them being the Guide. The CIE marks awarded for the Mini-project work shall be based on the evaluation of the project report, project presentation skill, and question and answer session in the ratio of 50:25:25. The marks awarded for the project report shall be the same for all the batches mates.
(ii) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all the guides of the project.
The CIE marks awarded for the Mini-project, shall be based on the evaluation of the project report, project presentation skill, and question and answer session in the percentage ratio of 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

Industrial Open Elective Courses-I:
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.

National Service Scheme /Physical Education/Yoga: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education(PE) (Sports and Athletics), and Yoga (YOG) with the concerned coordinator of the course during the first week of III semesters. Activities shall be carried out between III semester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, and Yoga activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of degree.

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 2024-2028 BATCH (2024 Scheme)

VI Semester														
S. No.	**Course and Course Code**		**Course Title**	**BoS**	**Credit Distribution**				**Overall Credits**	**Contact Hours**	**Marks**		
					L	**T**	**P**	**S**			**CIE**	**SEE**	**Total**
1	PCC	24ECE61	Embedded System Design	EC	3	0	0	0	3	3	50	50	**100**
2	PCCL	24ECL61	Embedded System Design Lab	EC	0	0	1	0	1	2	50	50	**100**
3	PCC	24ECE62	Communication Systems - II	EC	3	0	0	0	3	3	50	50	**100**
4	PCCL	24ECL62	Communication Systems - II Lab	EC	0	0	1	0	1	2	50	50	**100**
5	PCC	24ECE63	Introduction to Networking	EC	3	0	0	0	3	3	50	50	**100**
6	PEC	24ECE64X	Professional Elective Course-II	EC	3	0	0	0	3	3	50	50	**100**
7	AEC	24ECE65X	Ability Enhancement Course-V	EC	0	0	1	0	1	2	50	50	**100**
8	NCMC	24SDK66	Advanced Problem Solving Methodologies	-	0	0	0	0	0	2	50	--	**50**
9	PROJ	24ECE67	Capstone Project	EC	0	0	2	0	2	4	50	50	**100**
10	PCC	26NHOP6XX	Industrial Open Elective Course-II	Offering Dept.	3	0	0	0	3	3	50	50	**100**
11	NCMC	24NSS60	National Service Scheme	-	0	0	0	0	0	2	50	--	**50**
		24PED60	Physical Education	-									
		24YOG60	Yoga	-									
								Total	**20**	**29**	**550**	**450**	**1000**

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

Professional Elective Course-II			
24ECE641	Smart Sensor Technology	24ECE644	Image Processing
24ECE642	RTL Design and Verification	24ECE645	Machine Learning Algorithms
24ECE643	Optical Communication		

Ability Enhancement Course – V			
24ECE651	Computer-aided Simulation of Antennas	24ECE654	EMF programming using Octave
24ECE652	FPGA verification using Chipscope	24ECE655	Timing Optimization using Cadence
24ECE653	Linux and Shell Programming		

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.

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

Capstone Project :

Students have to discuss with the mentor /guide and with their help he/she has to complete the literature survey and prepare the report and finally define the problem statement for the project work.

The objective of the Project work is

- To encourage independent learning and the innovative attitude of the students.
- To develop interactive attitude, communication skills, organization, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire team working.
- To expand intellectual capacity, credibility, judgment and intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To install responsibilities to oneself and others.
- 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.

National Service Scheme /Physical Education/Yoga: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education(PE) (Sports and Athletics), and Yoga (YOG) with the concerned coordinator of the course during the first week of III semesters. Activities shall be carried out between III semester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, and Yoga activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of degree.

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

FIFTH SEMESTER SYLLABUS

OPERATIONS RESEARCH AND MANAGEMENT			
Course Code	**24ECE51**	**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:

24ECE51.1	Apply basic principles of project management and engineering economy to analyse time-cost trade-offs in real-time projects
24ECE51.2	Estimate interest rates, cash flows and costs of materials, production and overheads to evaluate the economic feasibility of engineering projects
24ECE51.3	Promote entrepreneurship as an individual or as a group by creating awareness on its needs and roles with respect to growth of economic development
24ECE51.4	Analyze cost structures and break-even conditions to develop economically viable solutions for small-scale engineering enterprises
24ECE51.5	Analyze and solve sequencing problems for n jobs on single, two, three and m machines using appropriate algorithms and graphical methods
24ECE51.6	Apply game theory concepts to analyze competitive decision-making problems and determine optimal strategies

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
24ECE51.1	3	3	-	-	-	-	-	-	-	-	3	-	-
24ECE51.2	3	3	-	-	-	-	-	-	-	-	3	-	-
24ECE51.3	3	3	2	-	-	2	-	2	2	2	3	-	-
24ECE51.4	3	3	2	-	2	-	-	-	-	-	3	-	-
24ECE51.5	3	3	2	2	2	-	-	-	-	-	3	-	2
24ECE51.6	3	3	2	2	2	-	-	2	-	-	3	-	2

MODULE-1	**PROJECT MANAGEMENT WITH TIME-COST ANALYSIS**	**24ECE51.1, 24ECE51.2**	**8 Hours**

Introduction, Definition of project, characteristics of projects, types of projects, need for project management, phases of project life cycle management, impact of delays in project completions, roles and responsibilities of project leader.

Engineering Economy: Law of demand and supply, Law of returns; Interest and Interest factors: Interest rate, Simple interest, Compound interest; Cash-flow diagrams for project phases; Personal loans and EMI Payment.

Exercises: Numerical problems on simple interest, compound interest, EMI computation and cash-flow diagram construction for real project scenarios.

Applications	Create a project management plan for a real-time project, construct its cash-flow diagram, and solve EMI and compound-interest problems related to project financing.
Text Book	Text Book 1: 1.1, 1.1, 1.8, 1.9, 1.10, 1.18, 1.16, Text Book 2: Chapters 1, 2 and 4

MODULE-2	**ENTREPRENEURSHIP, SSI AND COST ESTIMATION**	**24ECE51.2, 24ECE51.3, 24ECE51.4**	**8 Hours**

Meaning, Functions, Types & Stages in entrepreneurial process; Role of entrepreneurs in Economic Development. Entrepreneurship in India; women entrepreneurs, Entrepreneurship – its Barriers. SSI; Effect of WTO/GATT; Supporting Agencies of Government for SSI

Cost Estimation for SSI: Components of costs – Direct Material Costs, Direct Labour Costs, Fixed Overheads, Factory cost, Administrative Overheads, First cost, Marginal cost, Selling price; Estimation for simple components; Break-even analysis.

Exercises: Numerical problems on cost estimation and break-even point calculation for small-scale manufacturing scenarios.

Case Study	Study women-empowerment-based Small-Scale Industries (SSIs), analyse their cost structure using the component-of-cost framework, and solve break-even problems for a sample SSI product.		
Text Book	Text Book 3: 2.2, 2.3, 2.4 to 2.15, Text Book 2: Chapters 1, 2 and 4		
MODULE-3	**SEQUENCING – SINGLE MACHINE AND TWO/THREE MACHINES**	**24ECE51.5**	**8 Hours**
Basic assumptions in sequencing; Sequencing 'n' jobs on a single machine using priority rules (FCFS, SPT, LPT, EDD) – algorithm and solved examples. Johnson's Rule – Sequencing 'n' jobs on 2 machines: algorithm, optimality, and numerical examples. Sequencing 'n' jobs on 3 machines – conversion to equivalent 2-machine problem and solved numerical examples.			
Case Study	Analyze job sequencing of *n* jobs on single and two machines using a real-time manufacturing or service industry example and compare optimal sequences obtained using different priority rules.		
Text Book	Text Book 4: Chapter 11		
MODULE-4	**SEQUENCING – MULTIPLE MACHINES AND GRAPHICAL METHOD**	**24ECE51.5**	**8 Hours**
Sequencing 'n' jobs on 'm' machines: assumptions, procedure, and numerical examples. Sequencing 2 jobs on 'm' machines using the Graphical Method: construction of the graph, identification of the optimal path, computation of makespan, and worked examples. Exercises: Problems combining n-jobs on m-machines and graphical method; makespan analysis and comparison of sequences			
Self-study	Study applications of multi-machine sequencing in manufacturing and service industries and prepare a brief report on scheduling strategies used in practice.		
Text Book	Text Book 4: Chapter 11		
MODULE-5	**GAME THEORY**	**24ECE51.6**	**8 Hours**
Formulation of games, Two-person Zero-sum game, games with and without saddle point. Mixed strategies – Expected value method; Graphical solution (2×n and m×2 games); Dominance property. Exercises: Numerical problems on saddle point identification, mixed strategy computation, graphical solution and dominance reduction.			
Case Study	Analyze game theory concepts using real-time examples such as competitive pricing strategies, market entry decisions, or bidding in auctions.		
Text Book	Text Book 4: Chapter 14		

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	-
L4	**Analyze**	10	5	5
L5	**Evaluate**	-	-	**5**
L6	**Create**	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1) Timothy J Kloppenborg, "Contemporary Project Management", Cengage Learning, 4th Edition, 2022, ISBN: 9780357042090.
2) Engineering Economy, Leland T. Blank and Anthony J. Tarquin, McGraw Hill Education, 9th Edition, 2024.
3) Project Management: A Systems Approach to Planning, Scheduling, and Controlling, Harold Kerzner, Wiley, 13th Edition, 2022, ISBN: 9781119805373.
4) Operations Research: Theory, Methods and Applications, S. D. Sharma and Himanshu Sharma, Kedar Nath Ram Nath Publications, 18th Revised Edition, 2017, ISBN: 9789380803388.

Reference Books:

1) Engineering Economy, Thuesen H.G., PHI, 2022, ISBN: 9788120300040.
2) Operations Research: Principles and Practice, A. Ravindran, John Wiley & Sons, 2nd Edition, 2022, ISBN: 9781118886144.
3) Principles of Economics, N. Gregory Mankiw, Cengage Learning, 10th Edition, 2024.
4) Operations Research: An Introduction, Hamdy A. Taha, Pearson Education, 11th Edition, 2024, ISBN: 978-1292458755 (Global Edition).

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc26_mg66/preview (Project Management)
- https://www.youtube.com/watch?v=KnZdHPs04EI — "Drawing Cash Flow Diagrams - Engineering Economics Lightboard"
- https://www.youtube.com/watch?v=1vdAxZHDEf4 — "Industrial Engineering Lecture 1: Break even analysis, production system, fixed and variable cost"
- https://www.youtube.com/watch?v=O3Zuq9-9Hu0 — "Single machine sequencing. Two machine flow shop – Johnson's algorithm" (NPTEL, Prof. G. Srinivasan, IIT Madras)
- https://www.youtube.com/watch?v=wG-dm40Zn9s — "Graphical Method in Game Theory/Sequencing
  | 2xn and mx2 game without saddle point | Operation Research"
- https://www.youtube.com/watch?v=lm_VuwavA_Y — "Game Without Saddle Point | 2x2 Game without saddle Point | Problems Solved | Operation Research"

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

- Demonstration of project management and cash-flow analysis using a real-time project example.
- Cost estimation exercise: Students estimate production cost and break-even point for a sample SSI product.
- Sequencing problem-solving workshop: Students solve scheduling problems using Johnson's algorithm with real manufacturing datasets.
- Game theory case study: Group discussion on competitive pricing strategies using two-person zero-sum game formulation.

COMMUNICATION SYSTEMS – I

Course Code	**24ECE52**	**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:

24ECE52.1	Analyze the principles and performance characteristics of analog modulation and demodulation techniques
24ECE52.2	Compare analog modulation schemes based on power efficiency and bandwidth requirements
24ECE52.3	Analyze Power spectral density, Gaussian processes, and stochastic mobile radio channel models
24ECE52.4	Examine the fundamentals of digital communication for baseband signal processing and coding techniques
24ECE52.5	Compare digital modulation techniques based on Bit Error Rate performance
24ECE52.6	Evaluate optimum receiver techniques for signal detection and estimation

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
24ECE52.1	3	3	-	2	-	-	-	-	-	-	2	3	2
24ECE52.2	3	3	-	2	2	-	-	-	-	-	2	3	2
24ECE52.3	3	3	-	2	2	-	-	-	-	-	2	3	2
24ECE52.4	3	3	-	2	2	-	-	-	-	-	2	3	2
24ECE52.5	3	3	-	2	2	-	-	-	-	-	2	3	2
24ECE52.6	3	3	-	2	2	-	-	-	-	-	2	3	2

MODULE-1	**AMPLITUDE MODULATION**	**24ECE52.1, 24ECE52.2**	**8 Hours**

Introduction, Amplitude Modulation, Double side band-suppressed carrier modulation, Single Sideband and Vestigial Sideband Methods of Modulation, Frequency- Division Multiplexing.

Application	VSB transmission in analog and digital television systems.
Text Book	Text Book 1: 3.1-3.3, 3.5, 3.8

MODULE-2	**ANGLE MODULATION AND RANDOM PROCESSES**	**24ECE52.1, 24ECE52.2 24ECE52.3**	**8 Hours**

Phase and Frequency modulation: Introduction, Basic definitions, Frequency Modulation, Generation of FM Signals, Demodulation of FM Signals, Phase–Locked Loop.
Random processes, Ergodic Processes, Power Spectral Density, Gaussian process, Theme Example—Stochastic Model of a Mobile Radio Channel.

Application	Modelling communication-channel noise using Gaussian random processes and power spectral density.
Text Book	Text Book 1: 4.1 – 4.6, 5.5, 5.8, 5.12

MODULE-3	**WAVEFORM CODING TECHNIQUES**	**24ECE52.4**	**8 Hours**

Practical aspects of sampling and signal recovery, Pulse Amplitude Modulation, Time Division Multiplexing Pulse code modulation, Quantization noise and Signal-to-noise ratio, Discrete PAM signals, Intersymbol Interference, Nyquist's Criterion for Distortion less Baseband Binary Transmission.

Application	PCM in digital telephony and speech transmission.
Text Book	Text Book 2: 4.5-4.7, 5.1, 5.3, 6.1, 6.3, 6.4

MODULE-4	DIGITAL MODULATION TECHNIQUES	24ECE52.5	8 Hours
Digital Modulation formats, Coherent binary modulation techniques- Coherent Binary PSK, Coherent Binary FSK, Coherent quadrature modulation techniques-Quadri phase-shift keying, Noncoherent binary modulation techniques-Differential PSK, M-ary Modulation Techniques- M-ary QAM.			
Self-study	Comparative BER performance of BPSK, BFSK, QPSK and DPSK over an AWGN channel.		
Text Book	Text Book 2: 7.1, 7.2, 7.3 (1), 7.4 (2), 7.6 (2)		
MODULE-5	**DETECTION AND ESTIMATION**	**24ECE52.6**	**8 Hours**
Model of Digital Communication System, Gram-Schmidt Orthogonalization procedure, Geometric interpretation of signals, Detection of known signals in noise, Correlation receiver, Matched filter receiver Estimation: concepts and criteria, Maximum Likelihood Estimation.			
Self-study	Signal detection using matched-filter and correlation receivers in the presence of AWGN.		
Text Book	Text Book 2: 3.1–3.3, 3.5, 3.7, 3.8, 3.10, 3.11		

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	-
L4	Analyze	10	5	5
L5	Evaluate	-	-	5
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1) Simon Haykin, Michael Moher, Ajay Singh Raghuvanshi and Shweta Shah, Communication Systems, 5th Edition, An Indian Adaptation, Wiley India Pvt. Ltd., 2022, ISBN: 978-93-5464-089-6.

2) Digital Communications, Simon Haykin, Publisher: WILEY India Pvt. Ltd, 2006, ISBN- 81-265-0824-8

Reference Books:

1) Simon Haykin and Michael Moher, Introduction to Analog and Digital Communications, 2nd Edition, An Indian Adaptation, Wiley India Pvt. Ltd., 2022, 672 pages, ISBN: 978-93-5464-433-7

2) B. P. Lathi and Zhi Ding, Modern Digital and Analog Communication Systems, 5th Edition, Oxford University Press, 2022, ISBN: 978-0-19-068686-4.

3) George Kennedy, Bernard Davis and S. R. M. Prasanna, *Kennedy's Electronic Communication Systems*, 6th Edition, McGraw Hill Education, 2017, ISBN: 978-93-5260-660-3.

Web links and Video Lectures (e-Resources): • https://www.youtube.com/watch?v=-PWg-0k2oks • https://www.youtube.com/watch?v=ZW1glqkIgcwSt=135s • https://www.youtube.com/watch?v=692SRjrT2MY • https://www.youtube.com/watch?v=wMflxR3KsXgSlist=PLt3Fk5B7L7NZJv3PAZkxW83 Fp7ww6 JE
Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning • Visit to any communication-based company/public sector enterprise. • Simulation demonstration on modulation processes. • Video demonstration of latest trends in communication sector. • Contents related activities (Activity-based discussions) ➢ For active participation of students, instruct the students to prepare presentations on 19 current research topics in communication sector. ➢ Organizing Group wise discussions on applications or products. ➢ Seminars.

COMMUNICATION SYSTEMS – I LAB

Course Code	**24ECL52**	**CIE Marks**	**50**
L:T:P:S	**0:0:1:0**	**SEE Marks**	**50**
Hrs / Week	**2**	**Total Marks**	**100**
Credits	**01**	**Exam Hours**	**03**

Course outcomes:

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

24ECL52.1	Demonstrate the generation and detection of analog modulation techniques
24ECL52.2	Analyze pulse modulation systems and their performance
24ECL52.3	Examine the different digital modulation schemes used in the field of communication
24ECL52.4	Evaluate the performance of modulation and demodulation techniques in various transmission environments

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
24ECL52.1	3	3	2	1	3	-	-	2	-	-	3	3	3
24ECL52.2	3	3	2	1	3	-	-	2	-	-	3	3	3
24ECL52.3	3	3	2	1	3	1	-	2	-	-	3	3	3
24ECL52.4	3	3	2	1	3	1	-	2	-	-	3	3	3

Exp. No. / Pgm. No.	List of Experiments / Programs	Hours	Cos
	Prerequisite Experiments / Programs / Demo		
	• To learn the basics of using MATLAB simulation software, and also to learn the communication system toolbox in MATLAB • https://youtu.be/Ul9lup_hjnY	2	NA
	PART-A		
1	To generate amplitude modulation using a transistor.	2	24ECL52.1
2	Generation and detection of ASK.	2	24ECL52.1
3	Generation and detection of PAM.	2	24ECL52.1
4	Generation of PWM.	2	24ECL52.1
5	Generation of FSK using IC 555 Timer	2	24ECL52.2
6	Generation of PSK.	2	24ECL52.2
	PART-B		
7	Frequency Modulation and Demodulation using MATLAB.	2	24ECL52.2
8	Implementation and analysis of QPSK modulation and demodulation.	2	24ECL52.2
9	Generation and detection of Pulse Code Modulation using MATLAB.	2	24ECL52.3
10	Realize Time Division Multiplexing and Demultiplexing of two band-limited signals.	2	24ECL52.3
11	Signal-to-Noise Ratio Calculation Using MATLAB.	2	24ECL52.4
12	Simulation of QAM Generation and Detection Schemes.	2	24ECL52.4

PART-C

Beyond Syllabus Virtual Lab Content

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

1. Method to set and measure the depth of modulation and trapezoidal display. **https://web.njit.edu/~gilhc/ECE489/ece489-V.htm**
2. Study the envelope of a wideband signal. **https://web.njit.edu/~gilhc/ECE489/ece489-VI.htm**
3. Explore Two path channel pass band simulation. **https://www.etti.unibw.de/labalive/experiment/two-path-channel-baseband/**

4. Examination of AM transmission - synchronous detector.
   https://www.etti.unibw.de/labalive/experiment/amtransmissionsynchronousdetector/
5. Encode and decode messages and observe the impact of coding on error detection and correction.
   https://in.mathworks.com/help/comm/ug/error-detection-and-correction.html
6. Computation of BER for QAM System with AWGN Using MATLAB.
   https://in.mathworks.com/help/comm/gs/use-pulse-shaping-on-16-qam-signal.html

CIE Assessment Pattern (50 Marks – Lab)

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

SEE Assessment Pattern (50 Marks – Lab)

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

Suggested Learning Resources:

Reference Books:

1) Digital Communications: Fundamentals and Applications, 3rd edition Published by Pearson (12 July 2021) © 2022 Bernard Sklar, Fredric J. Harris ISBN-13: 9780137569076 (2021 update).

2) Raveendranathan, K. C. Communication systems modelling and simulation: using MATLAB and Simulink. Universities Press, 2011. ISBN: 978-81-737-1722-2.

3) Hari, Bhat K N, Digital Communications with Lab Manual, 3/E. Pearson Education India, 2010. ISBN-10. 8131732371; ISBN-13. 978-8131732373.

CMOS VLSI DESIGN

Course Code	**24ECE53**	**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:

24ECE53.1	Apply the basic concepts and generic model of MOSFETs to analyze their operating characteristics in CMOS circuits.
24ECE53.2	Identify the process sequence for the fabrication of ICs and the relevant layout design rules
24ECE53.3	Apply delay models to analyse the timing characteristics of combinational MOS circuits.
24ECE53.4	Compare different combinational MOS circuit design styles based on their performance characteristics.
24ECE53.5	Analyze sequential MOS circuits considering delay and timing constraints.
24ECE53.6	Evaluate the role and functionality of Data path and array subsystems in CMOS Integrated Circuits

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
24ECE53.1	3	-	-	-	-	-	-	-	-	-	-	3	2
24ECE53.2	3	3	1	-	-	-	-	-	-	-	2	3	2
24ECE53.3	3	3	-	-	-	-	-	-	-	-	2	3	2
24ECE53.4	3	3	1	2	-	-	-	-	-	-	2	3	2
24ECE53.5	3	3	-	2	-	-	-	-	-	-	2	3	2
24ECE53.6	3	3	1	2	-	-	-	-	-	-	2	3	2

MODULE-1	**MOS TRANSISTORS**	**24ECE53.1**	**8 Hours**

MOS Transistors: Introduction, MOS transistors, CMOS Logic, Design portioning. MOS Transistor Theory: Introduction, Long-Channel I-V characteristics, C-V Characteristics - Simple MOS Capacitance Models, Non-ideal I-V effects, DC transfer characteristics.

Self-study	Investigate how to Enhance the Power Efficiency in Mobile Devices with Advanced MOS Transistor Technology.
Text Book	Text Book-1: 1.3, 1.4, 1.6, 2.1, 2.2, 2.3 (up to 2.3.1), 2.4, 2.5

MODULE-2	**CMOS PROCESSING TECHNOLOGY**	**24ECE53.2**	**8 Hours**

CMOS Processing Technology: CMOS Fabrication and Layout, Exercises for stick diagram and layout, CMOS Technologies, Layout Design Rules, CMOS Process Enhancements.

Case Study	Explore the Significance of CMOS technology in various electronic applications.
Text Book	Text Book 1: 1.5, 3.1, 3.2, 3.3, 3.4

MODULE-3	**DELAY & COMBINATIONAL CIRCUIT BASICS**	**24ECE53.3, 24ECE53.4**	**8 Hours**

Delay: Introduction, Transient Response, RC Delay Model – Effective Resistance, Gate and Diffusion Capacitance, Equivalent RC Circuits, Transient Response, Elmore Delay, Layout Dependence of Capacitance, Linear Delay Model – Logical Effort, Parasitic Delay, Delay in a Logic Gate, Drive. Combinational Circuit Basics: Introduction, Circuit Families – Static CMOS.

Applications	Optimization of combinational circuits to minimize delay.
Text Book	Text Book 1: 4.1, 4.2, 4.3 (excluding 4.3.7), 4.4 (up to 4.4.4), 9.1, 9.2 (up to 9.2.1)

MODULE-4	**COMBINATIONAL & SEQUENTIAL CIRCUIT**	**22ECE53.4, 24ECE53.5**	**8 Hours**

Combinational Circuit Design: Circuit Families – Ratioed Circuits, Cascode Voltage Switch Logic, Dynamic Circuits- Domino Logic, Silicon-On-Insulator Circuit Design.

Sequential Circuit Design: Introduction, Sequencing Static Circuits, Circuit Design of Latches and Flip- Flops

- Conventional CMOS Latches, Conventional CMOS Flip-Flops, Pulsed Latches, Resettable Latches and Flip-Flops.			
Applications	Evaluation of Delay in CMOS Circuits		
Text Book	Text Book 1: 9.2 (up to 9.2.4.1), 9.5, 10.1, 10.2, 10.3 (up to 10.3.4)		
MODULE-5	**DATA PATH AND ARRAY SUBSYSTEMS**	**24ECE53.6**	**8 Hours**
Data Path Subsystems: Addition/Subtraction, Single bit addition, one/zero detectors, Binary counters, XOR/XNOR Circuit forms. Array Subsystems: Introduction, Design of Row and Column decoder()			
Self-study	Emphasizes the importance of CMOS subsystems analysis and optimization of CMOS VLSI design. Introduction, Static Read Write Memory Circuits, SRAM Operation, Power Consumption, SRAM Read Write Circuitry, Sense Amplifier, DRAM Circuits, Operation of 3T DRAM.		
Text Book	Text Book 1: 11.1-11.2.1, 11.3,11.5.1, 11.7.4, Text Book 2: 10.1, 10.3(417,431),10.4(435-442).		

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	5	**-**
L4	**Analyze**	10	5	5
L5	**Evaluate**	-	5	5
L6	**Create**	**-**	**-**	**-**

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1) Neil H. E. Weste and David Money Harris, *CMOS VLSI Design: A Circuits and Systems Perspective*, 4th Edition, Pearson, 2015, ISBN-13: 978-0321547743

2) Sung-Mo Kang and Yusuf Leblebici, *CMOS Digital Integrated Circuits: Analysis and Design*, 3rd Edition, McGraw-Hill, 2002/2003, ISBN-13: 978-0071243421.

Reference Books:

1) M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, *Digital Integrated Circuits: A Design Perspective*, 2nd Edition, Prentice Hall/Pearson, 2002/2003, ISBN-13: 978-0130909961.

2) Douglas A. Pucknell and Kamran Eshraghian, *Basic VLSI Design*, 3rd Edition, Prentice-Hall of India, ISBN-13: 978-8120309869.

3) J. Bhasker and Rakesh Chadha, *Static Timing Analysis for Nanometer Designs: A Practical Approach*, 1st Edition, Springer, 2009, ISBN-13: 978-0387938196.

Web links and Video Lectures (e-Resources):

- **https://onlinecourses.nptel.ac.in/noc22_ge24/preview**
- **https://onlinecourses.nptel.ac.in/noc21_ee09/preview**
- **https://nptel.ac.in/cour-ses/117101105**
- **https://biodesign.berkeley.edu/bioinspired-design-course/**
- https://www.youtube.com/watch?v=cwxXY9Qe8ss

• https://www.youtube.com/watch?v=V2GvQXvjhLA • https://nsf-gov-resources.nsf.gov/2023-03/Bio-inspired%20Design %20Workshop%20Report_2232327_October%202022_Final.508.pdf
Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning • Visit to any VLSI Industry. • Demonstration of Layout/STA/Fabrication Process. • Demonstration of working of Silicon Fab. • Demonstration of purification Silicon from MGS to EGS. • Video demonstration of latest trends in Semiconductor and VLSI Industry. • Contents related activities (Activity-based discussions) • For active participation of students, instruct the students to prepare Flowcharts and Handouts. • Organizing Group wise discussions on issues. • Seminars.

CMOS VLSI DESIGN LAB

Course Code	**24ECL53**	**CIE Marks**	**50**
L:T:P:S	**0:0:1:0**	**SEE Marks**	**50**
Hrs / Week	**2**	**Total Marks**	**100**
Credits	**01**	**Exam Hours**	**03**

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

24ECL53.1	Analyze the operation and performance of analog and digital CMOS circuits using simulation tools
24ECL53.2	Design and validate CMOS circuit layouts from schematic diagrams while adhering to layout design rules.
24ECL53.3	Apply switch-level modeling techniques to represent and evaluate the behavior of digital CMOS circuits.
24ECL53.4	Develop and verify gate-level descriptions of digital CMOS circuits for simulation and synthesis applications

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
24ECL53.1	3	3	-	3	3	-	-	-	-	-	-	3	3
24ECL53.2	3	3	3	3	3	-	-	-	-	-	-	3	3
24ECL53.3	3	3	3	3	3	-	-	-	-	-	-	3	3
24ECL53.4	3	3	3	3	3	-	-	-	-	-	-	3	3

Exp. No. / Pgm. No.	List of Experiments / Programs	Hours	COs
	Prerequisite Experiments / Programs / Demo		
	• Introduction to CMOS VLSI Design and analog VLSI Design. Introduction to Verilog and System Design using Verilog.	2	NA
	PART-A		
1	Draw the schematic of CMOS Inverter for the given specifications, and verify using Transient and DC Analyses.	2	24ECL53.1 24ECL53.2
2	Draw the schematic of the following circuits for the given specifications, and verify using Transient and DC Analyses: i) 2-input CMOS NAND gate, ii) 2-input CMOS NOR gate.	2	24ECL53.1 24ECL53.2
3	Draw the schematic of transmission gate for the given specifications, and verify using Transient and DC Analyses.	2	24ECL53.1 24ECL53.2
4	Draw the schematic of Common Source amplifiers for the given specifications, and verify the same using Transient, DC and AC Analyses.	2	24ECL53.1 24ECL53.2
5	Draw the layout of the CMOS Inverter and perform physical verification using DRC, ERC and LVS. Extract RC and back-annotate the same and verify the Design.	2	24ECL53.1 24ECL53.2
6	Draw the layout for 2-input CMOS NAND gate and perform physical verification using DRC, ERC and LVS. Extract RC and back-annotate the same and verify the Design.	2	24ECL53.1 24ECL53.2
	PART-B		
7	For the following circuits, write the switch level Verilog Code, and verify using Test Bench: i) CMOS inverter, ii) 2-input CMOS NAND and NOR gates.	2	24ECL53.3 24ECL53.4
8	For the following circuits, write the switch level Verilog Code and verify using Test Bench: i) 2-input EXOR gate using CMOS logic, ii) 2-input EXOR gate using PTL.	2	24ECL53.3 24ECL53.4
9	Synthesize the following circuits using the gate level Verilog Code, with the given Constraints: i) CMOS inverter, ii) 2-input CMOS NAND and NOR gates.	2	24ECL53.3 24ECL53.4

10	For the following circuits, write the Verilog Code, verify using Test Bench, and then synthesize with the given Constraints: i) 4-bit Parallel adder ii) D Flip-flop.	2	24ECL53.3 24ECL53.4
11	For the following circuits, write the Verilog Code, verify using Test Bench, and then synthesize with the given Constraints: i) T Flip-flop, ii) 4-bit Synchronous counter.	2	24ECL53.3 24ECL53.4
12	Write the Verilog Code for Sequence detector using Moore model, verify using Test Bench, and then synthesize with the given Constraints.	2	24ECL53.3 24ECL53.4

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

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

CIE Assessment Pattern (50 Marks – Lab)

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

SEE Assessment Pattern (50 Marks – Lab)

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

Suggested Learning Resources:
Reference Books

1. Neil H. E. Weste and David Harris, CMOS VLSI Design: A Circuits and Systems Perspective, 5th Edition, Pearson Education, 2023.
2. Jan M. Rabaey, Anantha Chandrakasan, and Borivoje Nikolić, Digital Integrated Circuits: A Design Perspective, 2nd Edition, Pearson Education, 2003.
3. Sung-Mo Kang and Yusuf Leblebici, CMOS Digital Integrated Circuits: Analysis and Design, 4th Edition, McGraw-Hill Education, 2021.
4. Samir Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis, 2nd Edition, Pearson Education, 2003.

OBJECT ORIENTED PROGRAMMING USING JAVA

Course Code	**24ECE54**	**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:

24ECE54.1	Apply fundamental Java programming concepts, including program structure, data types, operators, control statements, and user input, to develop basic Java programs
24ECE54.2	Apply arrays, strings, classes, objects, constructors, methods, and encapsulation concepts to write simple Java programs
24ECE54.3	Analyze object-oriented programming concepts such as inheritance, polymorphism, abstract classes, and interfaces in Java programs
24ECE54.4	Illustrate the use of packages, access modifiers, exception handling, and file handling techniques in Java programs
24ECE54.5	Apply the Java Collections Framework, wrapper classes, string processing techniques, and standard Java API libraries to solve programming problems
24ECE54.6	Demonstrate object-oriented programming concepts to solve simple real-world problems using Java

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 1	PSO 2
24ECE54.1	3	-	–	–	3	–	–	–	–	–	–	-	-
24ECE54.2	3	3	2	–	3	–	–	–	–	–	–	-	-
24ECE54.3	3	3	2	2	3	–	–	–	–	–	–	-	-
24ECE54.4	3	3	2	2	3	–	–	–	–	–	–	-	-
24ECE54.5	3	2	2	–	3	–	–	–	–	–	2	-	-
24ECE54.6	3	3	2	2	3	–	–	–	2	2	2	-	-

MODULE-1	**JAVA FUNDAMENTALS**	**24ECE54.1 24ECE54.6**	**8 Hours**

Introduction to Java programming, features and applications of Java, JVM, JDK and JRE, installation and IDE setup, structure of a Java program, identifiers, keywords, variables, data types, operators and expressions, type casting and type conversion, user input using the Scanner class, decision-making statements (if, if-else, switch), looping constructs (for, while, do-while), and basic programming applications using control statements.

Hands on:

1. Write a Java program to display "Hello World" and understand the structure of a Java program.
2. Write a Java program to perform arithmetic, relational, logical, and bitwise operations.
3. Write a Java program to demonstrate type casting and type conversion.
4. Write a Java program to accept user input using the Scanner class and perform basic calculations.
5. Write a Java program using conditional statements and looping constructs to solve programming problems.

Applications	Student Grade Calculator and Simple Banking Operations.

MODULE-2	**ARRAYS, STRINGS AND OOP**	**24ECE54.2 24ECE54.6**	**8 Hours**

One-dimensional and two-dimensional arrays, array declaration, initialization and traversal, string creation and manipulation using built-in String methods, classes and objects, methods, constructors (default and parameterized), encapsulation using private data members

Hands on:

1. Write a Java program to perform operations on one-dimensional and two-dimensional arrays.
2. Write a Java program to perform string manipulation using built-in String methods.
3. Write a Java program to create classes and objects for a real-world application.
4. Write a Java program to demonstrate constructors (default and parameterized).
5. Write a Java program to implement encapsulation using private data members.

Applications	Student Record Management System.		
MODULE-3	**INHERITANCE AND ABSTRACTION**	**24ECE54.3** **24ECE54.6**	**8 Hours**

Inheritance in Java, types of inheritance (single, multilevel and hierarchical), method overloading and method overriding, abstract classes and abstract methods, implementation of abstraction, and interfaces.

Hands on:

1. Write a Java program to demonstrate method overloading.
2. Write a Java program to demonstrate single and multilevel inheritance.
3. Write a Java program to demonstrate hierarchical inheritance.
4. Write a Java program to demonstrate method overriding using inheritance.
5. Write a Java program using abstract classes and abstract methods.

Case Study	Employee Payroll Management System.		
MODULE-4	**PACKAGES, EXCEPTIONS AND FILES**	**24ECE54.4** **24ECE54.6**	**8 Hours**

Packages and user-defined packages, access modifiers, importing packages, exception handling using try, catch, finally, throw, and throws, file handling concepts, reading from and writing to text files, and development of Java applications with proper error handling and file operations.

Hands on:

1. Write a Java program to create and use user-defined packages.
2. Write a Java program demonstrating access modifiers across different packages.
3. Write a Java program to implement exception handling using try, catch, finally, throw, and throws.
4. Write a Java program to read data from a text file.
5. Write a Java program to write and append data to a text file.

Applications	Library Management System.		
MODULE-5	**COLLECTIONS FRAMEWORK AND WRAPPER CLASSES**	**24ECE54.5**	**8 Hours**

Introduction to the Java Collections Framework, ArrayList, HashSet, and HashMap, wrapper classes, autoboxing and unboxing, string processing using the String class, commonly used Java API libraries.

Hands on:

1. Write a Java program to store and display student names using an ArrayList.
2. Write a Java program to perform basic operations (add, remove, search, display) using a HashSet.
3. Write a Java program to store and display student details using a HashMap.
4. Write a Java program to demonstrate the use of wrapper classes and autoboxing/unboxing.

Case Study	Student Information Management System.

CIE Assessment Pattern (50 Marks – Hands On) –

RBT Levels		**Marks Distribution**		
		Test (s)	**Online Learning / Certification**	**Weekly Assessment**
		25	**15**	**10**
L1	**Remember**	**-**	**-**	**-**
L2	**Understand**	-	-	5
L3	**Apply**	10	10	5
L4	**Analyze**	10	5	-
L5	**Evaluate**	5	-	-
L6	**Create**	-	-	-

SEE Assessment Pattern (50 Marks)

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

Reference Books:

1. Herbert Schildt, *Java: The Complete Reference*, 13th Edition, McGraw Hill, 2024. ISBN: 9789355325464
2. Paul Deitel and Harvey Deitel, *Java How to Program*, 12th Edition, Pearson, 2023. ISBN: 9780137896318

Web links and Video Lectures (e-Resources) :
IITB course on Java
https://spoken-tutorial.org/tutorial-search/?search_foss=JavaSsearch_language=English

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

- Contents related activities (Activity-based discussions)
- For active participation of students, instruct the students to prepare Flowcharts and Handouts.
- Organizing Group wise discussions on issues.

RESEARCH METHODOLOGY AND IPR

Course Code	**24RMK55**	**CIE Marks**	**50**
L: T: P: S	**1:0:0:0**	**SEE Marks**	**50**
Hours / Week	**01**	**Total Marks**	**100**
Credits	**01**	**Exam Hours**	**02**

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

24RMK55.1	Define research problems and formulate research questions and research objectives.
24RMK55.2	Demonstrate research processes, critical thinking, and academic writing skills.
24RMK55.3	Understand the statutory provisions and different forms of Intellectual Property Rights (IPRs).
24RMK55.4	Identify the significance and procedures of patents, including patent filing and protection.

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

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
24RMK55.1	3	3	2	2	2	–	–	1	2	–	2
24RMK55.2	3	3	2	2	2	–	–	1	2	–	2
24RMK55.3	3	3	2	1	1	–	1	1	2	–	2
24RMK55.4	3	3	2	1	–	–	1	1	2	–	2

MODULE-1	**FORMULATION OF RESEARCH PROBLEM**	**24RMK55.1**	**3 Hours**
Research– Meaning and Objectives–Types of Research–Research Approaches-Research Process–Literature Review–Research Problem– Identification and Defining the Research Problem.			
Text Book	Text Book 1: Ch. 1, 2		
MODULE-2	**RESEARCH DESIGN PROCEDURES**	**24RMK55.2**	**3 Hours**
Meaning of Research Design – Features of a Good Design –Concepts Related to Research Design– Different Research Designs – Basic Principles of Experimental Designs.			
Case Study	To find the solution for the given research problem using different types of research Methods		
Text Book	Text Book 1: Ch. 3		
MODULE-3	**INTERPRETATION AND REPORT WRITING**	**24RMK55.1** **24RMK55.2**	**3 Hours**
Meaning and Technique of Interpretation – Precautions in interpretation – Different Steps in Report Writing – Layout of a Research Report– Types of Report – Mechanics of Writing a Research Report –Conclusion-Referencing in Academic Writing –Bibliography.			
Text Book	Text Book 2: Ch. 14		
MODULE-4	**INTRODUCTION TO IPR**	**24RMK55.3**	**3 Hours**
Introduction and Significance of Intellectual Property Rights –Types of Intellectual Property Rights–Rationale for Protection of IPR–IPR in India and Abroad–Forms of IPR – Royalty – Copyright – Trademark – Patents – Industrial Designs –Application of Different Forms of IPR– Future Aspects of IPR– Some Examples of IPR.			
Text Book	Text Book 2: Ch. 1 and 2		
MODULE-5	**BASICS OF PATENTS**	**24RMK55.3,24RMK55.4**	**3 Hours**
Patents and its Basics – Patentable and Non-Patentable Inventions–Patent Application Process (National and International level) –Drafting and Filing a Patent –Types of Patent Applications–Patent Documents–Specification and Claims–Assignment, Licensing, Infringement–Different Layers of International Patent System			
Case Study	Analyze different domains of filed patents		
Text Book	Text Book 2: Ch. 1 and 2		

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	Patent drafting	Review paper writing
		25	15	10
L1	Remember	5	-	-
L2	Understand	5	-	-
L3	Apply	5	-	-
L4	Analyze	5	5	5
L5	Evaluate	5	5	5
L6	Create	-	5	-

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1) Kothari, C.R., Research Methodology: Methods and Techniques, New Age International, 2024, ISBN-9789389802559
2) Ramakrishna Chintakunta, A Text book of Intellectual Property rights, Blue Hill Publication, ASIN: B09T6YDB5N, 2022

Reference Books:

1) Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K, An Introduction to Research Methodology, RBSA Publishers. 2022, ISBN-13:978-8176111652
2) Ranjith Kumar, Research methodology, Saga publications,5th edition, 2024, ISBN- 9781529788785.
3) Sinha, S.C. and Dhiman, A.K., Research Methodology, EssEss Publications. 2 volumes, 2022. ISBN: 81-7000-324-5(Vol-I), 81-7000-334-2 (Vol-II)
4) Asha Vijay Durafe, Dhanashree K. Toradmalle , Intellectual Property Rights, Dreamtech Press,2024, ISBN: 9789351195191.

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=GSeeyJVD0JU
- https://www.youtube.com/watch?v=nv7MOoHMM2k
- https://www.youtube.com/watch?v=BGSgZ1J8-yQ
- https://onlinecourses.nptel.ac.in/noc22_ge08/preview
- https://www.coursera.org/learn/research-methods
- https://www.wipo.int/academy/en/

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

- Video Sessions
- Organizing Group Wise Discussions
- Paper Presentation
- Review paper writing
- Patent drafting

PROBLEM SOLVING METHODOLOGIES

Course Code	**24SDK56**	**CIE Marks**	**50**
L:T:P:S	**0:0:1:0**	**SEE Marks**	**-**
Hrs / Week	**2**	**Total Marks**	**50**
Credits	**1**	**Exam Hours**	**02**

Course outcomes:
Upon successful completion of this course, the student will be able to:

24SDK56.1	Demonstrate proficiency in solving quantitative aptitude problems using fundamental concepts
24SDK56.2	Apply advanced quantitative techniques to address and solve complex real-world problems.
24SDK56.3	Develop and enhance logical reasoning skills essential for problem-solving in various competitive examinations.
24SDK56.4	Cultivate critical and creative thinking skills necessary for analytical reasoning and problem-solving.

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
24SDK56.1	3	3	-	-	2	-	-	-	-	-	-
24SDK56.2	3	3	-	-	2	-	-	-	-	-	-
24SDK56.3	3	3	-	-	2	-	-	-	-	-	-
24SDK56.4	3	3	-	-	2	-	-	-	-	-	-

MODULE-1	**Critical Thinking through Quantitative Analysis**	**24SDK56.1 24SDK56.2**	**6 Hours**

Number systems: LCM and HCF of numbers, Squaring and Cubing Techniques, Multiplication Tricks, Divisibility rules, Digit sum method, Speed Math, Simplifications, Approximations.

Percentages: Conversion of Fraction to Percentage Table, Percentage Change, Net percentage change/Effective percentage change, Successive Percentage, Concept of more/less percentage, Percentage of percentage, Product constancy, Increased/decreased by P%, Percentage Changes in Numerator and Denominator, Successive Percentage.

Averages: Basic concept, Consecutive Numbers, Non-Consecutive Numbers, Equation Concept, True/False concept, Including/Excluding concept, Replacement concept, Average Speed concept.

MODULE-2	**Numerical Techniques for Problem Solving**	**24SDK56.1 24SDK56.2**	**6 Hours**

Profit and Loss: Basic concept, Profit Percentage, Loss Percentage, Profit/Loss Percentage, Overall Profit/Loss, Dishonest shopkeeper, More/less loss concept, Discounts

Ratio and Proportion: Concept Explanation, Duplicate Ratio, Triplicate Ratio, Direct Proportion, Indirect Proportion, Double rule of three or compound proportion, Ratio in investment, Ratio in partnership, Ratio in averages, Ratio in profit and loss, Ratio in interest rates.

Ages: Ratio and sum of ages, Ratio and Product of Ages, Ratio of Present and Future Ages, Ratio of Past and Present Ages.

Partnership: Simple Partnership, Compound Partnership, Partnership at Will, Partnership for a Fixed Term, Particular Partnership, General Partnership, Limited Partnership, Limited Liability Partnership.

MODULE-3	Quantitative Techniques	24SDK56.1 24SDK56.2	6 Hours

Time and Work: Unit work, Combined work, Individual efficiency, Group efficiencies, Time taken by an individual or a group, Work done by an individual or a group, Total work done, Chain Rule Concept, Pipes and Cisterns, 4 Rules of Pipes and Cistern.

Gamification: Switch Grid, Geo Sudoku, Grid Lock, Number Challenge, Cognitive reasoning games.

Cognitive Ability: Statements & Conclusions, Statements & Assertions, Statements & Assumptions, Causes & Effects and Flow Charts.

MODULE-4	Analytical Reasoning and Creative Problem Solving	24SDK56.3 24SDK56.4	6 Hours

Number Series - Missing numbers, Incomplete series - Odd-even series, primes, Fibonacci series, Arithmetic progression, Geometric progression, Harmonic progression, Squares and cubes, Operations on digits, Exponential series, Increasing multiplication, Hybrid series.

Alphabetical Series- Missing alphabets, incomplete letter series - series of words, series of letters, arrangement of words/letters, letters marked with corresponding numbers sequence, positions of letters, ranking of the word in dictionary; Mixed Series - Missing numbers and words/letters, complete the series. **Analogies:** Alphabet Classification, Word Classification, Number Classification.

Coding and Decoding: Coding based on order, Letter to Letter Mapping, Letter to number mapping, Letter to digit mapping, Re-ordering sequences; Word sequencing, Match the word to code, Symbol Coding.

MODULE-5	Problem Solving through Logical Analysis	24SDK56.3 24SDK56.4	6 Hours

Directions: Eight Directions, Distance, Displacement, Starting and ending points, Referential directions, Directions of shadows, Axis based problems, Actual and conditional directions.

Seating Arrangements: Linear arrangement, Square Arrangement, Rectangular Arrangement, Circular arrangement, Vertical arrangement, Seating arrangement in a photograph, Tabular arrangement, Hexagonal Seating Arrangement, Complex arrangement, Miscellaneous arrangements.

Blood Relations: Relations defined, Generation Verticals, Family Tree, Single Person Blood Relations, Mixed/Chain Blood Relations, Symbol based Blood Relation.

CIE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1. Quantitative Aptitude for Competitive Examinations — R.S. Aggarwal
2. How to Prepare for Quantitative Aptitude for CAT — Arun Sharma

Reference Books:

1. Quantum CAT — Sarvesh K. Verma
2. Fast Track Objective Arithmetic — Rajesh Verma
3. Quantitative Aptitude for Placements — Dinesh Khattar

Web links and Video Lectures (e-Resources):

- Freshersworld: Aptitude & Reasoning
  https://www.youtube.com/results?search_query=Freshersworld+Aptitude+Reasoning
- Adda24/7: Aptitude & Reasoning
  https://www.youtube.com/results?search_query=Adda247+Quantitative+Aptitude+Reasoning

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

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Activity	Aptitude Topic	Description
Math Relay Race	Percentages, Profit & Loss, Time & Work	• Divide students into teams. Each student solves one question and passes the sheet to the next teammate. The first team to finish with the most correct answers wins.
Puzzle & Seating Challenge	Seating Arrangements, Logical Reasoning	• Give each team a seating arrangement or logic puzzle. Teams compete to solve it within a fixed time.
DI Detective	Data Interpretation	• Provide charts, graphs, or tables. Students answer questions individually or in groups, explaining how they arrived at their answers.
Human Number Line	Number System, Averages, Ratio & Proportion	• Students hold number cards and physically arrange themselves to solve ordering, averages, ratios, or sequence-based problems.
Aptitude Quiz Bowl	Mixed Aptitude Topics	• Conduct a quiz with multiple rounds (MCQs, rapid fire, visual reasoning, puzzles, and calculation challenges). Award points to teams and maintain a leaderboard.

SOCIETAL BASED MINI PROJECT

Course Code	**24ECE57**	**Credits**	**01**
L:T:P:S	**0:0:1:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**30**	**SEE Marks**	**50**
TW & SL / Sem	**-**	**Total Marks**	**100**
Total Hours /Sem	**30**	**Exam Hours**	**03**

Course outcomes:

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

24ECE57.1	Apply engineering fundamentals to identify and analyze real-world societal challenges.
24ECE57.2	Design and implement an innovative solution addressing a societal need using appropriate technologies.
24ECE57.3	Evaluate the performance, feasibility, and impact of the developed solution through testing and validation.
24ECE57.4	Exhibit professional ethics, teamwork, project management, documentation, and communication skills during project execution.

The Societal based Mini Project shall encourage students to identify and address real-world societal needs through innovative, practical, and sustainable engineering solutions. Students are encouraged to select problems related to healthcare, education, agriculture, environment, energy conservation, accessibility, safety, smart communities, rural development, and public services, considering the needs of diverse sections of society. The project should demonstrate the potential to create social impact, improve quality of life, optimize resources, and promote affordable, frugal, inclusive, and eco-friendly solutions, while considering ethical, safety, cultural, and environmental aspects.

Students may work individually or in groups of 2 students for single-discipline projects in IT-allied branches, 3–4 students for single-discipline projects in core branches, and 3–4 students for multidisciplinary projects across branches, based on the project scope and mentor recommendations. The CIE shall be based on the project report, presentation, and question-and-answer session in the ratio of 50:25:25; for single-discipline projects, evaluation shall be carried out by the Head of the Department and two departmental faculty members, including the guide, while interdisciplinary projects shall be evaluated at the college level with participation of all project guides. The project report marks shall be common to all members of the respective group.

CIE Assessment Pattern (50 Marks)

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

SEE Assessment Pattern (50 Marks)

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

NATIONAL SERVICE SCHEME			
Course Code	**24NSS50, 24NSS60**	**CIE Marks (each Semester)**	**50**
L:T:P:S	**0:0:0:0**	**SEE Marks**	**--**
Hrs / Week	**2**	**Total Marks**	**50 x 4 = 200**
Credits	**00**	**Exam Hours**	**02**

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

24NSSX0.1	Understand the importance of his / her responsibilities towards society.
24NSSX0.2	Analyse the environmental and societal problems/issues and will be able to design solutions for the same.
24NSSX0.3	Evaluate the existing system and to propose practical solutions for the same for sustainable development. Implement government or self-driven projects effectively in the field.
24NSSX0.4	Develop capacity to meet emergencies and natural disasters & practice national integration and social harmony in general.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
24NSSX0.1	-	-	-	-	-	3	3	2	-	-	1
24NSSX0.2	-	-	-	-	-	3	3	2	-	-	1
24NSSX0.3	-	-	-	-	-	3	3	2	-	-	1
24NSSX0.4	-	-	-	-	-	3	3	2	-	-	1

Semester/ Course Code	CONTENT	COs	HOURS
3RD 24NSS30	1. Organic farming, Indian Agriculture (Past, Present and Future) Connectivity for marketing 2. Waste management–Public, Private and Govt organization, 5R's. 3. Setting of the information imparting club for women leading to contribution in social and economic issues.	24NSS30.1, 24NSS30.2, 24NSS30.3, 24NSS30.4	30 HRS
4TH 24NSS40	4. Water conservation techniques – Role of different stakeholders– Implementation. 5. Preparing an actionable business proposal for enhancing the village income and approach for implementation. 6. Helping local schools to achieve good results and enhance their enrolment in Higher/ technical/ vocational education.	24NSS40.1, 24NSS40.2, 24NSS40.3, 24NSS40.4	30 HRS
5TH 24NSS50	7. Developing Sustainable Water management system for rural areas and implementationapproaches. 8. Contribution to any national level initiative of Government of India. Foreg. Digital India, Skill India, Swachh Bharat, Atmanirbhar Bharath, Make in India, Mudra scheme, Skill developmentprograms etc. 9. Spreading public awareness under rural outreach programs. (minimum 5 programs).	24NSS50.1, 24NSS50.2, 24NSS50.3, 24NSS50.4	30 HRS
6TH 24NSS60	10. Organize National integration and social harmony events / workshops / seminars. (Minimum TWO programs). 11. Govt. school Rejuvenation and helping them to achieve good infrastructure.	24NSS60.1, 24NSS60.2, 24NSS60.3, 24NSS60.4	30 HRS

CIE Assessment Pattern (50 Marks – Activity based) –

CIE component for every semester	Marks
Presentation - 1 Selection of topic, PHASE - 1	10
Commencement of activity and its progress - PHASE - 2	10
Case study-based Assessment Individual performance	10
Sector wise study and its consolidation	10
Video based seminar for 10 minutes by each student at the end of semester with Report.	10
Total marks for the course in each semester	**50**

- Implementation strategies of the project (NSS work).
- The last report should be signed by NSS Officer, the HOD and principal.
- At last report should be evaluated by the NSS officer of the institute.
- Finally, the consolidated marks sheet should be sent to the university and also to be made available at LIC visit.

Suggested Learning Resources:
Reference Books:

1. NSS Course Manual, Published by NSS Cell, VTU Belagavi.
2. Government of Karnataka, NSS cell, activities reports and its manual.
3. Government of India, NSS cell, Activities reports and its manual.

Pre-requisites to take this Course:

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

Pedagogy:

- In every semester from 3rd semester to 6th semester, each student should do activities according to the scheme and syllabus.
- At the end of every semester student performance has to be evaluated by the NSS officer for the assigned activity progress and its completion.
- At last, in 6th semester consolidated report of all activities from 3rd to 6th semester, compiled report should be submitted as per the instructions.
- State the need for NSS activities and its present relevance in the society and provide real-life examples.
- Support and guide the students for self-planned activities.
- NSS coordinator will also be responsible for assigning homework, grading assignments and quizzes, and documenting students' progress in real activities in the field.
- Encourage the students for group work to improve their creative and analytical skills.

Plan of Action:

- Student/s in individual or in a group Should select any one activity in the beginning of each semester till end of that respective semester for successful completion as per the instructions of NSS officer with the consent of HOD of the department.
- At the end of every semester, activity report should be submitted for evaluation.
- Practice Session Description:
    - Lecture session by NSS Officer
    - Students Presentation on Topics
    - Presentation - 1, Selection of topic, PHASE – 1
    - Commencement of activity and its progress - PHASE – 2

- Execution of Activity
- Case study-based Assessment, Individual performance
- Sector/ Team wise study and its consolidation
- Video based seminar for 10 minutes by each student at the end of semester with Report.

Sl No	Topic	Groupsize	Location	Activity execution	Reporting	Evaluation of the Topic
1.	Organic farming, IndianAgriculture (Past, Present and Future) Connectivity for marketing.	May be individual or team	Farmers land/Villages/ roadside / Community area / College campus	Site selection /proper consultation/ Continuous monitoring/ Information board	Report should be submitted byindividual to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer
2.	Waste management– Public, Private and Govtorganization, 5 R's.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus	Site selection /proper consultation/Continuous monitoring/ Information board	Report should be submitted byindividual to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer
3.	Setting of the information imparting club for women leading to contributionin social and economic issues.	May be individual or team	Women empowerment groups/ Consulting NGOs & Govt Teams / College campus	Group selection/proper consultation/ Continuous monitoring/ Information board	Report should be submitted byindividual to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer
4.	Water conservation techniques – Role of different stakeholders– Implementation.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus	site selection / proper consultation/ Continuous monitoring/ Information board	Report should be submitted byindividual to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer

5.	Preparing an actionable business proposal for enhancing the village income and approach for implementation.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus	Group selection/proper consultation/ Continuous monitoring/ Information board	Report should be submitted byindividual to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer
6.	Helping local schools toachieve good results and enhance their enrolment in Higher/ technical/ vocational education.	May be individual or team	Local government / private/ aided schools/Government Schemes officers	School selection/proper consultation/ Continuous monitoring/ Information board	Report should be submitted byindividual to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer
7.	Developing SustainableWater management system for rural areas and implementation approaches.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus	site selection/properconsultation/ Continuous monitoring/ Information board	Report should be submitted byindividual to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer
8.	Contribution to any national level initiative of Government of India.For eg. Digital India, Skill India, Swachh Bharat, Atmanirbhar Bharath, Make in India, Mudra scheme,Skill development programs etc.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus	Group selection/proper consultation/ Continuous monitoring / Information board	Report should be submitted byindividual to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer
9.	Spreading public awareness under ruraloutreach programs. (minimum5 programs)	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus	Group selection/proper consultation/ Continuous monitoring / Information board	Report should be submitted byindividual to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer

10.	Organize National integration and socialharmony events / workshops / seminars. (Minimum 02 programs).	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus	Place selection/proper consultation/ Continuous monitoring / Information board	Report should be submitted byindividual to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer
11.	Govt. school Rejuvenation and helping them to achieve good infrastructure.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus	Place selection/proper consultation/ Continuous monitoring / Information board	Report should be submitted byindividual to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer

PHYSICAL EDUCATION AND SPORTS			
Course Code	**24PED50, 24PED60**	**CIE Marks (each semester)**	**50**
L:T:P:S	**0:0:0:0**	**SEE Marks**	**--**
Hrs / Week	**2**	**Total Marks**	**50 x 4= 200**
Credits	**00**	**Exam Hours**	**02**

Course outcomes:

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

24PEDX0.1	Understand the fundamental concepts and skills of Physical Education, Health, Nutrition and Fitness
24PEDX0.2	Create consciousness among the students on Health, Fitness and Wellness in developing and maintaining a healthy lifestyle
24PEDX0.3	Perform in the selected sports or athletics of student's choice and participate in the competition at regional/state / national / international levels.
24PEDX0.4	Understand the roles and responsibilities of organization and administration of sports and games

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
24PEDX0.1	-	-	-	-	-	2	-	3	3	-	-	2
24PEDX0.2	-	-	-	-	-	2	-	3	3	-	-	2
24PEDX0.3	-	-	-	-	-	2	-	3	3	-	-	2
24PEDX0.4	-	-	-	-	-	2	-	3	3	-	-	2

Semester	CONTENT	COs	HOURS
3RD 24PED30	**Module 1: Orientation** A. Lifestyle, B. Fitness C. Food & Nutrition D. Health & Wellness E. Pre-Fitness test.	24PED30.1, 24PED30.2	5 HRS
	Module 2: General Fitness & Components of Fitness A. Warming up (Free Hand exercises) B. Strength – Push-up / Pull-ups C. Speed – 30 Mtr Dash D. Agility – Shuttle Run E. Flexibility – Sit and Reach F. Cardiovascular Endurance – Harvard step Test	24PED30.2, 24PED30.3	15 HRS
	Module 3: Recreational Activities A. Postural deformities. B. Stress management. C. Aerobics. D. Traditional Games.	24PED30.3, 24PED30.4	10 HRS
4TH 24PED40	**Module 1: Ethics and Moral Values** A. Ethics in Sports B. Moral Values in Sports and Games	24PED40.1, 24PED40.2	5 HRS
	Module 2: Specific Games (Anyone to be selected by the student) A. Volleyball – Attack, Block, Service, Upper Hand Pass and	24PED40.3	20 HRS

	Lower hand Pass. B. Throwball – Service, Receive, Spin attack, Net Drop & Jump throw. C. Kabaddi – Hand touch, Toe Touch, Thigh Hold, Ankle hold and Bonus. D. Kho-Kho – Giving Kho, Single Chain, Pole dive, Pole turning, 3-6 Up. E. Table Tennis – Service (Fore Hand & Back Hand), Receive (Fore Hand & Back Hand), Smash. F. Athletics (Track / Field Events) – Any event as per availability of Ground.		
	Module 3: Role of Organization and administration	24PED40.4	5 HRS
5TH **24PED50**	**Fitness Components:** Meaning and Importance, Fit India Movement, Definition of fitness, Components of fitness, Benefits of fitness, Types of fitness and Fitness tips. **Practical Components:** Speed, Strength, Endurance, Flexibility, and Agility **Athletics**: 1. Track -Sprints: • Starting Techniques: Standing start and Crouch start (its variations) use of Starting Block. • Acceleration with proper running techniques. • Finishing technique: Run Through, Forward Lunging and Shoulder Shrug. 2. Jumps- Long Jump: Approach Run, Take-off, Flight in the air (Hang Style/Hitch Kick)and Landing 3. Throws- Shot Put: Holding the Shot, Placement, Initial Stance, Glide, Delivery Stance and Recovery (Perry O'Brien Technique) **Handball OR Ball Badminton** **Handball:** A. Fundamental Skills 1. Catching, Throwing and Ball control, 2. Goal Throws: Jumpshot, Centershot, Diveshot, Reverseshot. 3. Dribbling: High and low. 4. Attack and counter attack, simple counter attack, counter attack from two wings and center. 5. Blocking, Goal Keeping and Defensive skills. 6. Game practice with application of Rules and Regulations. B. Rules and their interpretations and duties of officials **Ball badminton:** A. Fundamental Skills 1. Basic Knowledge: Various parts of the Racket and Grip. 2. Service: Short service, Long service, Long-high service. 3. Shots: Overhead shot, Defensive clearshot, Attacking clearshot, Dropshot, Netshot, Smash. 4. Game practice with application of Rules and Regulations. B. Rules and their interpretation and duties of officials.	24PED50.1, 24PED50.2, 24PED50.3, 24PED50.4	Total 30 Hrs/ Semester 2 Hrs/week
6TH **24PED60**	**Athletics**: 1. Track -110 Mtrs and 400Mtrs: • Hurdling Technique: Lead leg Technique, Trail leg Technique, Side Hurdling, Over the Hurdles • Crouch start (its variations) use of Starting Block.	24PED60.1, 24PED60.2, 24PED60.3, 24PED60.4	Total 30 Hrs/ Semester 2 Hrs/week

- Approach to First Hurdles, In Between Hurdles, Last Hurdles to Finishing.

2. Jumps- High jump: Approach Run, Take-off, Bar Clearance (Straddle) and Landing.
3. Throws- Discus Throw: Holding the Discus, Initial Stance Primary Swing, Turn, Release and Recovery (Rotation in the circle).

Football OR Hockey

Football:

A. Fundamental Skills

1. Kicking: Kicking the ball with inside of the foot, Kicking the ball with Full Instep of the foot, Kicking the ball with Inner Instep of the foot, Kicking the ball with Outer Instep of the foot and Lofted Kick.
2. Trapping: Trapping- the Rolling ball, and the Bouncing ball with sole of the foot.
3. Dribbling: Dribbling the ball with Instep of the foot, Dribbling the ball with Inner and Outer Instep of the foot.
4. Heading: In standing, running and jumping condition.
5. Throw-in: Standing throw-in and Running throw-in.
6. Feinting: With the lower limb and upper part of the body.
7. Tackling: Simple Tackling, Slide Tackling.
8. Goal Keeping: Collection of Ball, Ball clearance-kicking, throwing and deflecting.
9. Game practice with application of Rules and Regulations.

A. Rules and their interpretation and duties of officials.

Hockey:

A. Fundamental Skills

1. Passing: Short pass, Longpass, pushpass, hit
2. Trapping.
3. Dribbling and Dozing
4. Penalty stroke practice.
5. Penalty corner practice.
6. Tackling: Simple Tackling, Slide Tackling.
7. Goal Keeping, Ball clearance- kicking, and deflecting.
8. Game practice with application of Rules and Regulations.

B. Rules and their interpretation and duties of officials

CIE Assessment Pattern (50 Marks – Practical) –

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

CIE	Marks
Participation of student in all the modules	10
Quizzes – 2, each of 7.5 marks	15
Final presentation / exhibition / Participation in competitions/ practical on specific tasks assigned to the students	25
Total	**50**

Suggested Learning Resources:

Reference Books:

1. Saha, A.K. Sarir Siksher Ritiniti, Rana Publishing House, Kalyani.
2. Bandopadhyay, K. Sarir Siksha Parichay, Classic Publishers, Kolkata.
3. Petipus, et.al., Athlete's Guide to Career Planning, Human Kinetics.
4. Dharma, P.N. Fundamentals of Track and Field, Khel Sahitya Kendra, New Delhi.
5. Jain, R. Play and Learn Cricket, Khel Sahitya Kendra, New Delhi.
6. Vivek Thani, Coaching Cricket, Khel Sahitya Kendra, New Delhi.
7. Saha, A.K. Sarir Siksher Ritiniti, Rana Publishing House, Kalyani.
8. Bandopadhyay, K. Sarir Siksha Parichay, Classic Publishers, Kolkata
9. Naveen Jain, Play and Learn Basketball, Khel Sahitya Kendra, New Delhi.
10. Dubey H.C., Basketball, Discovery Publishing House, New Delhi.
11. Rachana Jain, Teach Yourself Basketball, Sports Publication.
12. Jack Nagle, Power Pattern Offences for Winning basketball, Parker Publishing Co., New York.
13. Renu Jain, Play and Learn Basketball, Khel Sahitya Kendra, New Delhi.
14. SallyKus, Coaching Volleyball Successfully, Human Kinetics.

YOGA			
Course Code	**24YOG50, 24YOG60**	**CIE Marks**	**50**
L:T:P:S	**0:0:0:0**	**SEE Marks**	**--**
Hrs / Week	**2**	**Total Marks**	**50 x 4 = 200**
Credits	**00**	**Exam Hours**	**02**

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

24YOGX0.1	Understanding the origin, history, aim and objectives of Yoga
24YOGX0.2	Become familiar with an authentic foundation of Yogic practices
24YOGX0.3	Practice different Yogic methods such as Suryanamaskara, Pranayama and some of the Shat
24YOGX0.4	Use the teachings of Patanjali in daily life.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
24YOGX0.1	-	-	-	-	-	3	-	-	-	-	1
24YOGX0.2	-	-	-	-	-	3	-	-	-	-	1
24YOGX0.3	-	-	-	-	-	3	-	-	-	-	1
24YOGX0.4	-	-	-	-	-	3	-	-	-	-	1

Semester / Course Code	CONTENT	COs	HOURS
3rd 24YOG30	**Introduction of Yoga:** Aim and Objectives of yoga, Prayer: Yoga, its origin, history and development. Yoga, its meaning, definitions. Different schools of yoga, importance of prayer **Brief introduction of yogic practices for common man:** Yogic practices for common man to promote positive health **Rules and regulations:** Rules to be followed during yogic practices by practitioner **Misconceptions of yoga:** Yoga its misconceptions, Difference between yogic and non-yogic practices. **Suryanamaskara:** 1. Suryanamaskar prayer and its meaning, Need, importance and b of Suryanamaskar. 2. Suryanamaskar 12 count,2rounds **Different types of Asanas**: 1. Sitting: Padmasana, Vajrasana, Sukhasana 2. Standing: Vrikshana, Trikonasana, Ardhakati Chakrasana 3. Prone line: Bhujangasana, Shalabhasana 4. Supineline: Utthitadvipadasana, Ardhahalasana, Halasana	24YOG30.1, 24YOG30.2, 24YOG30.3, 24YOG30.4	Total 32 Hrs/ Semester 2 Hrs/week
4TH 24YOG40	**Suryanamaskara:** Suryanamaskar 12 count,4rounds **Brief introduction and importance of:** **Kapalabhati:** Revision of Kapalabhati -40strokes/min3rounds **Different types of Asanas**: 1. Sitting: Paschimottanasana, Ardha Ushtrasana, Vakrasana, Aakarna Dhanurasana 2. Standing: Parshva Chakrasana, Urdhva Hastothanasana, Hastapadasana 3. Prone line: Dhanurasana 4. Supine line: Karna Peedasana, Sarvangasana, Chakraasana **Patanjali's Ashtanga Yoga**: Asana, Pranayama **Pranayama:** Chandra Bhedana, Nadishodhana, Surya Bhedana	24YOG40.1, 24YOG40.2, 24YOG40.3, 24YOG40.4	Total 32 Hrs/ Semester 2 Hrs/week

5TH 24YOG50	**Kapalabhati:** Revision of Kapalabhati - 60strokes/min3rounds **Brief introduction and importance of:** **Different types of Asanas**: 1. Sitting: Yogamudra in Padmasana, Vibhakta Paschimottanasana, Yogamudra in Vajrasana 2. Standing: Parivritta Trikonasana, Utkatasana, Parshvakonasana 3. Prone line: Padangushtha Dhanurasana, Poorna Bhujangasana / Rajakapotasana 4. Supine line: Navasana/Noukasana, Pavanamuktasana, Sarvanga **Patanjali's Ashtanga Yoga**: Pratyahara, Dharana **Pranayama:** Ujjayi, Sheetali, Sheektari	24YOG50.1, 24YOG50.2, 24YOG50.3, 24YOG50.4	Total 32 Hrs/ Semester 2 Hrs/week
6TH 24YOG60	**Kapalabhati:** Revision of Kapalabhati – 80 strokes/min3rounds **Brief introduction and importance of:** **Different types of Asanas**: 1. Sitting: Bakasana, Hanumanasana, Ekapada Rajakapotasana 2. Standing: Parivritta Trikonasana, Utkatasana, Parshvakonasana 3. Supine line: Setubandhasana, Shavasanaa (Relaxation posture) 4. Balancing: Sheershasana **Patanjali's AshtangaYoga**: Dhyana (Meditation), Samadhi **Pranayama:** Bhastrika, Bhramari, Ujjai **Shat Kriyas:** Jalaneti and sutraneti, Sheetkarma Kapalabhati	24YOG60.1, 24YOG60.2, 24YOG60.3, 24YOG60.4	Total 32 Hrs/ Semester 2 Hrs/week

CIE Assessment Pattern (50 Marks – Practical)

CIE to be evaluated every semester based on practical demonstration of Yogasana learnt in the semester and internal tests (objective type)

CIE	Marks
Avg of Test 1 and Test 2	25
Demonstration of Yogasana	25
Total	**50**

Suggested Learning Resources:

Reference Books:

1. Swami Kuvulyananda: Asma (Kavalyadhama, Lonavala)
2. Tiwari, O P: Asana Why and How
3. Ajitkumar: Yoga Pravesha (Kannada)
4. Swami Satyananda Saraswati: Asana Pranayama, Mudra, Bandha (Bihar School of yoga, Munger)
5. Swami Satyananda Saraswati: Surya Namaskar (Bihar School of yoga, Munger)
6. Nagendra H R: The art and science of Pranayama
7. Tiruka: Shatkriyegalu (Kannada)
8. Iyengar B K S: Yoga Pradipika (Kannada)
9. Iyengar B K S: Light on Yoga (English)

Web links and Video Lectures (e-Resources):

- **https://youtu.be/KB-TYlgd1wE**
- **https://youtu.be/aa-TG0Wg1Ls**

SIXTH SEMESTER SYLLABUS

EMBEDDED SYSTEM DESIGN

Course Code	**24ECE61**	**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:

24ECE61.1	Analyze the architecture and features of ARM processors for embedded applications
24ECE61.2	Apply the Cortex-M programmer's model and instruction set to develop embedded solutions for practical applications
24ECE61.3	Analyze and evaluate different interrupt mechanisms to select appropriate interrupt strategies for embedded system applications
24ECE61.4	Apply exception handling techniques to enhance the reliability and fault tolerance of real-time embedded systems
24ECE61.5	Design and integrate hardware-software co-design methodologies and firmware development strategies for embedded products
24ECE61.6	Analyze the role and significance of Real-Time Operating Systems (RTOS) in managing tasks, resources, and timing constraints in embedded applications

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
24ECE61.1	3	3	-	-	-	-	-	-	-	-	2	3	2
24ECE61.2	3	-	2	-	3	-	-	-	-	-	2	3	2
24ECE61.3	3	3	-					-	-	-	2	3	2
24ECE61.4	3	-	2	-	3	-	-	-	-	-	-	3	2
24ECE61.5	3	3	2	-	-	-	-	-	-	-	-	3	2
24ECE61.6	3	3	-	2	3	-	-	-	-	-	2	3	2

MODULE-1	**Introduction to ARM EMBEDDED SYSTEMS**	**24ECE61.1**	**8 Hours**

Definition of Embedded System, Embedded Systems v/s general computing systems, history of embedded systems, classification of embedded systems, applications of embedded system, Purpose of embedded systems. The RISC design philosophy, ARM design philosophy, Embedded system software, ARM core data flow model, Registers of ARM processor, Current program status register, architecture revisions, ARM processor families.

Self-study	Analyze the architecture, design philosophies, software components, processor organization, and real-world applications of ARM-based embedded systems.
Text Book	Text Book 2: 1.1, 1.2, 1.3, 1.4, 1.5, 1.6 Text Book 1: 1.1, 1.2, 1.4, 2.1, 2.2, 2.4, 2.6, 2.7

MODULE-2	**ARM CORTEX M PROCESSOR AND INSTRUCTION SET**	**24ECE61.2**	**8 Hours**

Block Diagram, Architecture of ARM cortex processor, operation modes and states, registers, special function registers, floating point registers, exceptions and interrupts.
Data processing Instructions, Branch instructions, Load-store instructions, software interrupt instructions, program status register instructions, loading constants, Introduction to the thumb instruction set.

Self-study	Study the ARM Cortex processor architecture, registers, exceptions, interrupts, and ARM/Thumb instruction sets.
Text Book	Text Book 3: 3.14, 4.1, 4.2, 4.4, 4.5 Text Book 1: 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 4.1

MODULE-3	**EXCEPTIONS AND INTERRUPTS IN ARM PROCESSORS**	**24ECE61.3, 24ECE61.4**	**8 Hours**

Overview of exceptions and interrupts, Exception types, overview of interrupt management, Definition of priority, vector table and vector table relocation, Interrupts and pending behaviors, Exception sequence overview.

Applications	Used for handling real-time events and prioritizing tasks in embedded systems.		
Text Book	Text Book 3:7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7		
MODULE-4	**EMBEDDED SYSTEM DESIGN CONCEPTS**	**24ECE61.5**	**8 Hours**
Characteristics and Quality attributes of Embedded system, application and domain specific embedded system application, Hardware and Software Co-design, Computational models in embedded design, Embedded firmware design approaches, Embedded firmware development languages.			
Applications	Smart Home Automation System Design and Implementation.		
Text Book	Text Book 2: 4.1, 4.2.1, 4.2.2, 7.1, 7.2, 9.1, 9.2		
MODULE-5	**RTOS FOR EMBEDDED SYSTEM DESIGN**	**24ECE61.6**	**8 Hours**
Operating system basics, types of operating systems, tasks, process and threads, Multiprocessing and multitasking, task scheduling-non preemptive scheduling, preemptive scheduling, task synchronization-racing and deadlock only.			
Case Study	A real-time traffic signal controller uses an RTOS for multitasking, task scheduling, synchronization, and deadlock-free operation.		
Text Book	Text Book 2: 10.1, 10.2, 10.3, 10.4, 10.5, 10.7.1, 10.7.2, 10.8		

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	-
L4	**Analyze**	10	5	5
L5	**Evaluate**	-	-	**5**
L6	**Create**	**-**	**-**	**-**

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1) Andrew N Sloss, "ARM System Developer's guide", Elsevier Publications, 2016, ISBN 978-0124080828.
2) Introduction to Embedded Systems, Shibu K V,2nd Edition 2017, McGRAW HILL, ISBN 978-1259001764.
3) The Definitive Guide to ARM Cortex –M3 and Cortex-M4 Processors Joseph Yiu, 3rd Edition, 2014, Elsevier, ISBN 978-0124080828.

Reference Books:

1) Embedded Systems – A contemporary Design Tool, James K, Peckol, 2014, John Wiley, ISBN 978-1118332910.
2) Arm® Cortex®-M4 Processor Technical Reference Manual, ARM 2020.
3) STM32 Cortex®-M4 MCUs and MPUs programming manual, 2020.

Web links and Video Lectures (e-Resources): • https://archive.nptel.ac.in/courses/106/105/106105193/ • https://embeddedcomputing.com/technology/software-and-os/introduction-to-realtime-operat-ing-systems-rtos • https://www.youtube.com/watch?v=dOiJuXYFMkESlist=PLqmN55CTOn-LeArO1_td4vHkAY35h6GlHM • https://www.arm.com/resources/education/education-kits/efficient-embedded-systems • https://developer.arm.com/documentation/100166/0001/ https://www.st.com/resource/en/programming_manual/pm0214-stm32-cortexm4-mcus-and-mpus-programming-manual-stmicroelectronics.pdf
Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning • Configure ARM Cortex-M GPIO pins to interface LEDs and push buttons, and observe input-output operations through hardware experimentation. • Implement external and timer interrupts on an ARM microcontroller to study real-time event detection and response mechanisms. • Develop UART-based communication between an ARM processor and a PC to transmit and receive sensor or user data. • Connect temperature, light, or motion sensors to an ARM-based embedded system and process the acquired data for monitoring applications. • Create multiple tasks using an RTOS on an ARM platform to analyze task scheduling, synchronization, and resource management in real-time systems

EMBEDDED SYSTEM DESIGN LAB

Course Code	**24ECL61**	**CIE Marks**	**50**
L:T:P:S	**0:0:1:0**	**SEE Marks**	**50**
Hrs / Week	**2**	**Total Marks**	**100**
Credits	**01**	**Exam Hours**	**03**

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

24ECL61.1	Apply ARM processor instructions for data transfer, arithmetic/logic processing, and memory access operations through embedded programming experiments
24ECL61.2	Analyze the execution of ARM bit-field and process-control instructions and evaluate their effects on embedded system operations
24ECL61.3	Analyze the execution and performance of ARM programs involving saturation and floating-point operations.
24ECL61.4	Develop and validate Embedded C programs for peripheral interfacing with ARM development kits and simulation platforms

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
24ECL61.1	3	3	-	3	3	-	-	2	-	-	2	3	3
24ECL61.2	3	3	-	3	3	-	-	2	-	-	2	3	3
24ECL61.3	3	3	-	3	3	-	-	2	-	-	2	3	3
24ECL61.4	3	3	2	3	3	-	-	2	-	-	2	3	3

Pgm. No.	List of Programs	Hours	COs
	Prerequisite Experiments / Programs / Demo		
	• **Revisit to 8086 and 8051 programming basic programming** • **Study of ARM- Cortex M3,M4 processor development board**	2	NA
	PART-A		
1	a) Assembly Level Program (ALP) involving instructions for transferring data within the processor. b) Assembly Level Program (ALP) to demonstrate memory access instruction for various data sizes and addressing modes.	2	24ECL61.1
2	a) Assembly Level Program (ALP) involving logic operations. c) Assembly Level Program (ALP) to illustrate bit field processing instruction.	2	24ECL61.1 24ECL61.2
3	a) Assembly Level Program (ALP) involving data conversion operations. b) Assembly Level Program (ALP) involving shift and rotate operations.	2	24ECL61.1
4	a) Assembly Level Program (ALP) to illustrate bit field processing ins b) Assembly Level Program (ALP) to illustrate program flow instruction.	2	24ECL61.2
5	Assembly Level Program (ALP) to illustrate saturation operation.	2	24ECL61.3
6	Assembly Level Program (ALP) involving floating point operations.	2	24ECL61.3
	PART-B		
7	Develop a program for performing fundamental operations on a port.	2	24ECL61.4
8	Interfacing an LED with the ARM STM32F401xx Using a Push Button Input in Embedded C a. With delay b. Without delay	2	24ECL61.4

9	Create a program for interfacing a stepper motor and controlling its rotation in both clockwise and counterclockwise directions using	2	24ECL61.4
10	Design a program to interface with a DAC and generate various waveforms.	2	24ECL61.4
11	Implement a program to showcase specific characters on a 7-segment LED display.	2	24ECL61.4
12	Write a program to transmit a message using internal UART and display in LCD.(Universal Asynchronous Receiver-Transmitter).	2	24ECL61.4

PART-C

Beyond Syllabus Virtual Lab Content

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

1. PWM Generation for LED Brightness and DC Motor Speed Control
https://virtual-labs.github.io/exp-pwm-generation-coep/simulation/index.html?utm_source=chatgpt.com
2. DAC Interfacing and Analog Waveform Generation
https://virtual-labs.github.io/exp-digital-analog-converter-coep/?utm_source=chatgpt.com
3.UART/Serial Communication using Embedded System
https://virtual-labs.github.io/exp-shift-registers-iitkgp/procedure.html?utm_source=chatgpt.com

CIE Assessment Pattern (50 Marks – Lab)

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

SEE Assessment Pattern (50 Marks – Lab)

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

Suggested Learning Resources:

Reference Books:

1) Andrew N. Sloss, Dominic Symes and Chris Wright, *ARM System Developer's Guide: Designing and Optimizing System Software*, 1st Edition, Morgan Kaufmann/Elsevier, 2004, ISBN: 978-1-55860-874-

(Arm Developer documents)

1) https://developer.arm.com/documentation/dui0068/b/ARM-Instruction-Reference
2)https://developer.arm.com/documentation/ddi0403/d/Application-LevelArchitecture/Application-Level-Programmers--Model/The-optional-Floating-pointextension/Floating-point-data-types-and arithmetic?lang=e
3) https://www.st.com/en/development-tools/stm32cubeide.html

COMMUNICATION SYSTEMS-II

Course Code	**24ECE62**	**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:

24ECE62.1	Analyze the behavior and characteristics of Microwave Active Components
24ECE62.2	Solve the Transmission line problems using analytical and graphical approach
24ECE62.3	Apply the knowledge of low frequency network to express Scattering parameter for microwave multi-port junctions
24ECE62.4	Interpret the relationships between Antenna parameters
24ECE62.5	Analyze the power radiated by different antennas and their radiation characteristics
24ECE62.6	Interpret RADAR based system working and its specific applications

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
24ECE62.1	3	3	2	-	2	-	-	-	-	-	-	3	2
24ECE62.2	3	3	-	-	-	-	-	-	-	-	-	3	2
24ECE62.3	3	-	-	-	2	-	-	-	-	-	-	3	2
24ECE62.4	3	3	-	-	2	-	-	-	-	-	-	3	2
24ECE62.5	3	3	-	-	2	-	-	-	-	-	-	3	2
24ECE62.6	3	3	2	-	-	-	-	-	-	-	-	3	2

MODULE-1	**MODULE : Microwave Sources and Transmission Lines**	24ECE62.1 24ECE62.2	**8 Hours**

Introduction to EM Wave Equation and parameters.

MICROWAVE SOURCES: Introduction to Microwave System and Microwave frequencies. Generation of Microwaves- Reflex Klystron, TWT, Magnetron

TRANSMISSION LINES: Equivalent Circuit of a Transmission Line, Transmission Line equations and solutions Analysis of Primary and Secondary Constants. Reflection and Transmission Coefficients, Standing Waves and SWR, Smith Chart, Single Stub matching

Case Study	Investigate impedance matching techniques in RF communication systems.
Text Book	Text Book 2: 2.1,2.2,2.3,2.4.2,5.2,6.2,7 Text Book 2 - 0.1, 0.2, 0.3, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6

MODULE-2	**MICROWAVE SOURCES, M ICROWAVE NETWORK THEORY AND PASSIVE COMPONENTS**	24ECE62.3	**8 Hours**

MICROWAVE NETWORK THEORY: Introduction, S matrix representation of multiport networks, Properties of S parameters, S- parameters of a Two-port network with mismatched load.

PASSIVE COMPONENTS: Attenuators, Waveguide Tees, Magic Tees, Circulators and Isolators, Directional Couplers- Bethe Hole Coupler.

Self-study	Analyze Microwave components in Satellite Communication Systems
Text Book	Text Book 1: 9.1, 9.2, 9.3, 9.5 Text Book 2: 6.1, 6.2, 6.3, 6.4.2,6.4.14, 6.4.15, 6.4.16

MODULE-3	**ANTENNA FUNDAMENTALS**	24ECE62.4	**8 Hours**

Introduction, Radiation patterns, Radiation Power Density and intensity, Beam-width, Directivity, Antenna Efficiency, Gain, Beam Efficiency, Bandwidth, Polarization, Input Impedance, Antenna Radiation Efficiency, Vector Effective Length and Equivalent Areas, Maximum Effective Area, Antenna temperature, Friis Equation. Antenna field zones

Self-study	Study antenna selection for satellite, mobile and radar communication systems		
Text Book	Text Book 3: 2.1- 2.7, 2.9-2.11, 2.13		
MODULE-4	**POINT SOURCES AND ARRAYS AND ELECTRIC DIPOLES**	24ECE62.5	**8 Hours**
POINT SOURCES AND ARRAYS: Point Sources, Power Patterns, Power Theorem, Radiation Intensity, Arrays of two isotropic point sources, Linear Arrays of n Isotropic Point Sources of equal Amplitude and Spacing. **ELECTRIC DIPOLES:** Introduction, Short Electric Dipole, Fields of a Short Dipole, Radiation Resistance of a Short Electric Dipole, Thin Linear Antenna (Field Analyses)			
Applications	Explore antenna arrays used in 5G base stations and phased-array radar		
Text Book	Text Book 3: 5.1-5.6, 5.9, 5.13, 6.1 - 6.5		
MODULE-5	**RADAR AND ITS APPLICATIONS:**	24ECE62.6	**8 Hours**
Basic Radar, Radar frequencies, The simple form of the Radar equation, Radar block diagram. Introduction to Doppler and MT! Radar, delay line Cancellers, digital MT! processing, Moving target detector, Pulse Doppler Radar, application of Radar. Introduction to Photonic Radar and Quantum Radar			
Applications	Survey applications of radar in autonomous vehicles, defense and weather monitoring.		
Text Book	Text Book 4: 1.1, 1.2, 1.3, 3.1,3.2,3.5, 3.6, 3.9, 1.5		

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	**5**	-
L4	**Analyze**	10	5	5
L5	**Evaluate**	-	5	**5**
L6	**Create**	**-**		**-**

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1. Microwave Engineering - Sushrut Das, Oxford Higher Education, 2nd Edn, 2015, ISBN 978-0199458338
2. Microwave Engineering-Annapurna Das, Sisir K Das, TMH, Publication, 2nd, 2010, ISBN 978-0070667458.
3. Antennas and Wave Propagation-John D. Krauss, Ronald J Marhefka, Ahmad S Khan, 4th Edition, McGraw Hill Education, 2013, ISBN 978-0073380647.
4. Merrill I. Skolnik, "Introduction to Radar Systems", 3rd Edition, Tata McGraw-Hill/McGraw-Hill, 2001, ISBN: 978-0-07-044533-8

Reference Books:

1. Antennas and Wave Propagation - Harish and Sachidananda: Oxford University Press, 2007, ISBN 978-0195683351.
2. Principles of Modern Radar – Basic Principles – Mark A. Richards, William L. Melvin, James A. Scheer,2020, ISBN 9781891121524
3. Microwave Engineering – David M. Pozar, 5th Edition, 2022, Wiley, ISBN-13: 9781119770639

Web links and Video Lectures (e-Resources):

- NPTEL - Transmission Lines and Electromagnetic Waves https://nptel.ac.in/courses/117101057
- NPTEL - Electromagnetic Waves in Guided and Wireless Media
- https://www.digimat.in/nptel/courses/video/108104130/108104130.html
- NPTEL - Antenna Fundamentals and Arrays https://nptel.ac.in/courses/108101092
- NPTEL - Principles and Techniques of Modern Radar Systems https://www.digimat.in/nptel/courses/video/108105154/108105154.html
- NPTEL - Applied Engineering Electromagnetics https://www.digimat.in/nptel/courses/video/108104099/108104099.html

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

- Simulate transmission line parameters, SWR, and impedance matching using Smith Chart tools.
- Analyze antenna radiation patterns and antenna parameters using MATLAB/HFSS/CST simulations.
- Investigate radiation characteristics of antenna arrays and dipole antennas through simulation.
- Demonstrate the operation of microwave sources and passive microwave components using virtual laboratory tools.
- Simulate radar systems, Doppler radar, and moving target detection techniques and study their practical applications

COMMUNICATION SYSTEMS - II LAB

Course Code	**24ECL62**	**CIE Marks**	**50**
L:T:P:S	**0:0:1:0**	**SEE Marks**	**50**
Hrs / Week	**2**	**Total Marks**	**100**
Credits	**01**	**Exam Hours**	**03**

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

24ECL62.1	Measure the performance parameters of microwave components
24ECL62.2	Determine the characteristics of microwave components such as directional couplers, resonators and power dividers
24ECL62.3	Model optical and electromagnetic wave propagation systems to determine propagation loss, bending loss and other system characteristics
24ECL62.4	Simulate antenna and radar systems to evaluate radiation patterns, gain, directivity, scanning, range, loss and overall system performance.

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PSO1	PSO2
24ECL62.1	3	3	-	-	-	-	-	-	2	-	3	3	3
24ECL62.2	3	3	2	-	2	-	-	-	2	-	3	3	3
24ECL62.3	3	3	2	1	2	-	-	-	2	-	3	3	3
24ECL62.4	3	3	2	1	2	-	-	-	2	-	3	3	3

Exp. No. / Pgm. No.	List of Experiments / Programs	Hours	Cos
	Prerequisite Experiments / Programs / Demo		
	• Verification of basic gates using IC Trainer board • Basic gate implementation using Verilog code.	2	NA
	PART-A		
1	Measurement of frequency, guide wavelength, power, VSWR and attenuation in microwave test bench.	2	24ECL62.1
2	To conduct an experiment to find out the insertion loss and coupling factor for the Magic Tee.	2	24ECL62.1 24ECL62.2
3	Determination of Coupling and isolation characteristics of microstrip directional coupler.	2	24ECL62.2
4	Determination of (a) Resonance characteristics of microstrip ring resonator and computation of dielectric constant of the substrate. (b) Power division and isolation of microstrip power divider.	2	24ECL62.2
5	Measurement of propagation loss, bending loss and numerical aperture of an optical fiber.	2	24ECL62.3
6	Measurement of directivity and gain of microstrip dipole and Yagi Antennas	2	24ECL62.4
	PART-B		
7	To simulate electromagnetic wave generation.	2	24ECL62.3
8	To simulate the radiation pattern of a dipole antenna.	2	24ECL62.4
9	To simulate the radiation pattern of a uniform linear array.	2	24ECL62.4
10	To design and analyze radar system for the given requirements of PRF, Range and loss factors.	2	24ECL62.4
11	To simulate the pulse radar to analyze scanning & processing, while evaluating system performance degradation.	2	24ECL62.4
12	To simulate and analyze a radar system to evaluate the performance	2	24ECL62.4

	through waveform generation and Range-Doppler surface clutter prediction.		

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

1. https://me-iitr.vlabs.ac.in/exp/microwave-laboratory-apparatus/simulation.html
2. https://me-iitr.vlabs.ac.in/exp/directional-coupler-measuring/
3. https://me-iitr.vlabs.ac.in/exp/gunn-diode/
4. https://me-iitr.vlabs.ac.in/exp/pyramidal-horn-antenna/simulation.html
5. https://me-iitr.vlabs.ac.in/exp/plane-tee-magic-tee/

CIE Assessment Pattern (50 Marks – Lab)

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

SEE Assessment Pattern (50 Marks – Lab)

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

Suggested Learning Resources:
Reference Books:

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

INTRODUCTION TO NETWORKING

Course Code	**24ECE63**	**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:

24ECE63.1	Apply the concepts of network types, topologies, and OSI and TCP/IP reference models to solve basic computer networking problems
24ECE63.2	Analyze data link layer protocols, error detection and correction techniques, and media access control methods for reliable data transmission
24ECE63.3	Use IP addressing schemes including subnetting, and IPv6 addressing to design structured network configurations
24ECE63.4	Correlate network layer routing algorithms and protocols such as RIP, OSPF, and BGP to determine optimal data delivery paths
24ECE63.5	Evaluate transport layer protocols (TCP and UDP), their features, and their role in end-to-end reliable data communication
24ECE63.6	Interpret the functions of application layer protocols such as DNS, HTTP, FTP, SMTP, and network security fundamentals

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PSO1	PS O2
24ECE63.1	3	3	3	3	3	-	-	-	3	-	3	3	3
24ECE63.2	3	3	3	3	3	-	-	-	3	-	3	3	3
24ECE63.3	3	3	3	3	3	2	-	-	3	-	3	3	3
24ECE63.4	3	3	3	3	3	2	2	2	3	2	3	3	3
24ECE63.5	3	3	3	3	3	2		2	3	2	3	3	3
24ECE63.6	3	3	3	3	3	2	2	2	3	2	3	3	3

MODULE-1	**NETWORK FUNDAMENTALS AND REFERENCE MODELS**	**24ECE63.1**	**8 Hours**

Introduction to Computer Communication Networks: Definition, goals, and applications of computer communication networks. Types of networks: LAN, MAN, WAN, PAN. Network topologies: Bus, Star, Ring, Mesh, Tree, Hybrid.
Network Components: Hubs, Switches, Routers, Bridges, Gateways, Repeaters, NICs – functions and comparison.
OSI Reference Model: Seven layers, functions of each layer, data encapsulation, peer-to-peer communication.
TCP/IP Model: Four-layer architecture, comparison with OSI model, protocols at each layer.
Transmission Media: Guided media – Twisted pair, Coaxial cable, Fiber optic; Unguided media – Radio waves, Microwaves, Infrared.

Hands on:

1. Implement simple Local Area Network using packet tracer
2. Design Star, Bus topologies
3. Configure Switch using packet tracer
4. Configure Router using packet tracer
5. Verify the connectivity between the devices using packet tracer

Case Study	Analyze the network infrastructure of a real-world enterprise and map its components to the OSI model layers.

MODULE-2	**DATA LINK LAYER AND MEDIA ACCESS CONTROL**	**24ECE63.2**	**8 Hours**

Data Link Layer: Framing, error detection – Parity check, CRC, checksum; error correction – Hamming code.
Media Access Control (MAC): Random access – ALOHA, CSMA, CSMA/CD, CSMA/CA; Controlled access – Token passing, Polling.
Ethernet (IEEE 802.3): Frame format, addressing, CSMA/CD operation, Fast Ethernet, Gigabit Ethernet.
Wireless LAN (IEEE 802.11): Architecture, frame format, CSMA/CA, Wi-Fi standards (802.11a/b/g/n/ac).
Switching :Packet switching, Circuit switching, Packet Switching Versus Circuit Switching.

Hands on:

1. Compute each parity bit using even parity over its check positions.
2. Simulate two stations sensing the channel, both finding it idle, transmitting simultaneously, detecting collision, then applying binary exponential backoff. Show the backoff time calculation for attempts 1,2,3.
3. Calculate minimum frame size needed for CSMA/CD to work correctly given a network with a specific propagation delay (relate to the 512-bit-time slot time / 64-byte minimum frame rule).
4. Configure Wireless LAN
5. Draw a call setup for circuit switching (dedicated path, e.g., telephone) vs a packet-switched path (datagram/virtual circuit)

Applications	Simulate error detection using CRC and observe CSMA/CD collision resolution using Cisco Packet Tracer.

MODULE-3	**NETWORK LAYER: IP ADDRESSING AND SUBNETTING**	**24ECE63.3, 24ECE63.4**	**8 Hours**

IPv4 Addressing: Classful addressing (Class A, B, C, D, E), Classless addressing, Subnetting: Subnet mask, CIDR notation, DHCP
IPv6 Addressing: Need for IPv6, address format, types of IPv6 addresses, transition from IPv4 to IPv6 ICMPv4, ICMPv6 – purpose and working.
Routing: Static vs dynamic routing, routing algorithms – Distance Vector (Bellman-Ford), Link State (Dijkstra).
Routing Protocols: RIP, OSPF, BGP – features, working, and comparison.

Hands on:

1. Assign IPv4 Address to the network devices and end devices
2. Assign IPv6 Address to the network devices and end devices
3. Verify subnetting process using packet tracer
4. Verify Static and dynamic routing process using packet tracer
5. Configure RIP protocol

Applications	Configure OSPF

MODULE-4	**TRANSPORT LAYER PROTOCOLS**	**24ECE63.5**	**8 Hours**

Transport Layer Services: Process-to-process communication, port numbers, well-known and ephemeral ports, sockets.
UDP (User Datagram Protocol): Features, datagram format
TCP (Transmission Control Protocol): Features, segment format, connection establishment (3-way handshake), connection termination.
TCP Flow and Congestion Control: Sliding window, slow start, congestion avoidance, fast retransmit, fast recovery.
Comparison of TCP vs UDP: Use cases, advantages and disadvantages.

Hands on:

1. Classify the observed port numbers into: Well-known (0–1023), Registered (1024–49151), and Dynamic/Ephemeral (49152–65535).
2. Draw the UDP header format: Source Port (16b), Destination Port (16b), Length (16b), Checksum (16b), followed by Data.
3. Draw a timing diagram of both handshake and termination with the seq/ack numbers you captured, labeling each segment's flags.
4. Simulate a sliding window scenario by hand: sender window size = 4, sequence numbers 0–7 (mod 8). Show the window sliding as ACKs 1, 2, 3, 4 arrive one at a time.
5. Build a comparison table with rows — Connection type, Reliability, Ordering, Flow control, Congestion control, Header overhead, Speed

Applications	Capture and analyze TCP and UDP packets using Wireshark; observe 3-way handshake and congestion control behavior

MODULE-5	APPLICATION LAYER PROTOCOLS AND NETWORK SECURITY	24ECE63.6	8 Hours

Domain Name System (DNS): Hierarchy, resolution process, resource records, DNS security (DNSSEC).
Web Protocols: HTTP and HTTPS – request/response model, methods, status codes, persistent connections; HTTPS and SSL/TLS.
File and Email Protocols: FTP – modes of operation; SMTP, POP3, IMAP – email architecture and working.
Remote Access and Network Management: Telnet, SSH – comparison; SNMP – architecture, protocol data units.
Network Security Fundamentals: Threats – eavesdropping, spoofing, DoS; security services – confidentiality, integrity, authentication; Firewalls and VPNs.

Hands on:

1. Configure DNS server using packet tracer
2. Configure a basic secure network with VLANs using packet tracer
3. Configure SSH using packet tracer
4. Configure Telnet using packet tracer
5. Configure switchport security

Applications	Configure inter-VLAN routing using Cisco Packet Tracer.

CIE Assessment Pattern **(50 Marks – Hands On) –**

RBT Levels		Marks Distribution		
		Test (s)	Online Learning / Certification	Weekly Assessment
		25	15	10
L1	Remember	-	-	-
L2	Understand	-	-	5
L3	Apply	10	10	5
L4	Analyze	10	5	-
L5	Evaluate	5	-	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

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

Reference Books:

1) Cisco Networking Academy, "Introduction to Networks (ITN) Companion Guide", Cisco Press, 2023. ISBN: 978-0138166304
2) Andrew S. Tanenbaum and David J. Wetherall, "Computer Networks", 5th Edition, Pearson, 2022. ISBN: 978-0132126953
3) William Stallings, "Data and Computer Communications", 10th Edition, Pearson, 2021. ISBN: 978-0133506488

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/106105081
- https://www.netacad.com/courses/networking/ccna-introduction-networks
- https://www.coursera.org/learn/computer-networking
- https://www.geeksforgeeks.org/computer-network-tutorials

SMART SENSOR TECHNOLOGY

Course Code	**24ECE641**	**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:

24ECE641.1	Apply sensing principles to characterize smart sensors based on their operating principles and performance parameters.
24ECE641.2	Select suitable application-specific sensors based on their operating principles, characteristics, and application requirements.
24ECE641.3	Apply sensor interfacing concepts with microcontrollers for signal conditioning and data conversion.
24ECE641.4	Analyze sensor integration techniques and system considerations in smart sensing applications..
24ECE641.5	Analyze smart sensor solutions for real-world applications considering performance and implementation requirements.
24ECE641.6	Evaluate suitable smart sensor solutions for specific application requirements

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
24ECE641.1	3	-	-	-	-	-	-	-	-	-	2	3	2
24ECE641.2	3	-		2	-	-	-	-	-	-	2	3	2
24ECE641.3	3	-		2	-	-	-	-	-	-	2	3	2
24ECE641.4	3	3		2	-	-	-	-	-	1	2	3	2
24ECE641.5	3	3		2	-	-	1	-	-	1	2	3	2
24ECE641.6	3	3	2	2	-	1	2	1	2	2	2	3	2

MODULE-1	**SMART SENSOR BASICS AND FABRICATION**	**24ECE641.1**	**8 Hours**

Introduction to smart sensors, Nature of Sensors, Integration of Micromachining and Microelectronics, Wafer Bonding, Combining MEMS with IC Fabrication, Sensor Output Characteristics, Sensing Technologies, Digital Output Sensors, Classification of smart sensor

Case Study	Investigate different smart sensor technologies and compare smart sensors with conventional sensors in terms of functionality, accuracy, signal processing, and real-world applications
Text Book	Textbook 1: 1.1, 1.3, 1.4, 2.3, 2.6, 3.2-3.4 Textbook 2: 1.2

MODULE-2	**APPLICATION SPECIFIC SENSORS**	**24ECE641.2**	**8 Hours**

Ultrasonic sensor, Microwave Motion Detectors, Optoelectronic Motion detector, Optical and Radar sensor, Flow Sensor, Fiber Optic sensor, Thermoelectric Sensors, Gyroscope, VRP sensor, Photodiodes, CCD and CMOS Imaging Sensors, Optical Temperature Sensor

Self-study	Study various application specific sensors and evaluate their performance in real-world sensing applications.
Text Book	Textbook 2: 6.1, 6.2, 6.5, 7.5,7.7, 8.6,10.7, 11.1, 12.3, 14.2, 16.4

MODULE-3	**SENSOR WITH MICROCONTROLLER**	**24ECE641.3, 24ECE641.4**	**8 Hours**

Introduction, Amplification and Signal Conditioning, Integrated Signal Conditioning, Digital Conversion, MCU Control, MCUs for Sensor Interface, Techniques and Systems Considerations, DSP control, Sensor Integration.

Self-study	Study sensor interfacing and signal conditioning using microcontrollers
Text Book	Textbook 1: 4.1, 4.2, 4.3.1, 4.4, 5.2, 5.3,5.4, 5.5, 5.7

MODULE-4	**COMMUNICATIONS FOR SMART SENSORS**	**24ECE641.5**	**8 Hours**

Introduction, Various topologies, Sources (Organizations)and Standards, Automotive Protocols, Industrial Networks, Protocols in Silicon, Near Field Communication, Remote sensing, LIDAR, RF-ID, RF MEMS			
Self-study	Study wireless sensor networks and their applications in smart monitoring systems		
Text Book	Text Book 1: 6.2, 6.3, 6.4, 6.5, 6.7, 8.3.5, 8.5, 8.5.8, 8.7		
MODULE-5	**SMART APPLICATIONS AND NEXT PHASE SENSING SYSTEM**	**24ECE641.6**	**8 Hours**
Impact of Artificial Intelligence, Automotive Applications, Industrial (Robotic) Applications, Consumer Applications, Future Sensor Plus Semiconductor Capabilities, Future System Requirements, Software-Sensing and the System, Trusted Sensing, Alternate Views of Smart Sensing,			
Case Study	Analyze the role of smart sensing technologies in future intelligent systems and automation		
Text Book	Text book 1: 7.8, 14.3, 14.4, 14.5, 16.2-16.6		

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	5	-
L4	**Analyze**	10	5	5
L5	**Evaluate**	-	5	**5**
L6	**Create**	**-**	**-**	**-**

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Book:

1. Randy Frank, "Understanding Smart Sensors", Artech House Integrated Microsystems Series, 3rd Edition, 2013, ISBN: 9781608075089
2. Jacob Fraden, "Handbook of Modern Sensors: Physics, Designs, and Applications", 5th Edition, Springer, 2016., 978-3-319-19302-1.

Reference Books:

1. S. Kannadhasan, R. Nagarajan, Alagar Karthick, and V. Kumar Chinnaiyan (Eds.), Technological Applications for Smart Sensors: Intelligent Applications for Real-Time Strategies, 1st Edition, Apple Academic Press, 2025. ISBN: 978-1040334072.
2. Manoj Kumar Shukla, Praveen Kumar Malik, Anuj Jain, and Neeraj Kumar Mishra (Eds.), Smart Sensors: Design, Challenges, and Applications, 1st Edition, CRC Press, 2025. ISBN: 978-1040368534.

Web links and Video Lectures (e-Resources):

- **https://www.teledynevisionsolutions.com/en-in/learn/learning-center/imaging-fundamentals/ccd-vs-cmos/**
- **https://smartshop.lk-ea.com/blog-articles/post/smart-sensor.html?srsltid=AfmBOoqSDiBYbg5ez3QuexklRhgezzVMoOXUyKjJx3VSFcWtXmS1QVtC**

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

- Discuss smart sensor technologies and real-world engineering applications.
- Explain sensing principles through flipped classroom presentations.
- Analyze smart sensor applications using industry-based case studies.
- Compare application-specific sensors for different engineering scenarios.
- Present emerging trends in wireless and intelligent sensing.

RTL DESIGN AND VERIFICATION			
Course Code	**24ECE642**	**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:

24ECE642.1	Apply digital design concepts for RTL design and address its design challenges
24ECE642.2	Illustrate SystemVerilog data types and control structures for efficient implementation of digital systems
24ECE642.3	Use object-Oriented Programming concepts to create structured RTL verification
24ECE642.4	Construct Verilog RTL code using tasks and functions for modular and reusable design
24ECE642.5	Devise digital designs to develop and configure UVM-based testbenches and verification environments
24ECE642.6	Develop Universal Verification Methodology test benches to verify the functionality of different RTL designs

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
24ECE642.1	3	-	-	-	3	-	-	-	-	-	-	3	3
24ECE642.2	3	3	2	-	3	-	-	-	-	-	-	3	3
24ECE642.3	3	-	-	-	3	-	-	-	-	-	-	3	3
24ECE642.4	3	3	2	-	3	-	-	-	-	-	-	3	3
24ECE642.5	3	3	2	2	3	-	-	-	-	-	-	3	3
24ECE642.6	3	3	2	2	3	-	-	-	-	-	2	3	3

MODULE-1	**Introduction**	**24ECE642.1**	**8 Hours**

Digital design through Verilog: Overview of Combinational and Sequential circuits, Bus Structure, Simple processor design, RTL Designs, Goals and Constraints, RTL Based Chip Design Flow, Design Challenges.

Applications	Design basic combinational circuits and sequential circuits in Verilog.
Text Book	Text Book 1: Ch 4, 6,7. Text Book 2: Ch 1

MODULE-2	**System Verilog Basics**	**24ECE642.2**	**8 Hours**

Different Data Types, User-Defined and Enumerated Types: String Data Types, Event Data Types, User-Defined Types, Enumerated Types, Nets, Reg, Logic, Type Casting, Constants, Attributes, Packed Array and Unpacked Array, Dynamic, Associate Array, Its Methods, QUEUE Operators and Expressions, Control Structure: If-Else, Switch, Loop, repeat, break, continue, unique.

Self-study	Dynamic and Associative Arrays in System Verilog
Text Book	Text Book 3: Ch 2.

MODULE-3	**System function and Inter Process communication**	**22ECE642.3**	**8 Hours**

		24ECE642.4	
System Tasks and System Functions, Processes: Combinational Logic, Latch Logic, Sequential Logic, Fork Join (Join, Join_Any, Join_None), Event Controls, Process Control Inter process Communication: OOPS, Semaphores, Mailboxes, Constraints, Randomization.			
Self-study	Analyze how constraints and randomization are used in creating efficient and robust testbenches for verification.		
Text Book	Text Book 3: Ch 3.1,3.2,3.3,5.5-5.11,6.2-6.4,7.1, 7.5, 7.6,7.6.1		
MODULE-4	**UVM Overview**	**24ECE642.5**	**8 Hours**
UVM Test Bench and Environment, Interface UVCs, Module and System UVCs, Test Benches, System Verilog UVM Class Library, UVM Library Basics, UVM Sequences, UVM Sequencers			
Case Study	Develop a UVM test bench environment for verifying the functionality and performance of a UART (Universal Asynchronous Receiver/Transmitter) communication protocol.		
Text Book	Text Book 4: Ch 2,4,5		
MODULE-5	**Simple Test Bench Integration**	**24ECE642.5, 24ECE642.6**	**8 Hours**
Test Benches and Test, creating a simple test bench, Virtual sequencer, Test bench Configuration, creating a test, Virtual sequences, Checking DUT Correctness, Implementing a coverage model.			
Self-Study	Understand the purpose and function of each component in the test bench, and how they interact to test a digital design.		
Text Book	Text Book 4: Ch 7		

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	5	-
L4	**Analyze**	10	5	5
L5	**Evaluate**	-	5	**5**
L6	**Create**	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1) Fundamentals of Digital Logic with Verilog design, Stephen Brown and Zvonko Vranesic, McGraw Hill, 2014, 3rd edition, 978–0–07–338054–4.
2) Principles of VLSI RTL Design, A Practical Guide, Sanjay Churiwala and Sapan Garg, Springer 2011, 1st edition, 978-1-4419-9295-6
3) System Verilog for Verification, A Guide to Learning the Testbench Language Features, Chris Spear and Greg Tumbush, Springer 2012, 3rd edition 978-1-4614-0714-0.
4) A practical guide to adopting the Universal Verification Methodology, Kathleen A Meade and Sharon Rosenberg, 2013, 2nd edition, lulu Publisher, 978-1-300-53593-5.

Reference Books:

1) Ashok B. Mehta, "Introduction to System Verilog", Springer, New York, 1st Edition, 2021
2) Srivatsa Vasudevan, "Practical UVM Step by Step with IEEE 1800.2", R R Bowker, CA, USA, 2nd Edition, 2020.
3) R. Salemi, "The UVM Primer: A Step-By-Step Introduction to The Universal Verification Methodology" Boston Light Press, 2013, 1st edition, 978-0991160402.
4) Navabi, Zainalabedin, and Yuwen Xia. "Verilog Digital System Design: Register Transfer Level Synthesis, Testbench, and Verification", McGraw-Hill, 2006,1st edition, 978-0071475457.

Web links and Video Lectures (e-Resources):

1. https://chipverify.com/tutorials/systemverilog
2. https://chipverify.com/tutorials/uvm
3. https://verificationguide.com/systemverilog-topics/
4. https://verificationguide.com/uvm-topics/
5. http://www.systemverilog.org/

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

- Digital circuit Simulation to test and debug verilog design.
- Video demonstration of end-to-end process of RTL design
- Contents related activities (Activity-based discussions)
  - For active participation of students, instruct the students to prepare Flowcharts and Handouts.
  - Organizing Group wise discussions on issues
  - Course Mini Projects
  - Programming assignments

OPTICAL COMMUNICATION

Course Code	**24ECE643**	**Credits**	**03**
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:

24ECE643.1	Apply the fundamental principles of optical fiber communication to analyze modern communication systems
24ECE643.2	Select suitable optical fiber structures based on specific application requirements
24ECE643.3	Analyze the effects of channel impairments on the performance of optical fiber communication systems
24ECE643.4	Evaluate the performance of optical receivers based on system parameters
24ECE643.5	Analyze optical multiplexing techniques for efficient networking applications
24ECE643.6	**Analyze** optical amplification techniques for improving the performance of optical communication systems

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
24ECE643.1	3	-	-	-	-	-	-	-	-	-	1	3	2
24ECE643.2	3	-	-	-	-	-	-	-	-	-	1	3	2
24ECE643.3	3	3	-	2	2	-	-	-	-	-	1	3	2
24ECE643.4	3	3	-	2	2	-	-	-	-	-	1	3	2
24ECE643.5	3	3	-	-	2	-	-	-	-	-	1	3	2
24ECE643.6	3	3	-	-	2	-	-	-	-	-	1	3	2

MODULE-1	**OVERVIEW OF OPTICAL FIBER COMMUNICATION**	**24ECE643.1**	**8 Hours**

Historical development, The General System, advantages, disadvantages, and applications of optical fiber communication, Ray theory, Electromagnetic mode theory, cylindrical fiber (no derivations in section 2.4.4), single mode fiber, cutoff wave length, mode filed diameter.

Case Study	Evolution from copper links to fiber-optic backbone and submarine communication systems.
Text Book	Text Book 1: 1.1, 1.2, 1.3, 2.1, 2.2, 2.3.1,2.3.2,2.3.3,2.4, 2.5.1, 2.5.2

MODULE-2	**OPTICAL SOURCES AND TRANSMISSION CHARACTERISTICS OF OPTICAL FIBERS**	**24ECE643.2, 24ECE643.3**	**8 Hours**

Optical sources: LED, power and efficiency, LED structures, LED characteristics, LASER basic concepts, The Semiconductor Injection LASER Attenuation, absorption, scattering losses, bending loss, dispersion, Chromatic dispersion, Inter model dispersion.

Application	Source selection and impairment mitigation for a high-speed fiber-optic link.
Text Book	Text Book 1: 7.2,7.3.1,7.3.2,7.3.3,7.3.4, 7.4, 6.2,6.4, 3.1, 3.2 3.3, 3.4, 3.6, 3.8, 3.9, 3.10

MODULE-3	**PHOTODETECTION DEVICES AND OPTICAL RECEIVERS**	**24ECE643.4 24ECE643.5**	**8 Hours**

Operation of Photo diodes, The pin Photodetector, Basics of Avalanche Photodiodes, Basic Receiver Operation, performance characteristics of digital receivers, principles of Eye diagrams.

Application	Design of a 10-km digital optical link using power and rise-time budgets.
Text Book	Text Book2: 6.1, 7.1-7.3

MODULE-4	**OPTICAL AMPLIFIERS**	**24ECE643.5 24ECE643.6**	**8 Hours**

Fundamental Optical amplifier types, semiconductor optical amplifiers, Erbium-doped fiber amplifiers, noises generated in Optical amplifiers, Optical Signal-To-Noise Ratio (OSNR).

Case Study	Comparison of EDFA, SOA amplifiers for metro and long-haul systems.		
Text Book	Text Book 2: 11.1 - 11.5		
MODULE-5	**WDM CONCEPTS AND FIBER OPTIC COMMUNICATION NETWORKS**	**24ECE6435.5**	**8 Hours**

Concepts of WDM, Mach-Zehnder interferometry Techniques, Non-reciprocal Isolators and circulators, Concepts of Optical networks, Common network topologies, Basic SONET/SDH concepts, Schemes for Optical Add/Drop Multiplexing.

Case Study	PON-based FTTH deployment for a smart-city access network.
Text Book	Text Book2: 10.1, 10.2.5, 10.3, 13.1-13.3, 13.5

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	5	-
L4	Analyze	10	5	5
L5	Evaluate	-	5	5
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1) "Optical Fiber Communications", John M. Senior, Pearson Education, Second Edition, 7th Impression, 2010, ISBN 978-0135040659.
2) Gerd Keiser, Fiber Optic Communications, 1st Edition, Springer Singapore, 2022, ISBN978-981-33-4667-3.

Reference Books:

1) Joseph C. Palais, Fiber Optic Communications, 5th Edition, Pearson/Prentice Hall, 2005, ISBN: 978-0-13-008510-8.

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc23_ee80/preview
- https://www.tutorialspoint.com/optical-networks-and-laser-course/index.asp
- https://www.youtube.com/watch?v=pavBq7HIoIEShlist=PLgwJf8NK2e4d2AyXC7pvXtgJ51qz-HWV

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

- Industrial Visit to Electronics Based Companies
- Demonstration of Optical Fiber Cable
- Video demonstration of latest trends in Optical Networks
- Contents related activities (Activity-based discussions)
  - For active participation of students, instruct the students to prepare Flowcharts and Handouts
  - Organizing Group wise discussions on Fiber Optic Technology
  - Seminars and Workshops

IMAGE PROCESSING

Course Code	**24ECE644**	**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:

24ECE644.1	Explain the fundamentals of digital image processing.
24ECE644.2	Analyze image formation and the role of the human visual system in grayscale image perception.
24ECE644.3	Apply image processing techniques in both the spatial and frequency (Fourier) domains.
24ECE644.4	Design and evaluate image analysis techniques for effective image processing.Design and evaluate image analysis techniques
24ECE644.5	Analyze image restoration techniques based on their performance and application requirements.
24ECE644.6	Apply morphological operations to binary and grayscale images for image analysis

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
24ECE644.1	-	-	-	-	-	-	-	-	-	-	-	3	2
24ECE644.2	3	-	-	-	-	-	-	-	-	-	-	3	2
24ECE644.3	3	-	-	-	3	-	-	-	-	-	-	3	2
24ECE644.4	3	3	-	-	-	-	-	-	-	-	-	3	2
24ECE644.5	3	-	-	-	3	-	-	-	-	-	-	3	2
24ECE644.6	3	3	2	1	3	-	-	-	-	-	-	3	2

MODULE-1	**Image Fundamentals**	**24ECE644.1**	**8 Hours**

What is Digital Image Processing? Origins of Digital Image Processing, Examples of fields that use DIP, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Elements of Visual Perception, Image Sensing and Acquisition.

Self-study	Applications of Digital Image processing
Text Book	Text Book 1: 2.1, 2.2, 2.6.2

MODULE-2	**Image Enhancement in the Spatial Domain**	**24ECE644.2**	**8 Hours**

Image Sampling and Quantization, Some Basic Relationships Between Pixels, Linear and Nonlinear Operations. Some Basic Intensity Transformation Functions, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters.

Self-study	Spatial Filtering
Text Book	Text Book 1: 2.3, 2.4, 2.5, 2.62, 3.2, 3.3,3.4, 3.5 3.6

MODULE-3	**Frequency Domain**	**24ECE644.3, 24ECE644.4**	**8 Hours**

Preliminary Concepts, The Discrete Fourier Transform (DFT) of Two Variables, Properties of the 2-DDFT, Filtering in the Frequency Domain, Image Smoothing and Image Sharpening Using Frequency Domain Filters, Selective Filtering

Case Study	Selective Filtering for Binary image
Text Book	Text Book 1: 4.2, 4.5, 4.6, 4.7, 4.8, 4.9 4.10

MODULE-4	**Image Restoration**	**24ECE644.5**	**8 Hours**

Noise models, Restoration in the Presence of Noise Only using Spatial Filtering and Frequency Domain Filtering, Linear, Position-Invariant degradations Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering, Constrained Least Squares Filtering.

Self-study	Frequency Domain Filtering		
Text Book	Text Book 1: 5.2, 5.3, 5.4, 5.5, 5.6, 5.7,5.8, 5.9		
MODULE-5	**Morphological Analysis**	**24ECE644.6**	**8 Hours**
Morphological Image Processing: Preliminaries, Erosion and Dilation, Opening and Closing, The Hit-or-Miss Transforms, Some Basic Morphological Algorithms. Representation and Description: Representation, Boundary descriptors.			
Application	Implementation of Boundary descriptors		
Text Book	Text Book 1: 9.1, 9.2, 9.3, 9.4, 11.2,11.3		

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	-
L4	Analyze	10	5	5
L5	Evaluate		-	5
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1. Gonzalez, R. C., Woods, R. E., S Eddins, S. L. (2022). Digital image processing (4th ed.). Pearson. ISBN: 9780137848560

Reference Books:

1. Milan Sonka, Thomson, "Image Processing, Analysis and Machine Vision", Press India Ltd., 4th Edition., ISBN: 978-9386858146
2. Anil K. Jain, "Fundamentals of Digital Image Processing", 2nd Edition, Prentice Hall of India, ISBN : 978-9332551916
3. S. Sridhar, "Digital Image Processing", Oxford University Press, 2nd Edition, 2016, ISBN: 978-0199459353

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_ee126
- https://www.mygreatlearning.com/academy/learn-for-free/courses/digital-image-processing
- https://www.classcentral.com/course/xuetangx-digital-image-processing-448671
- https://www.udemy.com/course/digital-image-processing-operations-and-applications/?srsltid=AfmBOopQtPK9_pkppJu4VUZgjPaBC1g64X5HNLflewFHh4SoQNZ1L8bg
- https://www.coursera.org/learn/introduction-image-processing

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

- Problem solving Approach
- Organizing Group wise discussions on related Topics
- Seminars
- Mini Projects based on Image Processing

MACHINE LEARNING ALGORITHMS

Course Code	**24ECE645**	**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:

24ECE645.1	Understand the Core concepts of Machine learning
24ECE645.2	Analyze the Mathematical relationships within and across Machine learning algorithms
24ECE645.3	Categorize the paradigms of supervised and un-supervised learning
24ECE645.4	Implement supervised and unsupervised learning algorithms for solving classification, regression, and clustering problems.
24ECE645.5	Analyze the performance of analytical learning and reinforcement learning algorithms
24ECE645.6	Construct a simulation environment of Reinforced Learning problem

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
24ECE645.1	-	-	-	-	-	-	-	-	-	-	2	3	2
24ECE645.2	3	3	-	1	3	-	-	-	-	-	2	3	2
24ECE645.3	3	3	-	1	3	-	-	-	-	-	2	3	2
24ECE645.4	3	3	-	1	3	-	-	-	-	-	2	3	2
24ECE645.5	3	3	-	1	3	-	-	-	-	-	2	3	2
24ECE645.6	3	-	-	1	3	-	-	-	-	-	2	3	2

MODULE-1	**INTRODUCTION TO MACHINE LEARNING**	**24ECE645.1**	**8 Hours**

Introduction to Machine Learning: Need for Machine Learning, Machine Learning Explained, Machine Learning in Relation to Other Fields, Types of Machine Learning, Challenges of Machine Learning, Machine Learning Process, Machine Learning Application.

Understanding Data: Introduction, Big Data Analytics and Types of Analytics, Big Data Analysis Framework, Descriptive Statistics, Univariate Data Analysis and Visualization, Bivariate Data and Multivariate Data.

Applications	Create histograms and box plots for all numerical features and analyze the distribution of each feature, Use California Housing dataset.
Text Book	Textbook 1: 1.1-1.7, 2.1-2.6

MODULE-2	**BASICS OF LEARNING THEORY**	**24ECE645.2**	**8 Hours**

Understanding Data: Multivariate Statistics, Essential Mathematics for Multivariate Data, Overview of Hypothesis, Feature Engineering and Dimensionality Reduction Techniques.

Basics of Learning Theory: Introduction to Learning and its Types, Introduction to Computation Learning Theory, Design of a Learning System, Introduction to Concept Learning, Induction Biases, Modelling in Machine Learning.

Applications	Compute and visualize the correlation matrix to understand the relationships between pairs of features using heatmap, Use California Housing dataset.
Text Book	Textbook 1: 2.7-2.10, 3.1 – 3.6

MODULE-3	**REGRESSION ANALYSIS**	**24ECE645.3**	**8 Hours**

Similarity-based Learning: Introduction to Similarity or Instance-based Learning, Nearest-Neighbor Learning, Weighted K-Nearest-Neighbor Algorithm, Nearest Centroid Classifier, Locally Weighted Regression (LWR).

Regression Analysis: Introduction to Regression, Introduction to Linearity, Correlation, and Causation, Introduction to Linear Regression, Validation of Regression Methods, Multiple Linear Regression, Polynomial Regression, Logistic Regression.

Applications	Demonstrate the working of Linear Regression and Polynomial Regression, Use Boston Housing Dataset for Linear Regression and Auto MPG Dataset (for vehicle fuel efficiency prediction) for Polynomial Regression.

Text Book	Textbook 1: 4.1 – 4.5, 5.1 – 5.7		
MODULE-4	**DECISION TREE and BAYESIAN LEARNING**	**24ECE645.4, 24ECE645.5**	**8 Hours**

Models Based on Decision Trees: Introduction to Decision Tree, Decision Tree for Classification, Impurity Measures for Decision Tree Construction, Properties of Decision Tree Classifier (DTC), Applications in Breast Cancer Data, Regression Based on Decision Tress.
Bayesian Learning: Introduction to Probability-based Learning, Fundamentals of Bayes Theorem, Classification Using Bayes Model.

Case Study	Applying Naive Bayes Classifier for Email Spam Detection.
Text Book	Textbook 2: 3.1 – 3.6, Textbook 1: 8.1 – 8.3

MODULE-5	**CLUSTERING and REINFORCEMENT LEARNING**	**24ECE645.4, 24ECE645.5, 24ECE645.6**	**8 Hours**

Clustering: Introduction to Clustering, Clustering of Patterns, Divisive Clustering, Agglomerative Clustering, Partitional Clustering.
Reinforcement Learning: Overview and Scope of Reinforcement Learning, Components of Reinforcement Learning, Q-Learning.

Applications	Developing an Intelligent Tutoring System Using Explanation-Based Learning and Reinforcement Learning.
Text Book	Textbook 2: 7.1 – 7.5, Textbook 1: 14.1, 14.2, 14.4, 14.9

CIE Assessment Pattern (50 Marks – Theory) –

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

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1) S Sridhar and M Vijayalakshmi, "Machine Learning", Oxford University Press, 2021. ISBN: 9780190127275
2) M N Murty and Ananthanarayana V S, "Machine Learning: Theory and Practice", Universities Press (India) Pvt. Limited, 2024. ISBN: 978-93-93330-69-7

Reference Books:

1) Helena Hashemi Farzaneh, Udo Lindemann, "A Practical Guide to Bio-inspired Design", Springer Vieweg, 1st edition 2022, ISBN: 366257683X
2) Torben A. Lenau, Akhlesh Lakhtakia," Biologically Inspired Design: A Primer (Synthesis Lectures on Engineering, Science, and Technology)", Publisher: Morgan & Claypool Publishers, 2023, ISBN-10: 1636390471, ISBN: 978-1636390475
3) French M, "Invention and evolution: Design in nature and engineering", Publisher: Cambridge University

Press, 2023, ISBN: 978-1636390475 4) Tom M. Mitchell**,** *Machine Learning*, McGraw-Hill, 1997. ISBN: 9780070428072
Web links and Video Lectures (e-Resources): • **https://youtu.be/whSKA8aO6xQ?si=td4MqCH5l1jZDWZg** • **https://youtu.be/OTAR0kT1swg?si=tu9tv_oVGHn4xJKQ** • **https://youtu.be/BWlf7RefVrU?si=CgobyHTTG-7olwQK** • **https://www.nptel.ac.in/courses/106106139**
Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning • Course project by taking a suitable machine learning-based real-world application problem. • Video demonstration of latest trends in Image processing using Machine Learning. • Contents related activities (Activity-based discussions). • For active participation of students, conduct problem solving sessions.

COMPUTER-AIDED SIMULATION OF ANTENNAS

Course Code	**24ECE651**	**CIE Marks**	**50**
L:T:P:S	**0:0:1:0**	**SEE Marks**	**50**
Hrs/Week	**2**	**Total Marks**	**100**
Credits	**01**	**Exam Hours**	**03**

Course outcomes:

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

24ECE651.1	Understand and utilize the computer aided simulation environment for antenna modeling and simulation
24ECE651.2	Design and simulate basic antenna structures using HFSS
24ECE651.3	Analyze antenna performance using radiation patterns, gain, directivity, bandwidth, and VSWR
24ECE651.4	Evaluate and optimize antenna designs for specific wireless communication applications

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 1	PSO 2
24ECE651.1	3	-	-	2	3	-	-	3	-	-	-	3	3
24ECE651.2	3	3	2	2	3	-	-	3	-	-	-	3	3
24ECE651.3	3	3	2	2	3	-	-	3	-	-	-	3	3
24ECE651.4	2	3	2	2	3	2	1	3	-	-	-	3	3

Exp. No. / Pgm. No.	List of Experiments / Programs	Hours	COs
	Prerequisite Experiments / Programs / Demo		
	• Introduction to the software platform and laboratory environment. • Basic modeling, parameter setting, and simulation workflow. • Generation and interpretation of output results and reports.	2	NA
	PART-A		
1	Familiarization with HFSS Interface, Project Setup, Materials and Boundary Conditions.	2	24ECE651.1
2	Creation of basic 3D objects and assignment of ports and excitations.	2	24ECE651.1
3	Design and simulation of Monopole Antenna.	2	24ECE651.2
4	Design and simulation of Half-Wave Dipole Antenna.	2	24ECE651.2
5	Design and simulation of Folded Dipole Antenna.	2	24ECE651.2
6	Design and analysis of wideband antennas (Conical & Bow-Tie antennas).	2	24ECE651.2, 24ECE651.3
	PART-B		
7	Design and simulation of Rectangular Microstrip Patch Antenna at 2.4 GHz.	2	24ECE651.2
8	Design and simulation of circular Microstrip Patch Antenna at 2.4 GHz.	2	24ECE651.2
9	Parametric analysis of Patch Antenna dimensions and substrate properties.	2	24ECE651.3
10	Design and simulation of Rectangular Microstrip Patch Antenna at 5.2 GHz.	2	24ECE651.2, 24ECE651.3
11	Design and simulation of circular Microstrip Patch Antenna at 5.2 GHz.	2	24ECE651.2, 24ECE651.3
12	Design and analysis of a 2x2 antenna array using HFSS simulation software for 3.5 GHz.	2	24ECE651.4

PART-C
Beyond Syllabus Virtual Lab Content (4 Hours)
(To be done during Lab but not to be included for CIE or SEE)

1. **Introduction to Ansys HFSS - https://innovationspace.ansys.com/product/intro-to-ansys-hfss/**
2. **Ansys HFSS Port Types - https://innovationspace.ansys.com/product/ansys-hfss-port-types/**
3. **Example Antenna Types - https://innovationspace.ansys.com/product/example-antenna-types/**
4. **Simulation of a Dipole Array in Ansys HFSS - https://innovationspace.ansys.com/product/simulation-of-a-dipole-array-in-ansys-hfss/**
5. **Basics of Antenna Arrays - https://innovationspace.ansys.com/product/basics-of-antenna-arrays/**
6. **Microstrip Patch Antenna Array - https://innovationspace.ansys.com/product/microstrip-patch-antenna-array/**

CIE Assessment Pattern (50 Marks – Lab)

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

SEE Assessment Pattern (50 Marks – Lab)

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

Suggested Learning Resources:

Reference Books:

1. Constantine A. Balanis, Antenna Theory: Analysis and Design, 5th Edition, Wiley, 2024.ISBN: 978-1119986478
2. Yi Huang and Kevin Boyle, Antennas: From Theory to Practice, 3rd Edition, Wiley, 2021. ISBN: 978-1119561156

Online Resources:

1. Ansys HFSS Student Version: https://www.ansys.com/academic/students/ansys-electronics-desktop-student
2. Ansys Innovation Space Learning Courses: https://innovationspace.ansys.com/courses/

FPGA VERIFICATION USING CHIPSCOPE

Course Code	**24ECE652**	**CIE Marks**	**50**
L:T:P:S	**0:0:1:0**	**SEE Marks**	**50**
Hrs / Week	**2**	**Total Marks**	**100**
Credits	**01**	**Exam Hours**	**03**

Course outcomes:

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

24ECE652.1	Set up and configure the FPGA on-chip debug environment, including JTAG connectivity, ChipScope/ILA core insertion, and bitstream download to target hardware
24ECE652.2	Configure and apply single, Boolean, sequential, and bus-level trigger conditions in the Integrated Logic Analyzer to capture and verify the behavior of digital circuits such as counters, FSMs, and memory controllers on real hardware
24ECE652.3	Employ the Virtual Input/Output (VIO) core for real-time stimulus and monitoring, and verify the timing and data integrity of serial communication protocols (UART/SPI/I2C) using on-chip capture
24ECE652.4	Analyze multi-clock domain designs for clock-domain-crossing issues and execute a complete on-chip verification cycle — from debug planning to root-cause analysis and design correction — on a representative digital system

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
24ECE652.1	3	3	2	2	3	-	-	3	-	-	2	3	3
24ECE652.2	3	3	2	2	3	-	-	3	-	-	2	3	3
24ECE652.3	3	3	2	2	3	-	-	3	-	-	2	3	3
24ECE652.4	3	3	2	2	3	-	-	3	-	-	2	3	3

Exp. No. / Pgm. No.	List of Experiments / Programs	Hours	COs
	Prerequisite Experiments / Programs / Demo		
	• Verification of basic gates using IC Trainer board • Basic gate implementation using Verilog code.	2	NA
	PART-A		
1	Study the FPGA on-chip debug and verification flow, and to configure the ChipScope tool environment by establishing JTAG connectivity between the host PC and the target FPGA development board.	2	24ECE652.1
2	Design a synchronous counter using Hardware Description Language and to verify its functionality on FPGA hardware by manually instantiating ChipScope ICON and ILA cores within the source design.	2	24ECE652.1
3	Design and Verify the functionality of a Finite State Machine implemented on FPGA by inserting ChipScope debug cores into the post-synthesis net-list using the CoreInserter utility, without modification of the original source code.	2	24ECE652.1
4	Implement a shift register design on FPGA and to verify its operation using the Vivado-native Integrated Logic Analyzer flow, by marking debug signals and generating the corresponding probes file and bitstream.	2	24ECE652.1
5	Download the generated bitstream onto the target FPGA device through the JTAG interface and to establish a live debug session using the Hardware Manager/ChipScope Analyzer for real-time observation of internal signals.	2	24ECE652.1

6	Capture and verify the rollover event of a hardware counter by configuring single-bit edge and level triggering conditions in the Integrated Logic Analyzer.	2	24ECE652.2
PART-B			
7	Design and verify a traffic light controller Finite State Machine on FPGA by configuring Boolean and multi-stage sequential trigger conditions to detect a specified illegal state transition.	2	24ECE652.2
8	Verify the read/write operation of a synchronous RAM controller on FPGA by configuring bus-level and word-level triggering to capture address and data bus values during a specified transaction.	2	24ECE652.2
9	Control and monitor the operation of a UART transmitter module on FPGA in real time, without re-programming the device, using the Virtual Input/Output core in conjunction with the Integrated Logic Analyzer.	2	24ECE652.3
10	Verify the timing and data integrity of a serial communication protocol (UART/SPI/I2C) implemented on FPGA by capturing the transmitted frame using ChipScope and correlating it with the standard protocol timing diagram.	2	24ECE652.3
11	Identify and analyze clock domain crossing behavior in a dual-clock FIFO design implemented on FPGA by simultaneously capturing signals from two independent clock domains using synchronized Integrated Logic Analyzer cores.	2	24ECE652.4
12	carry out the complete on-chip verification cycle of a given memory-mapped peripheral/mini digital system with an intentionally introduced design fault — including debug core planning, insertion, hardware triggering, waveform capture, root-cause identification, RTL correction, and re-verification — using ChipScope.	2	24ECE652.4

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

1. https://www.youtube.com/watch?v=kTjeTOf6ACI
2. https://www.youtube.com/@AMDAdaptiveComputing/search?query=Vivado%20debug%20ILA

CIE Assessment Pattern (50 Marks – Lab)

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

SEE Assessment Pattern (50 Marks – Lab)

RBT Levels	Exam Marks Distribution (50)

L1	**Remember**	**-**
L2	**Understand**	05
L3	**Apply**	20
L4	**Analyze**	15
L5	**Evaluate**	10
L6	**Create**	**-**

Suggested Learning Resources:

Reference Books:

1) AMD (Xilinx), ChipScope Pro Software and Cores User Guide, Document ID: UG029, Version 14.7, October 2012.Covers ILA, VIO, ATC2 core architecture, Core Inserter, ChipScope Analyzer, ICON, and JTAG debug flow for ISE-based designs.

[2] AMD (Xilinx), Vivado Design Suite User Guide: Programming and Debugging, Comprehensive reference for Vivado ILA/VIO core insertion (Mark Debug, Set Up Debug Wizard, IP Catalog), advanced triggering, multi-clock debug, Hardware Manager, and bitstream download.

LINUX AND SHELL PROGRAMMING LAB

Course Code	**24ECE653**	**CIE Marks**	**50**
L:T:P:S	**0:0:1:0**	**SEE Marks**	**50**
Hrs / Week	**2**	**Total Marks**	**100**
Credits	**01**	**Exam Hours**	**03**

Course outcomes:

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

24ECE653.1	Apply Linux commands, file management utilities, networking tools, and system administration commands for effective operation of Linux-based systems
24ECE653.2	Analyze text files, databases, processes, and patterns using Linux utilities, regular expressions, and process management commands
24ECE653.3	Develop shell scripts and automate routine system tasks using Linux shell programming
24ECE653.4	Implement and evaluate basic Linux Device Driver operations and Embedded Linux interfaces for hardware peripherals such as USB devices and Arduino-based systems

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
24ECE653.1	3	3	2	2	3	-	-	3	-	-	2	3	-
24ECE653.2	3	3	2	2	3	-	-	3	-	-	2	3	-
24ECE653.3	3	3	2	2	3	-	-	3	-	-	2	3	-
24ECE653.4	3	3	2	2	3	-	-	3	-	-	2	3	-

Exp. No. / Pgm. No.	List of Experiments / Programs	Hours	COs
	Prerequisite Experiments / Programs		
	• Basics of Operating systems. • C programming concepts.	2	NA
	PART-A		
1	(a) Perform the following commands, including their respective options, if available: Date with all available options, cal, calendar, who, whoami, tty, stty, clear,tput, (b) Run the following commands along with their respective options, if applicable- Man, echo, whatis, Uname	2	24ECE653.1
2	(a) Execute the following commands: bc with a specified scale factor for precision, base conversion using bc (e.g., binary to decimal, decimal to octal, decimal to hexadecimal, etc.), password management, viewing command history, managing aliases, (b) Execute the "ls" command to display comprehensive file attributes with all available options,-view the file's contents, perform file copying and moving operations between locations, and subsequently remove the file	2	24ECE653.1
3	(a) Execute the following directory-related commands: Create a new directory, navigate between directories, print the current directory path, check disk space usage, compress file content, and archive files. (b) Execute Networking commands-ifconfig, ip command, ping, traceroute, netstat, ss, hostname.	2	24ECE653.1
4	Establish a student database consisting of 10 records, each containing five fields, and employ the following commands to present the records as per your requirements: head, tail, cut, paste, sort, uniq, tee, nl, and tr, making use of all available options.	2	24ECE653.1
5	Construct a student/employee database encompassing 5 fields, and employ the grep command along with its full range of options to exhibit	2	24ECE653.2

	records or patterns using regular expressions		
6	Show both user and system processes, and terminate specific processes by their process IDs.	2	24ECE653.2
PART-B			
7	Create a shell script that prompts the user for a pattern and a filename, then searches for the pattern within the specified file.	2	24ECE653.2
8	Develop a shell script that requests a filename, starting line number, and ending line number from the user. It will then display the lines within that range from the specified file.	2	24ECE653.2
9	Design a login shell script that greets the user with "Good Morning," "Good Afternoon," or "Good Evening" based on the time of login.	2	24ECE653.3
10	(a) Execute the Linux Device Drivers commands – uname, lsmod, modinfo usbcore (b) Explore device files using commands – ls /dev, ls -l /dev. Also, perform USB Device driver Exploration using – lsusb, dmesg and tail.	2	24ECE653.3
11	Write a simple Linux Character device driver and perform driver loading, verification and unloading using – modprobe, lsmod and rmmod.	2	24ECE653.4
12	Interface Linux with Arduino, to read serial data from Arduino using Screen utility.	2	24ECE653.4

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

1. https://www.youtube.com/watch?v=Wgi-OfbP2Gw
2. https://www.udemy.com/course/learn-linux-in-5-days/
3. https://www.youtube.com/watch?v=ROjZy1WbCIA
4. https://nptel.ac.in/courses/117106113/

CIE Assessment Pattern (50 Marks – Lab)

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

SEE Assessment Pattern (50 Marks – Lab)

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

Suggested Learning Resources:

Reference Books:

1) Sumitabha Das, "Unix Concepts and Applications", 4th Edition, McGraw Hill Education.
2) Yashavant Kanetkar, "Unix Shell Programming", BPB Publications.
3) Jonathan Corbet, Alessandro Rubini, and Greg Kroah-Hartman, "Linux Device Drivers", 3rd Edition, O'Reilly Media.

EMF PROGRAMMING USING OCTAVE			
Course Code	**24ECE654**	**CIE Marks**	**50**
L:T:P:S	**0:0:1:0**	**SEE Marks**	**50**
Hrs / Week	**02**	**Total Marks**	**100**
Credits	**01**	**Exam Hours**	**03**

Course outcomes:

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

24ECE654.1	Apply GNU Octave programming techniques and visualization tools for solving basic electromagnetic field problems.
24ECE654.2	Analyze vector calculus operations and electrostatic field parameters through numerical computation and simulation.
24ECE654.3	Analyze magnetostatic fields and electromagnetic wave propagation characteristics using computational models developed in GNU Octave.
24ECE654.4	Develop simulation-based solutions for practical electromagnetic engineering applications using GNU Octave.

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
24ECE654.1	3	2	1	1	2	-	-	3	-	-	2	3	3
24ECE654.2	3	3	2	2	2	-	-	3	-	-	2	3	3
24ECE654.3	3	3	2	2	2	-	-	3	-	-	2	3	3
24ECE654.4	3	3	2	2	2	-	-	3	-	-	2	3	3

Exp. No. / Pgm. No.	List of Experiments / Programs	Hours	COs
	Prerequisite Experiments / Programs / Demo		
	Fundamentals of Electromagnetic theory Fundamentals of Plotting techniques.	2	NA
	PART-A		
1	Introduction to GNU Octave Programming for Electromagnetic Applications: Matrix and vector operations, User-defined functions and scripts, Basic plotting techniques	2	24ECE654.1
2	To develop programs for plotting and visualizing scalar and vector fields using 2D and 3D graphical representations.	2	24ECE654.1
3	To implement vector differential operators and analyze their significance in electromagnetic field computations.	2	24ECE654.1,24ECE654.2
4	To compute line, surface, and volume integrals numerically and verify their applications in electromagnetic field theory.	2	24ECE654.1,24ECE654.2
5	To calculate and visualize electric field intensity produced by a point charge.	2	24ECE654.2
6	To determine and visualize the electric potential distribution generated by various charge configurations.	2	24ECE654.2
	PART-B		
7	To evaluate electric flux through closed surfaces and verify Gauss's Law for different charge distributions.	2	24ECE654.2
8	To compute electric field intensity, potential distribution, and capacitance of a parallel plate capacitor using GNU Octave.	2	24ECE654.2
9	To calculate and visualize magnetic field intensity due to current-carrying conductors using Bio–Savart Law.	2	24ECE654.3
10	To determine magnetic field intensity around current-carrying	2	24ECE65

	conductors and numerically verify Ampere's Circuital Law.		4.3
11	To model electromagnetic wave propagation and analyze wave characteristics such as wavelength, frequency, and phase velocity.	2	24ECE65 4.3
12	To analyze transmission line parameters and obtain reflection coefficient and SWR for electromagnetic patterns.	2	24ECE65 4.4

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

1. Simulation of Plane Wave Reflection and Transmission at Dielectric Boundaries https://www.ee.iitb.ac.in/course/~vel/about.html
2. Antenna Radiation Pattern Visualization and Beam width Analysis https://eem-iitd.vlabs.ac.in/experiments.html
3. Electromagnetic Wave Propagation in Rectangular Waveguides https://me-iitr.vlabs.ac.in
4. Finite Difference Method (FDM) for Solving Laplace's Equation in Electrostatic Fields https://www.ee.iitb.ac.in/course/~vel/about.html

CIE Assessment Pattern (50 Marks – Lab)

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

SEE Assessment Pattern (50 Marks – Lab)

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

Suggested Learning Resources:
Reference Books:
Reference Books:

1. Matthew N. O. Sadiku and S. V. Kulkarni, Principles of Electromagnetics, 7th Edition, Oxford University Press. ISBN: 9780199461851
2. John W. Eaton, David Bateman, and Søren Hauberg, GNU Octave Manual, GNU Project. ISBN: 9780954612061

Web References:
1. https://octave.org
2. https://docs.octave.org/latest
3. https://eem-iitd.vlabs.ac.in/experiments.html

TIMING OPTIMIZATION USING CADENCE			
Course Code	**24ECE655**	**Credits**	**01**
L:T:P:S	**0:0:1:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**30**	**SEE Marks**	**50**
TW & SL / Sem	**-**	**Total Marks**	**100**
Total Hours /Sem	**30**	**Exam Hours**	**03**

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

24ECE655.1	Apply delay and timing-parameter concepts to correctly determine propagation-delay paths in combinational and sequential digital circuits using Cadence Tempus.
24ECE655.2	Analyse the effect of coupling capacitance and crosstalk noise on signal timing to identify and mitigate crosstalk-induced delay and glitches in nanometre designs.
24ECE655.3	Examine clock and timing constraints to correctly classify timing exceptions such as multicycle paths, false paths, and clock grouping in a given design.
24ECE655.4	Evaluate setup and hold timing violations from STA timing reports and recommend effective design-closure techniques to resolve the identified violations.

Exp. No.	List of Experiments	Hours	COs
	Prerequisite Demonstration		
Demo	Introduction to Cadence Tempus Environment: Tool overview, design flow, input/output files, and GUI walkthrough.	2	NA
	PART-A		
1	Introduction to Cadence Tempus Environment: Understand the Tempus tool interface, design flow, input file types, and execute a basic STA run on a sample netlist.	2	24ECE655.1
2	Timing Analysis of Combinational Circuits: Load a combinational circuit netlist and Liberty file into Tempus; identify critical paths and measure propagation delays.	2	24ECE655.1
3	Timing Analysis of Sequential Circuits: Perform STA on a flip-flop-based sequential circuit; measure setup time, hold time, and clock-to-Q delay.	2	24ECE655.1
4	Understanding Liberty (.lib) Files: Parse and interpret a standard-cell Liberty file; correlate cell timing arcs and drive-strength variants with STA results.	2	24ECE655.1
5	Netlist Analysis and Delay Calculation: Analyze a gate-level Verilog netlist in Tempus; compute cell delays and interconnect delays along selected paths.	2	24ECE655.2
6	SPEF/DSPF Parasitic File Analysis: Read and annotate SPEF/DSPF parasitic files onto the design in Tempus; observe the impact of parasitics on path delays.	2	24ECE655.2
	PART-B		
7	Back-Annotated Timing Analysis: Perform full back-annotated STA using RC-extracted parasitics; compare pre- and post-layout timing results.	2	24ECE655.2
8	Crosstalk and Noise Analysis: Enable crosstalk analysis in Tempus; identify aggressor/victim nets and evaluate crosstalk-induced delay bumps and glitch violations.	2	24ECE655.2
9	SDC Constraint Creation and Validation: Write and load Synopsys Design Constraints (SDC) for clock definition, input/output delays, and load attributes; verify constraint correctness.	2	24ECE655.3

10	Timing Exceptions – False Path and Multicycle Path: Apply false path and multicycle path constraints in Tempus; verify their effect on slack and timing report paths.	2	24ECE655.3
11	Setup and Hold Violation Analysis: Identify setup and hold violations from Tempus timing reports; analyse the root causes and suggest corrective measures.	2	24ECE655.4
12	Timing Closure and Violation Fixing Techniques: Apply ECO-based fixes, buffer insertion, cell sizing, and path retiming in Tempus to achieve timing closure on a design with violations.	2	24ECE655.4

PART-C

Beyond Syllabus Virtual Lab Content (4 Hours)

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

1. https://github.com/The-OpenROAD-Project/OpenSTA (OpenSTA – Open Source Static Timing Analyzer)
2. https://openroad.readthedocs.io/en/latest/main/src/sta/README.html (OpenSTA Documentation and Tutorials)
3. https://github.com/OpenTimer/OpenTimer (OpenTimer – High-Performance Static Timing Analysis Tool)
4. https://theopenroadproject.org/ (OpenROAD Project – Open Source RTL-to-GDSII Physical Design Flow)
5. https://github.com/The-OpenROAD-Project/OpenROAD (OpenROAD Source Code and User Resources)
6. https://github.com/The-OpenROAD-Project/OpenROAD-flow-scripts (OpenROAD Flow Scripts for Complete Physical Design and STA Flow)

CIE Assessment Pattern (50 Marks – Lab)

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

SEE Assessment Pattern (50 Marks – Lab)

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

Suggested Learning Resources:

Reference Books:

1. R. Jayagowri and Pushpendra S. Yadav, "Static Timing Analysis for VLSI Circuits", 2nd Edition, MedTech Science Press, 2024, ISBN: 978-81-96544-560.
2. Vikas Chandra, Rakesh Aitken, and Dong-Ho Cho, Static Timing Analysis for Nanometer Designs: A Practical Approach, Springer, 2009.
3. J. Bhasker and Rakesh Chadha, Static Timing Analysis for Timing Closure, Springer, 2009.
4. Cadence Design Systems, Tempus Timing Signoff Solution User Guide, Cadence Design Systems

Online Resources:

1. **Cadence Tempus Tool Documentation:** https://www.cadence.com/en_US/home/tools/digital-design-and-signoff/static-and-physical-verification/tempus-timing-signoff-solution.html
2. **EDA Tool Tutorials – Cadence Learning Centre:** https://learning.cadence.comInc.

ADVANCED PROBLEM SOLVING METHODOLOGIES

Course Code	**24SDK66**	**CIE Marks**	**50**
L:T:P:S	**0:0:0:0**	**SEE Marks**	**-**
Hrs / Week	**2**	**Total Marks**	**50**
Credits	**0**	**Exam Hours**	**02**

Course outcomes:
Upon successful completion of this course, the student will be able to:

24SDK66.1	Infer the complex problems using the concepts of data structures and C programming
24SDK66.2	Apply object-oriented programming concepts in C++and Java to solve real time problem statements.
24SDK66.3	Solve real-world problem using python and C#
24SDK66.4	Develop the skills of handling data base queries and procedures

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
24SDK66.1	3	3	-	-	2	-	-	-	-	-	-
24SDK66.2	2	3	3	-	3	-	-	-	-	-	-
24SDK66.3	2	2	3	2	3	-	-	-	-	-	-
24SDK66.4	2	3	3	-	3	-	-	-	-	-	-

MODULE-1	**Problem Solving On Data Structures and C**	**24SDK66.1**	**6 Hours**

Data Structures using C: Stack and queues, list, graph, tree, sorting and searching, Hash functions
Advanced C programming: Pointers, Recursion, Functions, Structure, Union, C Preprocessor

MODULE-2	**Problem Solving on Object Oriented Programming Using CPP**	**24SDK66.2**	**6 Hours**

Object Oriented Programming: Inheritance, Polymorphism, Exception handling, File Handling, Predefined function, Void function, Name spaces, Input and output streams.

MODULE-3	**Problem Solving on JAVA And XML**	**24SDK66.2**	**6 Hours**

Object oriented programming using Java: Inheritance, Polymorphism, Abstract class and Interface, Collections, Exception handling, Streams, Functional Interface.
XML: DTD, Schema, Server Path, DOM, XSLT, Name Space, AJAX.

MODULE-4	**Problem Solving Using C # And Python**	**24SDK66.3**	**6 Hours**

Python: Functions, iterators, Object oriented Programming, Exception Handling, Packages, Frame works- Django, Collections.
C#: Object oriented Programming, Delegate, Collections and generic, Name space.

MODULE-5	**Scenario Based Problems On DBMS**	**24SDK66.4**	**6 Hours**

ER Model, SQL- DDL, DML, TCL, DCL, Joins, subquery, PL/SQL-Index, Sequence, procedures and functions, normalization, B tree, B+ tree, Forms.

Note:

1. **Students shall solve the programming exercises and scenario-based problems available on the designated portal as part of the prescribed boot camp.**
2. **The CIE assessment and evaluation will be as per the guidelines framed by CDC.**

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution
		Tests
		50
L1	**Remember**	5
L2	**Understand**	10
L3	**Apply**	20
L4	**Analyze**	15
L5	**Evaluate**	-
L6	**Create**	-

Suggested Learning Resources:

Reference Books:

1. Martin C Brown, "Python-The Complete Reference", Mc Graw Hill, 4th edition, 2020
2. Reema Tharega, "Data Structures using C", Oxford University Press, 2020
3. Ullakirch-Prinz, "A complete guide to program in C++", Jonas and Bartlett Learning, 2022
4. Kathy Sierra, "Headfirst Java", O'reilly Media, 2021
5. Andrew Stellman, "Headfirst C#", O'reilly Media, 2021

Web links and Video Lectures (e-Resources):

1. **https://www.learncpp.com/**
2. **https://www.programiz.com/dsa**
3. **https://code.visualstudio.com/Docs/languages/csharp**
4. **https://www.udemy.com/course/the-complete-java-course-from-basics-to-advanced/?couponCode=ST16MT70224**
5. **https://www.codecademy.com/learn/paths/c**

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

- Analysis of industry relevant use cases
- Problem solving on scenario-based questions
- Placement portal practice sessions

CAPSTONE PROJECT			
Course Code	**24ECE67**	**CIE Marks**	**50**
L: T:P:S	**0:0:2:0**	**SEE Marks**	**50**
Hrs / Week	**2**	**Total Marks**	**100**
Credits	**02**	**Exam Hours**	**03**

Course outcomes:

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

24ECE67.1	Identify societal challenges aligned with the Sustainable Development Goals (SDGs) and classify them within ECE and interdisciplinary domains.
24ECE67.2	Conduct effective literature reviews using research databases, search strategies, and citation management tools
24ECE67.3	Analyze existing literature to formulate a clear problem statement.
24ECE67.4	Formulate an idea and share the idea in a suitable platform.
24ECE67.5	Organize the article with a structured format, including introduction, background, methodology, analysis, discussion, and conclusion.
24ECE67.6	Demonstrate effective communication skills through technical presentations.

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
24ECE67.1	3	3	2	-	-	3	2	-	3	3	2	-	2
24ECE67.2	3	3	3	2	-	3	2	-	3	3	2	-	2
24ECE67.3	3	3	3	2	3	3	-	2	3	3	2	2	2
24ECE67.4	3	3	3	2	2	-	-	-	3	3	2	2	2
24ECE67.5	3	3	3	2	2	-	2	-	3	3	2	2	2
24ECE67.5	3	-	-	-	2	-	-	-	3	3	2	2	2

Project Phase I: Roadmap, activities, and deliverables

Goal Selection and Project Planning:

- Identification of suitable topic based on Sustainable Development Goals.
- Forming project teams based on common interests and skill sets.
- Teams' involvement in developing project proposals outlining objectives, strategies, and expected out comes.

Research and Needs Assessment: -

- Conduct a thorough survey of the chosen SDGs, covering global and local contexts, challenges, and opportunities.
- Perform needs assessments to identify specific issues or gaps that student projects can address.

Interdisciplinary approaches:

- Integrate interdisciplinary approaches and innovative solutions to address sustainability challenges.

Knowledge Sharing and Communication:

- Communicate project experiences and insights effectively through presentations, reports, and social media.
- Promote peer learning and collaboration through knowledge sharing and networking platforms.

CIE Assessment Pattern (50 Marks – Theory) –

RBT Levels		Marks Distribution	
		Review-1	Review-2
		25	25
L1	Remember	-	-
L2	Understand	5	5
L3	Apply	5	5
L4	Analyze	5	5
L5	Evaluate	5	5
L6	Create	5	5

SEE Assessment Pattern (50 Marks – Theory)

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

NATIONAL SERVICE SCHEME

Course Code	**24NSS50, 24NSS60**	**CIE Marks (each Semester)**	**50**
L:T:P:S	**0:0:0:0**	**SEE Marks**	**--**
Hrs / Week	**2**	**Total Marks**	**50 x 4 = 200**
Credits	**00**	**Exam Hours**	**02**

Course outcomes:

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

24NSSX0.1	Understand the importance of his / her responsibilities towards society.
24NSSX0.2	Analyse the environmental and societal problems/issues and will be able to design solutions for the same.
24NSSX0.3	Evaluate the existing system and to propose practical solutions for the same for sustainable development. Implement government or self-driven projects effectively in the field.
24NSSX0.4	Develop capacity to meet emergencies and natural disasters & practice national integration and social harmony in general.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
24NSSX0.1	-	-	-	-	-	3	3	2	-	-	1
24NSSX0.2	-	-	-	-	-	3	3	2	-	-	1
24NSSX0.3	-	-	-	-	-	3	3	2	-	-	1
24NSSX0.4	-	-	-	-	-	3	3	2	-	-	1

Semester/ Course Code	CONTENT	COs	HOURS
3RD 24NSS30	1. Organic farming, Indian Agriculture (Past, Present and Future) Connectivity for marketing 2. Waste management–Public, Private and Govt organization, 5R's. 3. Setting of the information imparting club for women leading to contribution in social and economic issues.	24NSS30.1, 24NSS30.2, 24NSS30.3, 24NSS30.4	30 HRS
4TH 24NSS40	4. Water conservation techniques – Role of different stakeholders– Implementation. 5. Preparing an actionable business proposal for enhancing the village income and approach for implementation. 6. Helping local schools to achieve good results and enhance their enrolment in Higher/ technical/ vocational education.	24NSS40.1, 24NSS40.2, 24NSS40.3, 24NSS40.4	30 HRS
5TH 24NSS50	7. Developing Sustainable Water management system for rural areas and implementationapproaches. 8. Contribution to any national level initiative of Government of India. Foreg. Digital India, Skill India, Swachh Bharat, Atmanirbhar Bharath, Make in India, Mudra scheme, Skill developmentprograms etc. 9. Spreading public awareness under rural outreach programs. (minimum 5 programs).	24NSS50.1, 24NSS50.2, 24NSS50.3, 24NSS50.4	30 HRS
6TH 24NSS60	10. 11. 12. Organize National integration and social harmony events / workshops / seminars. (Minimum TWO programs). 13. Govt. school Rejuvenation and helping them to achieve good infrastructure.	24NSS60.1, 24NSS60.2, 24NSS60.3, 24NSS60.4	30 HRS

CIE Assessment Pattern (50 Marks – Activity based) –

CIE component for every semester	Marks

Presentation - 1 Selection of topic, PHASE - 1	10
Commencement of activity and its progress - PHASE - 2	10
Case study-based Assessment Individual performance	10
Sector wise study and its consolidation	10
Video based seminar for 10 minutes by each student at the end of semester with Report.	10
Total marks for the course in each semester	**50**

- Implementation strategies of the project (NSS work).
- The last report should be signed by NSS Officer, the HOD and principal.
- At last report should be evaluated by the NSS officer of the institute.
- Finally, the consolidated marks sheet should be sent to the university and also to be made available at LIC visit.

Suggested Learning Resources:
Reference Books:

10. NSS Course Manual, Published by NSS Cell, VTU Belagavi.
11. Government of Karnataka, NSS cell, activities reports and its manual.
12. Government of India, NSS cell, Activities reports and its manual.

Pre-requisites to take this Course:

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

Pedagogy:

- In every semester from 3rd semester to 6th semester, each student should do activities according to the scheme and syllabus.
- At the end of every semester student performance has to be evaluated by the NSS officer for the assigned activity progress and its completion.
- At last, in 6th semester consolidated report of all activities from 3rd to 6th semester, compiled report should be submitted as per the instructions.
- State the need for NSS activities and its present relevance in the society and provide real-life examples.
- Support and guide the students for self-planned activities.
- NSS coordinator will also be responsible for assigning homework, grading assignments and quizzes, and documenting students' progress in real activities in the field.
- Encourage the students for group work to improve their creative and analytical skills.

Plan of Action:

- Student/s in individual or in a group Should select any one activity in the beginning of each semester till end of that respective semester for successful completion as per the instructions of NSS officer with the consent of HOD of the department.
- At the end of every semester, activity report should be submitted for evaluation.
- Practice Session Description:
    - Lecture session by NSS Officer
    - Students Presentation on Topics
    - Presentation - 1, Selection of topic, PHASE – 1
    - Commencement of activity and its progress - PHASE – 2
    - Execution of Activity
    - Case study-based Assessment, Individual performance
    - Sector/ Team wise study and its consolidation

- Video based seminar for 10 minutes by each student at the end of semester with Report.

Sl No	Topic	Groupsize	Location	Activity execution	Reporting	Evaluation of the Topic
1.	Organic farming, IndianAgriculture (Past, Present and Future) Connectivity for marketing.	May be individual or team	Farmers land/Villages/ roadside / Community area / College campus	Site selection /proper consultation/ Continuous monitoring/ Information board	Report should be submitted byindividual to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer
2.	Waste management– Public, Private and Govtorganization, 5 R's.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus	Site selection /proper consultation/Continuous monitoring/ Information board	Report should be submitted byindividual to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer
3.	Setting of the information imparting club for women leading to contributionin social and economic issues.	May be individual or team	Women empowerment groups/ Consulting NGOs & Govt Teams / College campus	Group selection/proper consultation/ Continuous monitoring/ Information board	Report should be submitted byindividual to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer
4.	Water conservation techniques – Role of different stakeholders– Implementation.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus	site selection / proper consultation/ Continuous monitoring/ Information board	Report should be submitted byindividual to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer
5.	Preparing an actionable business proposal for enhancing the village income and approach for implementation.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus	Group selection/proper consultation/ Continuous monitoring/ Information board	Report should be submitted byindividual to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer

6.	Helping local schools toachieve good results and enhance their enrolment in Higher/ technical/ vocational education.	May be individual or team	Local government / private/ aided schools/Government Schemes officers	School selection/proper consultation/ Continuous monitoring/ Information board	Report should be submitted byindividual to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer
7.	Developing SustainableWater management system for rural areas and implementation approaches.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus	site selection/properconsultation/ Continuous monitoring/ Information board	Report should be submitted byindividual to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer
8.	Contribution to any national level initiative of Government of India.For eg. Digital India, Skill India, Swachh Bharat, Atmanirbhar Bharath, Make in India, Mudra scheme,Skill development programs etc.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus	Group selection/proper consultation/ Continuous monitoring / Information board	Report should be submitted byindividual to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer
9.	Spreading public awareness under ruraloutreach programs. (minimum5 programs)	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus	Group selection/proper consultation/ Continuous monitoring / Information board	Report should be submitted byindividual to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer
10.	Organize National integration and socialharmony events / workshops / seminars. (Minimum 02 programs).	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus	Place selection/proper consultation/ Continuous monitoring / Information board	Report should be submitted byindividual to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer

11.	Govt. school Rejuvenation and helping them to achieve good infrastructure.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus	Place selection/proper consultation/ Continuous monitoring / Information board	Report should be submitted byindividual to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer	

PHYSICAL EDUCATION AND SPORTS

Course Code	**24PED50, 24PED60**	**CIE Marks (each semester)**	**50**
L:T:P:S	**0:0:0:0**	**SEE Marks**	**--**
Hrs / Week	**2**	**Total Marks**	**50 x 4= 200**
Credits	**00**	**Exam Hours**	**02**

Course outcomes:

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

24PEDX0.1	Understand the fundamental concepts and skills of Physical Education, Health, Nutrition and Fitness
24PEDX0.2	Create consciousness among the students on Health, Fitness and Wellness in developing and maintaining a healthy lifestyle
24PEDX0.3	Perform in the selected sports or athletics of student's choice and participate in the competition at regional/state / national / international levels.
24PEDX0.4	Understand the roles and responsibilities of organization and administration of sports and games

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
24PEDX0.1	-	-	-	-	-	2	-	3	3	-	-	2
24PEDX0.2	-	-	-	-	-	2	-	3	3	-	-	2
24PEDX0.3	-	-	-	-	-	2	-	3	3	-	-	2
24PEDX0.4	-	-	-	-	-	2	-	3	3	-	-	2

Semester	CONTENT	COs	HOURS
3RD 24PED30	**Module 1: Orientation** A. Lifestyle, B. Fitness C. Food & Nutrition D. Health & Wellness E. Pre-Fitness test.	24PED30.1, 24PED30.2	5 HRS
	Module 2: General Fitness & Components of Fitness A. Warming up (Free Hand exercises) B. Strength – Push-up / Pull-ups C. Speed – 30 Mtr Dash D. Agility – Shuttle Run E. Flexibility – Sit and Reach F. Cardiovascular Endurance – Harvard step Test	24PED30.2, 24PED30.3	15 HRS
	Module 3: Recreational Activities A. Postural deformities. B. Stress management. C. Aerobics. D. Traditional Games.	24PED30.3, 24PED30.4	10 HRS
4TH 24PED40	**Module 1: Ethics and Moral Values** A. Ethics in Sports B. Moral Values in Sports and Games	24PED40.1, 24PED40.2	5 HRS
	Module 2: Specific Games (Anyone to be selected by the student) A. Volleyball – Attack, Block, Service, Upper Hand Pass and Lower hand Pass. B. Throwball – Service, Receive, Spin attack, Net Drop & Jump throw. C. Kabaddi – Hand touch, Toe Touch, Thigh Hold, Ankle hold and	24PED40.3	20 HRS

	Bonus. D. Kho-Kho – Giving Kho, Single Chain, Pole dive, Pole turning, 3-6 Up. E. Table Tennis – Service (Fore Hand & Back Hand), Receive (Fore Hand & Back Hand), Smash. F. Athletics (Track / Field Events) – Any event as per availability of Ground.		
	Module 3: Role of Organization and administration	24PED40.4	5 HRS
5TH **24PED50**	**Fitness Components:** Meaning and Importance, Fit India Movement, Definition of fitness, Components of fitness, Benefits of fitness, Types of fitness and Fitness tips. **Practical Components:** Speed, Strength, Endurance, Flexibility, and Agility **Athletics**: 1. Track -Sprints: • Starting Techniques: Standing start and Crouch start (its variations) use of Starting Block. • Acceleration with proper running techniques. • Finishing technique: Run Through, Forward Lunging and Shoulder Shrug. 2. Jumps- Long Jump: Approach Run, Take-off, Flight in the air (Hang Style/Hitch Kick)and Landing 3. Throws- Shot Put: Holding the Shot, Placement, Initial Stance, Glide, Delivery Stance and Recovery (Perry O'Brien Technique) **Handball OR Ball Badminton** **Handball:** A. Fundamental Skills 1. Catching, Throwing and Ball control, 2. Goal Throws: Jumpshot, Centershot, Diveshot, Reverseshot. 3. Dribbling: High and low. 4. Attack and counter attack, simple counter attack, counter attack from two wings and center. 5. Blocking, Goal Keeping and Defensive skills. 6. Game practice with application of Rules and Regulations. B. Rules and their interpretations and duties of officials **Ball badminton:** A. Fundamental Skills 5. Basic Knowledge: Various parts of the Racket and Grip. 6. Service: Short service, Long service, Long-high service. 7. Shots: Overhead shot, Defensive clearshot, Attacking clearshot, Dropshot, Netshot, Smash. 8. Game practice with application of Rules and Regulations. B. Rules and their interpretation and duties of officials.	24PED50.1, 24PED50.2, 24PED50.3, 24PED50.4	Total 30 Hrs/ Semester 2 Hrs/week
6TH **24PED60**	**Athletics**: 1. Track -110 Mtrs and 400Mtrs: • Hurdling Technique: Lead leg Technique, Trail leg Technique, Side Hurdling, Over the Hurdles • Crouch start (its variations) use of Starting Block. • Approach to First Hurdles, In Between Hurdles, Last Hurdles to Finishing. 2. Jumps- High jump: Approach Run, Take-off, Bar Clearance	24PED60.1, 24PED60.2, 24PED60.3, 24PED60.4	Total 30 Hrs/ Semester 2 Hrs/week

(Straddle) and Landing.

3. Throws- Discus Throw: Holding the Discus, Initial Stance Primary Swing, Turn, Release and Recovery (Rotation in the circle).

Football OR Hockey

Football:

A. Fundamental Skills

1. Kicking: Kicking the ball with inside of the foot, Kicking the ball with Full Instep of the foot, Kicking the ball with Inner Instep of the foot, Kicking the ball with Outer Instep of the foot and Lofted Kick.
2. Trapping: Trapping- the Rolling ball, and the Bouncing ball with sole of the foot.
3. Dribbling: Dribbling the ball with Instep of the foot, Dribbling the ball with Inner and Outer Instep of the foot.
4. Heading: In standing, running and jumping condition.
5. Throw-in: Standing throw-in and Running throw-in.
6. Feinting: With the lower limb and upper part of the body.
7. Tackling: Simple Tackling, Slide Tackling.
8. Goal Keeping: Collection of Ball, Ball clearance-kicking, throwing and deflecting.
9. Game practice with application of Rules and Regulations.

B. Rules and their interpretation and duties of officials.

Hockey:

A. Fundamental Skills

1. Passing: Short pass, Longpass, pushpass, hit
2. Trapping.
3. Dribbling and Dozing
4. Penalty stroke practice.
5. Penalty corner practice.
6. Tackling: Simple Tackling, Slide Tackling.
7. Goal Keeping, Ball clearance- kicking, and deflecting.
8. Game practice with application of Rules and Regulations.

B. Rules and their interpretation and duties of officials

CIE Assessment Pattern (50 Marks – Practical) –

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

CIE	Marks
Participation of student in all the modules	10
Quizzes – 2, each of 7.5 marks	15
Final presentation / exhibition / Participation in competitions/ practical on specific tasks assigned to the students	25
Total	**50**

Suggested Learning Resources:

Reference Books:

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

3. Petipus, et.al., Athlete's Guide to Career Planning, Human Kinetics.
4. Dharma, P.N. Fundamentals of Track and Field, Khel Sahitya Kendra, New Delhi.
5. Jain, R. Play and Learn Cricket, Khel Sahitya Kendra, New Delhi.
6. Vivek Thani, Coaching Cricket, Khel Sahitya Kendra, New Delhi.
7. Saha, A.K. Sarir Siksher Ritiniti, Rana Publishing House, Kalyani.
8. Bandopadhyay, K. Sarir Siksha Parichay, Classic Publishers, Kolkata
9. Naveen Jain, Play and Learn Basketball, Khel Sahitya Kendra, New Delhi.
10. Dubey H.C., Basketball, Discovery Publishing House, New Delhi.
11. Rachana Jain, Teach Yourself Basketball, Sports Publication.
12. Jack Nagle, Power Pattern Offences for Winning basketball, Parker Publishing Co., New York.
13. Renu Jain, Play and Learn Basketball, Khel Sahitya Kendra, New Delhi.
14. SallyKus, Coaching Volleyball Successfully, Human Kinetics.

YOGA			
Course Code	**24YOG50, 24YOG60**	**CIE Marks**	**50**
L:T:P:S	**0:0:0:0**	**SEE Marks**	**--**
Hrs / Week	**2**	**Total Marks**	**50 x 4 = 200**
Credits	**00**	**Exam Hours**	**02**

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

24YOGX0.1	Understanding the origin, history, aim and objectives of Yoga
24YOGX0.2	Become familiar with an authentic foundation of Yogic practices
24YOGX0.3	Practice different Yogic methods such as Suryanamaskara, Pranayama and some of the Shat
24YOGX0.4	Use the teachings of Patanjali in daily life.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
24YOGX0.1	-	-	-	-	-	3	-	-	-	-	1
24YOGX0.2	-	-	-	-	-	3	-	-	-	-	1
24YOGX0.3	-	-	-	-	-	3	-	-	-	-	1
24YOGX0.4	-	-	-	-	-	3	-	-	-	-	1

Semester / Course Code	CONTENT	COs	HOURS
3rd 24YOG30	**Introduction of Yoga:** Aim and Objectives of yoga, Prayer: Yoga, its origin, history and development. Yoga, its meaning, definitions. Different schools of yoga, importance of prayer **Brief introduction of yogic practices for common man:** Yogic practices for common man to promote positive health **Rules and regulations:** Rules to be followed during yogic practices by practitioner **Misconceptions of yoga:** Yoga its misconceptions, Difference between yogic and non-yogic practices. **Suryanamaskara:** 1. Suryanamaskar prayer and its meaning, Need, importance and b of Suryanamaskar. 2. Suryanamaskar 12 count,2rounds **Different types of Asanas**: 1. Sitting: Padmasana, Vajrasana, Sukhasana 2. Standing: Vrikshana, Trikonasana, Ardhakati Chakrasana 3. Prone line: Bhujangasana, Shalabhasana 4. Supineline: Utthitadvipadasana, Ardhahalasana, Halasana	24YOG30.1, 24YOG30.2, 24YOG30.3, 24YOG30.4	Total 32 Hrs/ Semester 2 Hrs/week
4TH 24YOG40	**Suryanamaskara:** Suryanamaskar 12 count,4rounds **Brief introduction and importance of:** **Kapalabhati:** Revision of Kapalabhati -40strokes/min3rounds **Different types of Asanas**: 1. Sitting: Paschimottanasana, Ardha Ushtrasana, Vakrasana, Aakarna Dhanurasana 2. Standing: Parshva Chakrasana, Urdhva Hastothanasana, Hastapadasana 3. Prone line: Dhanurasana 4. Supine line: Karna Peedasana, Sarvangasana, Chakraasana **Patanjali's Ashtanga Yoga**: Asana, Pranayama **Pranayama:** Chandra Bhedana, Nadishodhana, Surya Bhedana	24YOG40.1, 24YOG40.2, 24YOG40.3, 24YOG40.4	Total 32 Hrs/ Semester 2 Hrs/week

5TH 24YOG50	**Kapalabhati:** Revision of Kapalabhati - 60strokes/min3rounds **Brief introduction and importance of:** **Different types of Asanas**: 1. Sitting: Yogamudra in Padmasana, Vibhakta Paschimottanasana, Yogamudra in Vajrasana 2. Standing: Parivritta Trikonasana, Utkatasana, Parshvakonasana 3. Prone line: Padangushtha Dhanurasana, Poorna Bhujangasana / Rajakapotasana 4. Supine line: Navasana/Noukasana, Pavanamuktasana, Sarvanga **Patanjali's Ashtanga Yoga**: Pratyahara, Dharana **Pranayama:** Ujjayi, Sheetali, Sheektari	24YOG50.1, 24YOG50.2, 24YOG50.3, 24YOG50.4	Total 32 Hrs/ Semester 2 Hrs/week
6TH 24YOG60	**Kapalabhati:** Revision of Kapalabhati – 80 strokes/min3rounds **Brief introduction and importance of:** **Different types of Asanas**: 1. Sitting: Bakasana, Hanumanasana, Ekapada Rajakapotasana 2. Standing: Parivritta Trikonasana, Utkatasana, Parshvakonasana 3. Supine line: Setubandhasana, Shavasanaa (Relaxation posture) 4. Balancing: Sheershasana **Patanjali's AshtangaYoga**: Dhyana (Meditation), Samadhi **Pranayama:** Bhastrika, Bhramari, Ujjai **Shat Kriyas:** Jalaneti and sutraneti, Sheetkarma Kapalabhati	24YOG60.1, 24YOG60.2, 24YOG60.3, 24YOG60.4	Total 32 Hrs/ Semester 2 Hrs/week

CIE Assessment Pattern (50 Marks – Practical)

CIE to be evaluated every semester based on practical demonstration of Yogasana learnt in the semester and internal tests (objective type)

CIE	Marks
Avg of Test 1 and Test 2	25
Demonstration of Yogasana	25
Total	**50**

Suggested Learning Resources:

Reference Books:

1. Swami Kuvulyananda: Asma (Kavalyadhama, Lonavala)
2. Tiwari, O P: Asana Why and How
3. Ajitkumar: Yoga Pravesha (Kannada)
4. Swami Satyananda Saraswati: Asana Pranayama, Mudra, Bandha (Bihar School of yoga, Munger)
5. Swami Satyananda Saraswati: Surya Namaskar (Bihar School of yoga, Munger)
6. Nagendra H R: The art and science of Pranayama
7. Tiruka: Shatkriyegalu (Kannada)
8. Iyengar B K S: Yoga Pradipika (Kannada)
9. Iyengar B K S: Light on Yoga (English)

Web links and Video Lectures (e-Resources):

- https://youtu.be/KB-TYlgd1wE
- https://youtu.be/aa-TG0Wg1Ls

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.

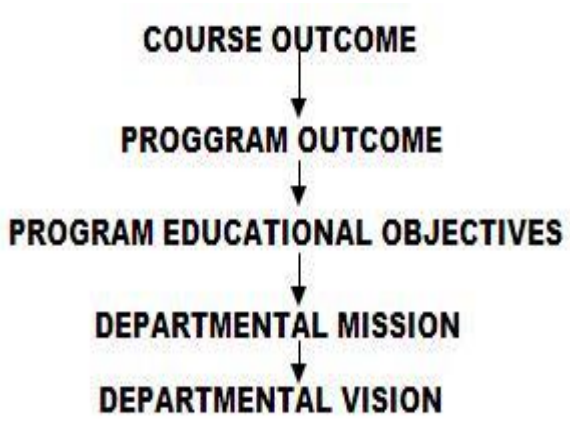
There are three educational Outcomes as defined by the National Board of Accreditation:

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 knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop solutions to complex engineering problems.

Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems, components or processes to meet identified needs with consideration for public health and safety, whole-life cost, net zero carbon, culture, society and environment.

Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis and interpretation of data to provide valid conclusions.

Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering and IT tools, including prediction and modelling, recognizing their limitations to solve complex engineering problems.

The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for their impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national and international laws.

Individual and Collaborative Team Work: Function effectively as an individual, and as a member or leader in diverse and multidisciplinary teams.

Communication: Communicate effectively and inclusively within the engineering community and society at large, including effective reports, design documentation and presentations, considering cultural, language and learning differences.

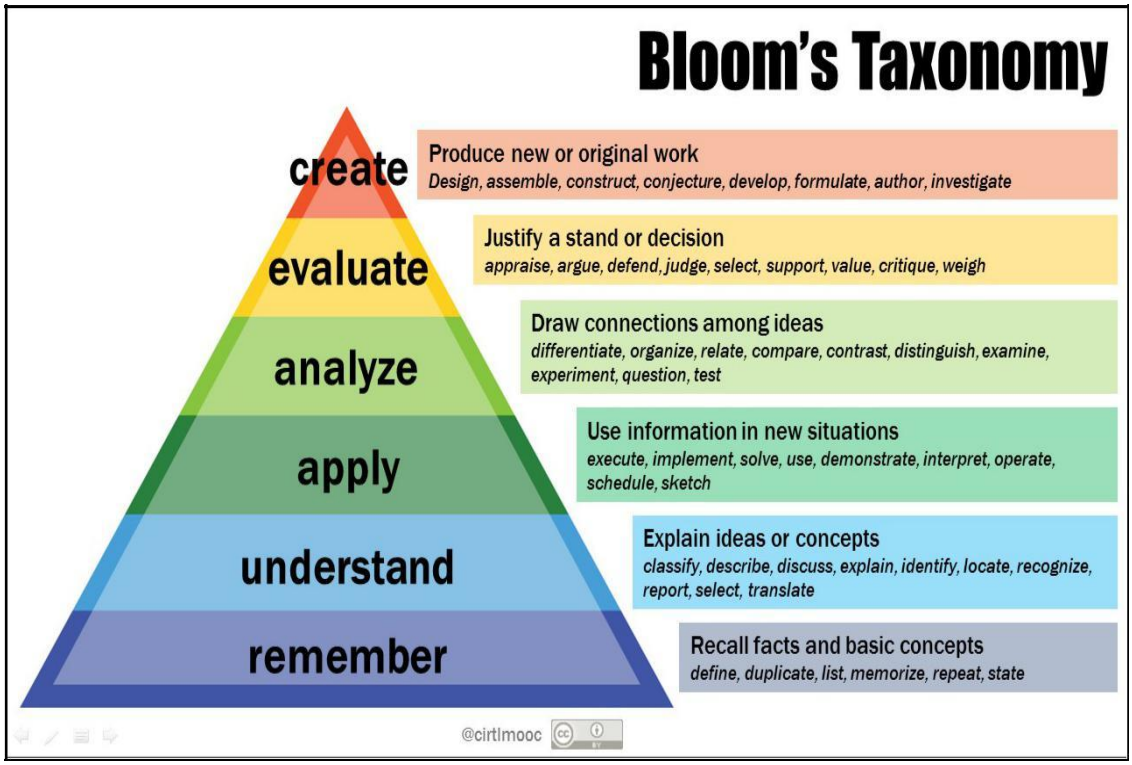
Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

Life-Long Learning: Recognize the need for, and have the preparation and ability for independent and life-long learning, adaptability to new and emerging technologies, and critical thinking 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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New Horizon Knowledge Park, Bellandur Main Road,
Near Marathahalli, Bengaluru 560103

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