VIVEKANAND EDUCATION SOCIETY'S

Institute of Technology

(An Autonomous Institute Affiliated to University of Mumbai, Approved by A.I.C.T.E & Recognized by Govt. of Maharashtra)

Department of Electronics and Computer Science

Department of Electronics and Computer Science

Syllabus (NEP Scheme)

Sem-V and Sem-VI

w.e.f. A.Y. 2025-26

Semester V Teaching Scheme								
Course Code	Course Name	Teaching Scheme (Contact hours)			Credits Assigned			
		TH	PR	TUT	TH	PR	TUT	TOTAL
NECPC51	Digital VLSI	3	2	---	3	1	---	4
NECPC52	Digital Signal Processing	3	---	1	3	---	---	3
NECPC53	Software Engineering	3	2	---	2	1	---	3
NECPE15X	Program Elective 1*	3	2	---	3	1	---	4
NECMM 53	Internet of Things	3	2	---	3	1	---	4
NOE5XX	Open Elective **	3	---	1	3	---	1	4
Total Credits								22

Semester V Marks Scheme							
Course Code	Course Name	TH	MT	CA	TW	PR/OR	Total
NECPC51	Digital VLSI	60	20	20	25	25	150
NECPC52	Digital Signal Processing	60	20	20	25	---	125
NECPC53	Software Engineering	60	20	20	25	25	150
NECPE15X	Program Elective 1*	60	20	20	25	25	150
NECMM 53	Internet of Things	60	20	20	25	25	150
NOE5XX	Open Elective **	60	20	20	---	---	100
Total Marks							825

*Program Electives (PEC 1)	**Open Electives (OE)
NECPE151: Statistics for Engineers	**NOE501:**AI for Healthcare
NECPE152: Design and Analysis of Algorithms	**NOE502:** Geographical Information Systems
NECPE153: Communication System	**NOE503:** Cyber Laws and Digital Forensics
	NOE504: Social Media Analytics
	NOE505: Mobile App Development

Semester V
Syllabus

COURSE NAME: - DIGITAL VLSI

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NECPC 51	Digital VLSI (Theory)	03	---	---	03	---	---	03
NECPCL 51	Digital VLSI (Lab)	---	02	---	---	01	---	01
Total Credits								04

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NECPC 51	Digital VLSI (Theory)	03	---	---	03	---	---	03

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NECPC 31	Digital VLSI (Theory)	20	20	60	---	---	100

Course Prerequisite: Digital System Design (NECPC32), Electronic Devices and Circuits (NECPC41)	
Course Objectives:	
1	To understand VLSI Design flow and technology trends.
2	To realise MOS based circuits using different design styles.
3	To explore static and dynamic CMOS logic styles.
4	To design and implement complex Boolean functions and sequential circuits.
5	To study and analyze different memory circuits.
6	To understand and design high-performance arithmetic units.
Course Outcomes: After successful completion of the course students will be able to:	
1	Explain VLSI design methodologies and semiconductor fabrication processes.
2	Analyze the static and dynamic behavior of NMOS and CMOS inverters.
3	Design CMOS logic gates using various design styles.
4	Realize combinational and sequential logic functions.
5	Demonstrate understanding of memory architectures and their working principles
6	Design and evaluate high-speed arithmetic circuits.

DIGITAL VLSI (THEORY)

Module	Contents	Hrs
1	**VLSI Design flow and Technology Trends**	**05**
1.1	VLSI Design Flow: Full custom and Semicustom IC design flow.	
1.2	Semiconductor Manufacturing: Semiconductor technology trend, clean rooms, Fabrication flowchart for steps in IC fabrication.	
1.3	Scaling: Types of scaling, comparison of MOSFET Model levels.	
1.4	Technology Comparison: Comparison of BJT and MOS technologies, long channel and short channel MOS devices.	
2	**MOSFET Inverters**	**08**
2.1	Introduction to MOS inverters: Active and passive load nMOS inverters, CMOS inverter and their comparison.	
2.2	Circuit Analysis of MOS Inverters Static Analysis of Resistive nMOS and CMOS Inverters: Calculation of critical voltages and noise margins.	
2.3	Design of symmetric CMOS inverter.	
2.4	Analysis of CMOS inverter: Calculation of rise time, fall time and propagation delay.	
3	**MOS Circuit Design Styles**	**07**
3.1	Static CMOS.	
3.2	Pseudo NMOS design styles.	
3.3	Pass transistor, Transmission gate.	
3.4	Dynamic: C^2MOS.	
3.5	Layout of CMOS Inverter, CMOS NAND, CMOS NOR.	
4	**Combinational and Sequential Circuit Realization**	**07**
4.1	Analysis and design of 2-I/P NAND, 2-I/P NOR and complex Boolean function realization using equivalent CMOS inverter for simultaneous switching, Complex Boolean function realization using various design styles and Basic gates and MUX realization using pass transistor and transmission gate logic.	
4.2	SR Latch, JK FF, D FF using CMOS logic.	
5	**Semiconductor Memories**	**05**
5.1	SRAM: 6T SRAM operation, design strategy, read/write circuits, sense amplifier.	
5.2	DRAM: 1TDRAM, operation modes, leakage currents, refresh operation, physical design.	
6	**Data Path Design**	**07**

6.1	Adder: CLA adder, MODL, Manchester carry chain, High-speed adders: carry skip, carry select and carry save.	
6.2	Multipliers and shifter: Array multiplier and barrel shifter.	
Total		**39**

Textbooks:	
1	CMOS Digital Integrated Circuits Analysis and Design, Sung-Mo Kang and Yusuf Leblebici, Tata McGraw Hill, Revised 4thEdition.
2	Introduction to VLSI Circuits and Systems, John P. Uyemura, Wiley India Pvt. Ltd.
3	Sorab K. Gandhi, "VLSI Fabrication Principles", Wiley, Student Edition.

Reference books:	
1	Digital Integrated Circuits: A Design Perspective, Jan M. Rabaey, Anantha ChandrakasanBorivoje Nikolic, Pearson Education, 2nd Edition.
2	Basic VLSI Design, Douglas A Pucknell, Kamran Eshraghian, Prentice Hall of India Private Ltd.
3	Logical Effort: Designing Fast CMOS Circuits, Ivan Sutherlan and Bob Sproull
4	Basics of CMOS Cell Design, Etienne Sicard and Sonia Delmas Bendhia, Tata McGraw Hill
5	CMOS VLSI Design: A Circuits and Systems Perspective, Neil H. E. Weste, David Harris and Ayan Banerjee, Pearson Education
6	Analysis and Design of Digital Integrated Circuits, David Hodges, Horace Jackson, Resve Saleh, McGraw-Hill, Inc.
7	Advanced Semiconductor Memories: Architectures, Designs, and Applications, Ashok K. Sharma, Wiley Publication

Internal Assessment:	
1	Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2	Mid Term test is to be conducted when approx. 50% syllabus is completed.
3	Duration of the midterm test shall be one hour.

Continuous Assessment:
Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon pertaining to the course.	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk/competition followed by a small report and certificate of participation relevant to the subject	05 marks
8	Multiple Choice Questions (Quiz)	05 marks
9	Literature review of papers/journals.	05 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks.
2	Question paper will have a total of five questions.
3	All questions have equal weightage and carry 20 marks each.
4	Any three questions out of five needs to be solved.

DIGITAL VLSI (LAB)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tut	Total
NECPCL 51	Digital VLSI Lab	---	02	---	---	01	---	01

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NECPCL 51	Digital VLSI Lab	---	---	---	25	25	50

Lab Objectives:	
1	To understand and analyze the transfer and output characteristics.
2	To design and simulate CMOS inverters and logic gates.
3	To perform comparative analysis of NMOS inverters.
4	To implement combinational and sequential digital circuits.
5	To explore SRAM cell operation and stability.
6	To develop and simulate CMOS layouts.
Lab Outcomes: After successful completion of the lab course students will be able to:	
1	Plot and interpret the transfer and output characteristics of NMOS and PMOS devices.
2	Design and simulate CMOS inverters and evaluate parameters.
3	Implement and analyze complex logic functions.
4	Model and simulate arithmetic circuits.
5	Design and analyze 6T SRAM cell operation.
6	Create, simulate, and extract CMOS layouts.

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr.No.	**Name of the Experiments**
1	Plot Transfer and output characteristics of NMOS and PMOS
2	Design CMOS inverter. Carry out static as well as transient simulation with different aspect ratio of pull up and pull-down devices
3	Comparative analysis of the NMOS Inverter with different types of loads.
4	Find the equivalent CMOS inverter for the given 2-input NAND and NOR gates
5	Implement the given equation using various logic design style
6	Implementation of any Flip- Flop using various logic design styles
7	Simulate Minimum Sized CMOS INVERTER circuit to calculate τPHL and τPLH
8	Design and Simulate 4:1 multiplexer using NMOS pass transistor
9	Design and simulate 4-bit adder/subtractor
10	Design CMOS transmission gate and perform all the analysis to verify its Characteristics.
11	Design and Simulate 4-bit multiplier
12	Simulate and carry out comparative analysis for 6T SRAM cell with a) β= 1.5 and α=1, and b) β= 1 and α=1
13	Draw the CMOS schematic and Layout of the inverter circuit, simulate layout
14	Extraction of CMOS layout and simulation of the extracted Inverter
15	Draw and simulate layout for CMOS NAND and CMOS NOR gate

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Term-Work:	
1	Term work should consist of 10 experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks (Experiments: 15-marks, Term work Assessment: 10-marks)

COURSE NAME: - DIGITAL SIGNAL PROCESSING

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NECPC 52	Digital Signal Processing (Theory)	03	---	01	03	---	---	03
Total Credits								03

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NECPC 52	Digital Signal Processing (Theory)	02	---	---	02	---	---	02

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NECPC 52	Digital Signal Processing (Theory)	20	20	60	---	---	100

Course Objectives:	
1	To make conversant with the fundamentals of digital signal processing
2	To familiarise with the transforms used in Digital Signal Processing
3	To familiarise with the design techniques and performance analysis of digital filters
4	To introduce digital signal processors and applications
Course Outcomes: After successful completion of the course students will be able to:	
1	Apply the concept of DT Signal and DT Systems.
2	Classify and analyse discrete time signals and systems
3	Implement Digital Signal Transform techniques DTFT, DFT and FFT.
4	Design IIR digital filters to meet arbitrary specifications and Develop algorithms for implementation
5	Design FIR digital filters to meet arbitrary specifications and Develop algorithms for implementation
6	Understand different signal processing applications using DSP processors.

DIGITAL SIGNAL PROCESSING (THEORY)

Module	Contents	Hrs
1	**Discrete-Time Signal and Discrete-Time Systems**	**05**
1.1	Introduction to Digital Signal Processing, Sampling and Reconstruction, Standard DT Signals, Concept of Digital Frequency, Representation of DT signal using Standard DT Signals, Signal Manipulations-shifting, reversal, scaling, addition, multiplication.	
1.2	Classification of Discrete-Time Signals, Classification of Discrete-Systems, LTI system, Impulse Response, Step Response, linear convolution, Correlation.	
2	**Frequency Domain Analysis using DTFT and Z Transform**	**07**
2.1	Introduction to DTFT.	
2.2	Z transform - definition transform of standard signals, ROC, poles and zeros of transfer function, Inverse Z transform.	
2.3	Analysis and characterization of LTI system using Z transform, impulse and step response, causality, stability, stability of causal system.	
3	**Discrete Fourier Transform and Fast Fourier Transform**	**07**
3.1	Introduction to DFT and IDFT.	
3.2	Properties of DFT, circular convolution of sequences using DFT	
3.3	Fast Fourier transforms (FFT), Radix-2 decimation in time and decimation in frequency FFT algorithms, inverse FFT.	
4	**IIR Digital Filters**	**07**
4.1	Comparison of IIR and FIR filters, Types of IIR Filters.	
4.2	Mapping of S-plane to Z-plane, impulse invariance method, bilinear transformation method, Design of IIR digital filters from analog filters with examples, Software simulation – Design of IIR Filters.	
5	**FIR Digital Filters**	**07**
5.1	Characteristics of FIR digital filters, Linear Phase Filter.	
5.2	Design of FIR filters using window techniques -Rectangular, Hamming, Blackman, Software simulation – Design of FIR Filters.	
6	**DSP Processors and Applications**	**06**
6.1	General purpose digital signal processors, DSP processor architecture, Selecting digital signal processors, Special purpose DSP hardware.	
6.2	Applications of DSP: Radar Signal Processing and Speech Processing.	
Total		**39**

Textbooks:	
1	Emmanuel C. Ifeachor, Barrie W. Jervis, "Digital Signal Processing", A Practical Approach by, Pearson Education – Second edition.
2	Tarun Kumar Rawat, "Digital Signal Processing", Oxford University Press, 2015.
3	S Salivahanan, A Vallavaraj, C Gnanapriya. "Digital Signal Processing" – TMH, 2007.
Reference books:	
1	ProakisJ., Manolakis D., "Digital Signal Processing", 4th Edition, Pearson Education
2	Sanjit K. Mitra, "Digital Signal Processing – A Computer Based Approach", edition 4e McGraw Hill Education (India) Private Limited
3	Oppenheim A, Schafer R, Buck J., "Discrete Time Signal Processing", 3rd Edition, Pearson Education.
4	B. Venkata Ramani and, M. Bhaskar, "Digital Signal Processors, Architecture, Programming and Applications", Tata McGraw Hill, 2nd edition 2017.
5	L. R. Rabiner and B. Gold, "Theory and Applications of Digital Signal Processing", Prentice-Hall of India, 2015.

Internal Assessment:	
1	Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2	Mid Term test is to be conducted when approx. 50% syllabus is completed.
3	Duration of the midterm test shall be one hour.

Continuous Assessment:
Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon pertaining to the course.	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk/competition followed by a small report and certificate of participation relevant to the subject	05 marks
8	Multiple Choice Questions (Quiz)	05 marks
9	Literature review of papers/journals.	05 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks.
2	Question paper will have a total of five questions.
3	All questions have equal weightage and carry 20 marks each.
4	Any three questions out of five needs to be solved.

COURSE NAME: - SOFTWARE ENGINEERING

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NECPC 53	Software Engineering (Theory)	02	---	---	02	---	---	02
NECPCL 53	Software Engineering (Lab)	---	02	---	---	01	---	01
Total Credits								03

Department of Electronics and Computer Science

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NECPC 53	Software Engineering (Theory)	02	---	---	02	---	---	02

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NECPC 53	Software Engineering (Theory)	20	20	60	---	---	100

Course Prerequisite: Fundamentals of Programming (NES14), Data Structures (NECPC31)	
Course Objectives:	
1	To learn the basics of software engineering and software development process models, agile software development and other agile practices.
2	To Identify, Specify, analyse Software Requirements and prepare model.
3	To understand concepts and principles of software design and Development.
4	To learn about Project Scheduling concept and Software Cost Estimation Techniques.
5	To understand concept of software quality assurance and Risk Management.
6	To learn different software testing strategies and tactics.
Course Outcomes: After successful completion of the course students will be able to:	
1	Apply software engineering concept and choose process models for a software project development.
2	Analyse and specify software requirement specification (SRS) for software system.
3	Convert requirement model into the design model and demonstrate the use of software and user-interface design principles.
4	Generate the project schedule and estimate the cost of software system.
5	Identify risks and prepare RMMM plan for quality software system.
6	Apply testing strategies and tactics for software system.

SOFTWARE ENGINEERING (THEORY)

Module	Contents	Hrs
1	**Introduction to Software Engineering and Process Models**	**06**
1.1	Nature of Software, Software Process framework.	
1.2	Prescriptive Models: Waterfall Model, Incremental, RAD Models Evolutionary Process Models Prototyping, Spiral and Concurrent Development Model. Specialized Models: Component based. Introduction to Agile methodology.	
2	**Requirement Engineering and Modelling**	**02**
2.1	Feasibility Study Types of Requirements, Requirement Engineering Task, Software Requirement Specification (SRS).	
3	**Design Engineering**	**06**
3.1	Developing Use Cases (UML) ,Requirement Model: Scenario-based model, Class-based model, Behavioural model.	
3.2	User Interface Design- **Introduction to User Interface (UI) Design:**Definition, purpose, and importance in software systems,Key differences between UI and UX,Real-world examples of good and bad UI. **Principles of Good UI Design:** Core design principles: consistency, simplicity, feedback, visibility.	
4	**Project scheduling & Cost Estimation**	**05**
4.1	Project Scheduling, defining a Task Set for the Software Project, Ganttcharts, Program Evaluation Review Techniques (PERT), Tracking the Schedule	
4.2	Software Project Estimation, Decomposition Techniques, LOC based, FP based , COCOMO I Model and COCOMO II Model.	
5	**Software Risk & Quality Management**	**04**
5.1	Software Risk, Types of Risk, Risk Identification, Risk Assessment, Risk Projection, RMMM.	
5.2	Software Quality Assurance Task and Plan, McCall's Quality Factors, Software Reliability, Formal Technical Review (FTR).	
6	**Software Testing Strategies and Tactics**	**03**
6.1	Software Testing Fundamentals, Testing strategies for conventional and Object-Oriented architectures, Unit testing, Integration testing, System Testing, Validation and System Testing.	
6.2	Testing Tactics: White-Box Testing, Basis Path Testing, Control Structure Testing, Black-Box Testing.	
Total		**26**

Textbooks:	
1	Roger S Pressman "Software Engineering: A Practitioner's Approach" 8th Edition McGraw-Hill, ISBN:978-0-07-802212-8
2	Pankaj Jalote, "An integrated approach to Software Engineering", Springer/Narosa
Reference books:	
1	Ian Sommerville, "Software Engineering", Pearson Education (9th edition)
2	Jibitesh Mishra and Ashok Mohanty, "Software Engineering", Pearson edition
3	Rajib Mall, "Fundamentals of Software Engineering", Prentice Hall India
4	Hans Van Vilet, "Software Engineering Principles and Practice" 3rd edition Wiley

Internal Assessment:	
1	Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2	Mid Term test is to be conducted when approx. 50% syllabus is completed.
3	Duration of the midterm test shall be one hour.

Continuous Assessment:

Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon pertaining to the course.	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk/competition followed by a small report and certificate of participation relevant to the subject	05 marks
8	Multiple Choice Questions (Quiz)	05 marks
9	Literature review of papers/journals.	05 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks.
2	Question paper will have a total of five questions.
3	All questions have equal weightage and carry 20 marks each.
4	Any three questions out of five needs to be solved.

SOFTWARE ENGINEERING (LAB)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tut	Total
NECPCL 53	Software Engineering (Lab)	---	02	---	---	01	---	01

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NECPCL 53	Software Engineering (Lab)	---	---	---	25	25	50

Lab Outcomes: After successful completion of the lab course students will be able to:	
1	Demonstrate the ability to perform feasibility analysis and select an appropriate software process model with justification.
2	Develop comprehensive Software Requirement Specification (SRS) documents and effectively model software using UML diagrams.
3	Apply project scheduling and management techniques using tools to create timelines and monitor progress.
4	Identify, analyze, and plan for software risks through a structured Risk Mitigation, Monitoring, and Management (RMMM) approach.
5	Estimate software size, cost, and effort using LOC, FP, use-case techniques, and the COCOMO II model.
6	Design and execute test cases using white-box and black-box testing methods, and conduct system-level testing.

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr.No.	**Name of the Experiments**
1	Prepare detailed statement of problem with feasibility study and identify suitable process model for the same with justification.
2	Develop Software Requirement Specification (SRS) document in IEEE format for the project.
3	Prepare schedule for the project using any project management tool
4	Prepare RMMM plan for the project.
5	Identify scenarios & develop UML Use case and Class Diagram for the project.
6	Develop Activity / State Transition diagram and Sequence diagram for the project.
7	Develop test cases for the project using white box testing.
8	Estimate project size using LOC, FP, and Use-Case based techniques
9	Apply the COCOMO II model for cost and effort estimation.
10	Write and review a Software Quality Assurance (SQA) plan.
11	Conduct Integration and System Testing on a modular application.

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Term-Work:	
1	Term work should consist of 10 experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks (Experiments: 15-marks, Term work Assessment: 10-marks)

COURSE NAME: - STATISTICS FOR ENGINEERS

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NECPE151	Statistics for Engineers (Theory)	03	---	---	03	---	---	03
NECPE1L51	Statistics for Engineers (Lab)	---	02	---	---	01	---	01
Total Credits								04

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NECPE151	Statistics for Engineers (Theory)	03	---	01	03	---	---	04

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NECPE 151	Statistics for Engineers (Theory)	20	20	60	---	---	100

Course Prerequisite: Fundamentals of Engineering Mathematics-1 (NBS11), Fundamentals of Engineering Mathematics-2 (NBS21).	
Course Objectives:	
1	To understand basic statistical foundations for roles of Data Scientist.
2	To develop problem-solving skills.
3	To infer about the population parameters using sample data and perform hypothesis testing.
4	To understand the importance and techniques of predicting a relationship between data and determine the goodness of model fit.
Course Outcomes: After successful completion of the course students will be able to:	
1	Develop various visualizations of the data in hand.
2	Analyze a real-world problem and solve it with the knowledge gained from probability distributions.
3	Analyze large data sets and perform data analysis to extract meaningful insights from the sampling and its distributions.
4	Fit a regression model to data and use it for prediction.
5	Develop and test a hypothesis about the population parameters to draw meaningful conclusions.
6	Develop inference on decision making using decision trees.

STATISTICS FOR ENGINEERS (THEORY)

Module	Contents	Hrs
1	**Introduction**	**05**
1.1	**Data and Statistics**: Elements, Variables, and Observations, Scales of Measurement, Categorical and Quantitative Data, Descriptive Statistics: Tabular and Graphical Summarizing Categorical Data, Summarizing Quantitative Data, Cross Tabulations and Scatter Diagram.	
1.2	**Descriptive Statistics:** Measures of dispersion, central tendency, Detecting Outliers, Box Plot.	
2	**Probability**	**06**
2.1	**Probability :** Experiments, Counting Rules, and Assigning Probabilities, Events and Their Probabilities, Complement of an Event, Addition Law Independent Events, Multiplication Law, Bayes' theorem, Central limit Theorem.	
2.2	**Discrete Probability Distributions** Random Variables, Discrete Probability Distributions, Expected Value and Variance, Binomial Probability Distribution and Poisson Probability Distribution without proof.	
2.3	**Continuous Probability Distributions:** Uniform Probability Distribution, Normal Curve, Standard Normal Probability Distribution without proof, Computing Probabilities for Any Normal Probability Distribution.	
3	**Sampling and Sampling Distributions**	**05**
3.1	Sampling Methods, Simple random sampling with and without replacement, Stratified Random Sampling, Cluster Sampling, Systematic Sampling, Convenience Sampling, Judgment Sampling.	
3.2	Interval Estimation: Population Mean: Known, Population Mean: Unknown, Determining the Sample Size, Population Proportion.	
4	**Hypothesis Tests**	**10**
4.1	Developing Null and Alternative Hypotheses, Type I and Type II Errors, One tailed and two tailed test.	
4.2	Small samples test (student's t - distributions), Large samples test (z - test).	
5	**Regression**	**08**
5.1	**Simple Linear Regression:** Simple Linear Regression Model, Regression Model and Regression Equation, Estimated Regression Equation, Least Squares Method, Coefficient of Determination, Correlation Coefficient, Model Assumptions, testing for Significance, Using the Estimated Regression Equation for Estimation and Prediction Residual Analysis: Validating Model Assumptions.	

5.2	**Multiple Regression:** Multiple Regression Model, Least Squares Method, Partial correlation coefficients and Partial regression coefficients.	
6	**Decision Theory**	**05**
6.1	Decision making in case of unknown probability of events: Maximin Criterion, Minimax Criterion, Maximax Criterion, Minimin Criterion, Laplace Criterion, Savage method, Hurwitz criterion. Decision Table, Decision trees.	
Total		**39**

Textbooks:	
1	https://static1.squarespace.com/static/5ff2adbe3fe4fe33db902812/t/6009dd9fa7bc363aa822d2c7/ 1611259312432/ISLR+Seventh+Printing.pdf
2	Data Science from Scratch, FIRST PRINCIPLES WITH PYTHON, O'Reilly, Joel Grus,
3	Data Science from Scratch (oreillystatic.com)
4	Practical Time Series Analysis, Prediction with statistics and Machine Learning, O'Reilly, Aileen Nielsen [DOWNLOAD] O'Reilly Practical Time Series Analysis PDF (lunaticai.com)
5	R for data science: Import, Tidy, Transform, Visualize, And Model Data, O'Reilly , Garrett Grolemund, Hadley Wickham
6	Python for Data Analysis, 2nd Edition, O'Reilly Media, Wes McKinney.
7	https://static1.squarespace.com/static/5ff2adbe3fe4fe33db902812/t/6009dd9fa7bc363aa822d2c7/ 1611259312432/ISLR+Seventh+Printing.pdf
Reference books:	
1	Data Science for Dummies Paperback, Wiley Publications, Lillian Pierson
2	Storytelling with Data: A Data Visualization, Guide for Business Professionals, Wiley Publications, Cole Nussbaumer Knaflic
3	Probability and Statistics for Engineering and the Sciences, Cengage Publications Jay L. Devore.

Internal Assessment:	
1	Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2	Mid Term test is to be conducted when approx. 50% syllabus is completed.
3	Duration of the midterm test shall be one hour.

Continuous Assessment:
Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon pertaining to the course.	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk/competition followed by a small report and certificate of participation relevant to the subject	05 marks
8	Multiple Choice Questions (Quiz)	05 marks
9	Literature review of papers/journals.	05 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks.
2	Question paper will have a total of five questions.
3	All questions have equal weightage and carry 20 marks each.
4	Any three questions out of five needs to be solved.

STATISTICS FOR ENGINEERS (LAB)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tut	Total
NECPE1L51	Statistics for Engineers (Lab)	---	02	---	---	01	---	01

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NECPE1L51	Statistics for Engineers (Lab)	---	---	---	25	25	50

Lab Outcomes: After successful completion of the lab course students will be able to:	
1	Apply theory of probability in identifying and solving relevant problems.
2	Differentiate continuous and discrete random variables and their distributions
3	Analyze mean, variance, and distribution function of random variables and functions of random variables.
4	Define a random process, determine the type of the process, and find the response of the LTI system.
5	Explain linear regression algorithms and apply for predictive applications.

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr.No.	**Name of the Experiments**
1	Write a MATLAB program to simulate a dice game and estimate the probability of winning
2	Implement Bayes' theorem to compute probability of error in a binary symmetric channel using simulated data
3	Estimate the probability mass function using relative frequency approach using MATLAB
4	Construct the random variable theta which is uniformly distributed over zero to two pie and then form a new random variable x = sin(theta)
5	Generate the random variable according to Gaussian or normal distributions.
6	Perform Monte Carlo simulations to estimate probabilities and validate against theoretical values
7	Generate and plot PDF, CDF, and PMF for Binomial, Poisson, Uniform, and Gaussian distributions.
8	Compute statistical measures (mean, variance, skewness, kurtosis) for a real-world dataset.
9	Compute and plot the characteristic function; verify its relation with moments.
10	Estimate and plot the joint PDF of two random variables using simulation.
11	Simulate sums of independent random variables and demonstrate convergence to normal distribution
12	Simulate a random process, compute autocorrelation, check for mean ergodicity.
13	Perform simple linear regression and predict outcomes based on features.
14	Evaluate predictive performance by calculating Mean Squared Error and R^2 score.

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Term-Work:	
1	Term work should consist of 10 experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks (Experiments: 15-marks, Term work Assessment: 10-marks)

COURSE NAME: - DESIGN AND ANALYSIS OF ALGORITHMS

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NECPE152	Design and Analysis of Algorithms (Theory)	03	---	---	03	---	---	03
NECPE1L52	Design and Analysis of Algorithms (Lab)	---	02	---	---	01	---	01
Total Credits								04

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NECPE152	Design and Analysis of Algorithms (Theory)	03	---	---	03	---	---	03

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NECPE152	Design and Analysis of Algorithms (Theory)	20	20	60	---	---	100

Course Prerequisite: Data structures (NECPC31), Discrete structures and Automata Theory (NECPC43).	
Course Objectives:	
1	To provide mathematical approaches for Analysis of Algorithms.
2	To understand and solve problems using various algorithmic approaches.
3	To analyze algorithms using various methods.
Course Outcomes: After successful completion of the course students will be able to:	
1	Analyze the running time and space complexity of algorithms.
2	Describe, apply and analyze the complexity of divide and conquer strategy.
3	Describe, apply and analyze the complexity of greedy strategy.
4	Describe, apply and analyze the complexity of dynamic programming strategy.
5	Explain and apply backtracking, branch and bound.
6	Explain and apply string matching techniques.

DESIGN AND ANALYSIS OF ALGORITHMS (THEORY)

Module	Contents	Hrs
1	**Introduction**	**08**
1.1	Brief introduction of Algorithms and its design methods. Analysis of Algorithm - Time & Space Complexity. Growth of Functions: Asymptotic Notation (O, Ω, θ, w, o), Standard Notation and Common Functions. Complexity class: Definition of P, NP, NP-Hard, NP-Complete Analysis of selection sort, insertion sort.	
1.2	Recurrences: The substitution method, Recursion tree method, Master method	
2	**Divide and Conquer Approach**	**06**
2.1	General Method, Analysis of Merge Sort, Analysis of Quick sort, Analysis of Binary search.	
2.2	Strassen's Matrix Multiplication.	
3	**Greedy Method Approach**	**07**
3.1	General Method, Single source shortest path-Dijkstra's algorithm, Job sequencing with deadlines, Fractional Knapsack problem,	
3.2	Minimum cost spanning trees-Kruskal and Prim's algorithm.	
4	**Dynamic Programming Approach**	**08**
4.1	General Method, Multistage graphs, Single source shortest path: Bellman Ford Algorithm, All pair shortest path problem: Floyd Warshall Algorithm.	
4.2	Assembly-line scheduling Problem, 0/1 knapsack Problem, Travelling Salesperson problem, longest common subsequence.	
5	**Backtracking and Branch and bound**	**06**
5.1	Backtracking: General method, N queen problem, Sum of subsets, Graph coloring.	
5.2	Branch and Bound: Travelling salesman problem, 15 puzzle problem.	
6	**String Matching algorithms**	**04**
6.1	The Naïve string-matching algorithm, The Rabin Karp algorithm, The Knuth-Morris-Pratt algorithm	
Total		**39**

Textbooks:	
1	T. H. Cormen, C.E. Leiserson, R. L. Rivest, and C. Stein, "Introduction to algorithms", 2nd Edition, PHI Publication 2005.
2	Ellis Horowitz, Sartaj Sahni, S. Rajsekaran. "Fundamentals of computer algorithms" University Press 2010.
Reference books:	
1	Parag Himanshu Dave, Himanshu Bhalchandra Dave, Design and Analysis Algorithms - Publisher: Pearson
2	Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, "Algorithms", Tata McGrawHill Edition.
3	S. K. Basu, "Design Methods and Analysis of Algorithm", PHI
Access to NPTEL / Swayam Course:	
1	https://nptel.ac.in/courses/106/106/106106131/
2	https://swayam.gov.in/nd1_noc19_cs47/preview
3	https://www.coursera.org/specializations/algorithms
4	https://www.mooc-list.com/tags/algorithms

Internal Assessment:	
1	Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2	Mid Term test is to be conducted when approx. 50% syllabus is completed.
3	Duration of the midterm test shall be one hour.

Continuous Assessment:

Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon pertaining to the course.	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk/competition followed by a small report and certificate of participation relevant to the subject	05 marks
8	Multiple Choice Questions (Quiz)	05 marks
9	Literature review of papers/journals.	05 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks.
2	Question paper will have a total of five questions.
3	All questions have equal weightage and carry 20 marks each.
4	Any three questions out of five needs to be solved.

DESIGN AND ANALYSIS OF ALGORITHMS (LAB)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tut	Total
NECPE 1L 52	Design and Analysis of Algorithms (Lab)	---	02	---	---	01	---	01

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NECPE 1L 52	Design and Analysis of Algorithms (Lab)	---	---	---	25	25	50

Lab Prerequisite: Knowledge of one or more programming language e.g. Python, C++. and proficiency in any one of them.	
Lab Objectives:	
1	To understand and solve problems using various algorithmic approaches.
2	To analyze algorithms using various methods.
Lab Outcomes: After successful completion of the lab course students will be able to:	
1	Analyze the running time and space complexity of algorithms.
2	Describe, apply and analyze the complexity of divide and conquer strategy.
3	Describe, apply and analyze the complexity of greedy strategy.
4	Describe, apply and analyze the complexity of dynamic programming strategy.
5	Explain and apply backtracking, branch and bound.
6	Explain and apply string matching techniques.

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr.No.	**Name of the Experiments**
1	Experiment on comparative analysis of Selection Sort and Insertion Sort.
2	Experiment on comparative analysis of Quick Sort and Merge Sort.
3	Experiment on Fractional Knapsack Problem.
4	Experiment on Prim's and Kruskal's Algorithm for finding Minimum Cost Spanning Tree.
5	Experiment on Single source shortest path-Dijkstra's algorithm.
6	Experiment on Single source shortest path: Bellman Ford Algorithm
7	Experiment on Traveling Salesperson Problem using Dynamic Programming.
8	Experiment on longest common subsequence.
9	Experiment using Backtracking strategy.
10	Experiment using branch and bound strategy.
11	Experiment on string matching algorithms.

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Term-Work:	
1	Term work should consist of 10 experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks (Experiments: 15-marks, Term work Assessment: 10-marks)

COURSE NAME: - COMMUNICATION SYSTEMS

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NECPE153	Communication Systems (Theory)	03	---	---	03	---	---	03
NECPE1L53	Communication Systems (Lab)	---	02	---	---	01	---	01
Total Credits								04

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NECPE153	Communication Systems (Theory)	03	---	---	03	---	---	03

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NECPE153	Communication Systems (Theory)	20	20	60	---	---	100

Course Prerequisite: Digital System Design (NECPC32), Electronics Devices and Circuits (NECPC41).	
Course Objectives:	
1	To understand and analyse the need for various analog modulation techniques.
2	To analyse the characteristics of the receivers.
3	To understand pulse modulation methods.
4	To understand the effect of ISI in Baseband transmission of a digital signal.
5	To analyse various Digital modulation techniques.
Course Outcomes: After successful completion of the course students will be able to:	
1	Understand the fundamentals of electronic communication and analyze the impact of noise on system performance.
2	Analyse various analog modulation methods.
3	Analyse the characteristics of radio receivers.
4	Explain various pulse modulation techniques.
5	Analyze pulse shaping techniques and apply methods to mitigate inter-symbol interference in digital communication.
6	Compare various Digital modulation methods based on spectral efficiency, Euclidean distance etc.

COMMUNICATION SYSTEMS (THEORY)

Module	Contents	Hrs
1	**Introduction to Electronic Communication**	**04**
1.1	Electromagnetic Spectrum	
1.2	Block diagram of Analog communication system	
1.3	Need for modulation	
1.4	Types of Noise, Signal-to-noise ratio, Noise factor, Noise Figure, Noise Temperature	
2	**Analog Modulation Systems**	**12**
2.1	Principle of Amplitude Modulation (AM): Representation of AM wave (Mathematical & Graphical), Frequency spectrum of AM wave, AM Power Distribution, AM for a Complex Modulating Signal	
2.2	Types of AM: Generation of DSB-SC using diode based balanced modulator, Generation of SSB using phase shift method	
2.3	Principles of Angle Modulation: Theory of Frequency Modulation (FM) & Phase Modulation (PM) - Basic Concepts, Spectrum Analysis of FM Wave, Noise triangle, Pre-emphasis, De-emphasis	
2.4	Comparison of AM, FM and PM	
3	**Radio Transmitters and Receivers**	**04**
3.1	Radio Transmitters: Block diagram of AM & FM transmitters	
3.2	Radio receivers: Receiver Characteristics, Superheterodyne Receiver, diode detector, Automatic gain control (AGC), Automatic frequency control (AFC)	
4	**Pulse Modulation**	**05**
4.1	Sampling theorem and quantization of signals	
4.2	Generation and Detection of Pulse Amplitude Modulation (PAM)	
4.3	Pulse Code Modulation (PCM), and Delta Modulation (DM)	
4.4	Multiplexing Techniques: Time Division Multiplexing (TDM):T1 carrier system, Frequency Division Multiplexing (FDM)	
5	**Pulse Shaping for Optimum Transmission**	**04**
5.1	Line codes and their desirable properties	
5.2	Concept of Inter symbol interference (ISI), Eye diagram: Quality Factor and BER, Nyquist Bandwidth	
5.3	Types of equalizers: Linear equalizer	
5.4	Correlative coding: Duo-binary encoding and modified duo-binary encoding	
6	**Digital Modulation Techniques**	**10**
6.1	Advantages of Digital Modulation.	

6.2	Generation, detection, signal space diagram, power spectral density and spectrum efficiency analysis of: Binary Phase Shift Keying (BPSK), Quaternary Phase Shift Keying (QPSK), M-ary PSK, Binary Amplitude Shift Keying (BASK), Quadrature Amplitude Modulation (QAM), Binary Frequency Shift Keying (BFSK), Minimum Shift Keying (MSK).	
Total		**39**

Textbooks:	
1	Simon Haykin, "Communication System", John Wiley And Sons ,4th Ed
2	Taub Schilling & Saha, "Principles Of Communication Systems", Tata Mc-Graw Hill, Third Ed
3	Kennedy and Davis "Electronics Communication System", Tata McGraw Hill
4	T. L. Singal, "Analog and Digital Communication," Tata Mc-Graw Hill, New Delhi, First Edition, 2012.
5	Sklar B, and Ray P. K., "Digital Communication: Fundamentals and Applications," Pearson, Dorling Kindersley (India), Delhi, Second Edition, 2009.
Reference books:	
1	Bernad Sklar,- "Digital communication", Pearson Education, 2nd Ed
2	Simon Haykin, "Digital communication", John Wiley and sons
3	Wayne Tomasi, "Electronics Communication Systems" Pearson Education, Third Edition, 2001.
4	R P Singh &S. Sapre, "Analog and Digital Communication", Tata McGraw Hill 2nd Ed.
5	Haykin Simon, "Digital Communication Systems," John Wiley and Sons, New Delhi, Fourth Edition, 2014.
6	Proakis & Salehi, "Communication System Engineering", Pearson Education.

Internal Assessment:	
1	Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2	Mid Term test is to be conducted when approx. 50% syllabus is completed.
3	Duration of the midterm test shall be one hour.

Continuous Assessment:
Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon pertaining to the course.	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk/competition followed by a small report and certificate of participation relevant to the subject	05 marks
8	Multiple Choice Questions (Quiz)	05 marks
9	Literature review of papers/journals.	05 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks.
2	Question paper will have a total of five questions.
3	All questions have equal weightage and carry 20 marks each.
4	Any three questions out of five needs to be solved.

COMMUNICATION SYSTEMS (LAB)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tut	Total
NECPE1L53	Communication Systems (Lab)	---	02	---	---	01	---	01

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NECPE1L53	Communication Systems (Lab)	---	---	---	25	25	50

Lab Outcomes: After successful completion of the lab course students will be able to:	
1	Perform hardware implementation of various analog and digital modulation methods.
2	Illustrate generation and detection of various pulse modulation techniques.
3	Apply techniques to insert Inter Symbol Interference and methods to mitigate its effect.
4	Simulate various analog and digital modulation methods.
5	Demonstrate multiplexing and demultiplexing of signals using multiplexing techniques.
6	Illustrate the effect of sampling frequency on the reconstructed signal.

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr.No.	**Name of the Experiments**
1	Analog Modulation and demodulation: AM
2	Analog Modulation and demodulation: FM
3	Pre-emphasis & De-emphasis
4	Analog Pulse modulation (PAM/PWM/PPM)
5	Time division multiplexing
6	Frequency division multiplexing
7	Generation of Line codes
8	Binary modulation and demodulation of BASK
9	Binary modulation and demodulation of BPSK
10	Binary modulation and demodulation of BFSK
Simulation-based experiments	
11	Simulation of AM and FM
12	Simulation of PAM, PPM, PWM
13	Simulation of BPSK/BASK/MSK modulation
14	Simulation of duo binary encoder, decoder

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Term-Work:	
1	Term work should consist of 10 experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks (Experiments: 15-marks, Term work Assessment: 10-marks)

COURSE NAME: - INTERNET OF THINGS

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NECMM 53	Internet of Things (Theory)	03	---	---	03	---	---	03
NECMML 53	Internet of Things (Lab)	---	02	---	---	01	---	01
Total Credits								04

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NECMM 53	Internet of Things (Theory)	03	---	---	03	---	---	03

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NECMM 53	Internet of Things (Theory)	20	20	60	---	---	100

Course Prerequisite: Microprocessor and Microcontroller (NECMM34), Embedded System and RTOS (NECMM44)	
Course Objectives:	
1	To understand the basic building blocks of IoT
2	To understand various IoT protocols.
3	To introduce data handling in IoT
4	To understand the Design Methodology in IoT through case studies.
Course Outcomes: After successful completion of the course students will be able to:	
1	Understand concepts, functional blocks and communication methodology relevant to IoT.
2	Identify various components of IoT
3	Compare various communication protocols for IoT.
4	Understand various methods for data handling in IoT-based systems.
5	Design basic applications based on IoT using specific components.
6	Introduce various security issues in IoT.

INTERNET OF THINGS (THEORY)

Module	Contents	Hrs
1	**Introduction to IoT**	**05**
1.1	Definition and Characteristics of IoT, IoT Protocols, IoT Functional Blocks, IoT Communication Models.	
1.2	IoT Communication APIs: - REST and WebSocket's, IoT Enabling Technologies, Introduction to M2M and Difference between IoT and M2M.	
2	**Components (Things) in IoT**	**05**
2.1	Sensor Technology, Examples of Sensors.	
2.2	Actuators, Applications of RFID and WSN in IoT, Exemplary Device: - R–Pi and its Interfaces, PCDuino, Beagle Bone	
3	**Data Handling in IoT**	**09**
3.1	Data Acquiring and Storage, Organizing the Data, Transactions and Business Processes, Analytics.	
3.2	Data Collection, Storage and Computing Using Cloud Platform.	
3.3	Introduction to Cloud Computing, Virtualization, Cloud Models, Cloud Services.	
4	**Design Principles for Web Connectivity**	**10**
4.1	Communication Technologies – A comparison.	
4.2	Web Communication Protocols for connected devices: - CoRE Environment, CoAP, LWM2M, MQTT, XMPP, HTTP, SOAP Protocols.	
4.3	LPWAN Fundamentals: LORA and NBIoT.	
5	**IoT Design Methodology**	**06**
5.1	Defining Specifications About: - Purpose & requirements, process, domain model, information model, service, IoT level, Functional view, Operational view, Device and Component Integration, Case Study on Home automation, Case Study on Weather Monitoring.	
5.2	IoT Levels and Deployment Templates.	
6	**IoT Security and Vulnerabilities Solutions**	**04**
6.1	IoT Security Tomography and Layered Attacker Model	
6.2	Identity Management, Establishment, Access Control and Secure Message Communication.	
Total		**39**

Textbooks:	
1	Arshdeep Bahga and Vijay Madisetti, ―Internet of Things: A Hands-on Approach, Universities Press.
2	Raj Kamal, ―Internet of Things: Architecture and Design Principles‖, McGraw Hill Education, First edition.
3	David Hanes, Gonzalo Salgueiro ―IoT Fundamentals Networking Technologies, Protocols and Use Cases for Internet of Things‖, Cisco Press, Kindle 2017 Edition.
4	Andrew Minteer, ―Analytics for the Internet of Things (IoT)‖, Kindle Edition.
Reference books:	
1	Adrian McEwen, Hakim Cassimally: Designing the Internet of Things‖, Paperback, First Edition.
2	Yashvant Kanetkar, Shrirang Korde : Paperback ―21 Internet of Things (IOT) Experiments, BPB Publications.

Internal Assessment:	
1	Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2	Mid Term test is to be conducted when approx. 50% syllabus is completed.
3	Duration of the midterm test shall be one hour.

Continuous Assessment:
Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon pertaining to the course.	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk/competition followed by a small report and certificate of participation relevant to the subject	05 marks
8	Multiple Choice Questions (Quiz)	05 marks
9	Literature review of papers/journals.	05 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks.
2	Question paper will have a total of five questions.
3	All questions have equal weightage and carry 20 marks each.
4	Any three questions out of five needs to be solved.

INTERNET OF THINGS (LAB)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tut	Total
NECMML 53	Internet of Things (Lab)	---	02	---	---	01	---	01

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NECMML 53	Internet of Things (Lab)	---	---	---	25	25	50

Lab Outcomes: After successful completion of the lab course students will have:	
1	Ability to interface various analog and digital sensors with microcontrollers (e.g., temperature, humidity, motion, gas sensors).
2	Proficiency in programming IoT development boards such as Arduino, NodeMCU (ESP8266/ESP32), or Raspberry Pi using C/C++ or Python.
3	Experience with cloud-based IoT platforms like ThingSpeak, Blynk, Firebase, or AWS IoT for data visualization, storage, and control.
4	Ability to interface IoT systems with mobile apps or web dashboards for remote monitoring and control.

Suggested Experiments: Students are required to complete at least 08 experiments.	
Sr.No.	**Name of the Experiments**
1	**Introduction to Arduino/Raspberry Pi/ESP32** • Pin configuration, IDE setup, and basic programming
2	**Blinking LED using Arduino/ESP32** • Digital output pin control
3	**Interfacing Temperature Sensor (e.g., LM35 or DHT11)** • Analog/Digital sensor read and display on serial monitor
4	**Interfacing Motion Sensor (PIR)** • Motion detection and triggering an alert (e.g., buzzer or LED)
5	**Interfacing Gas Sensor (MQ2/MQ135)** • Gas level detection and real-time monitoring
6	**Sending Sensor Data to a Mobile Device via Bluetooth (HC-05)** • Simple data logging or monitoring via a mobile app
7	**Sending Sensor Data to ThingSpeak/Adafruit IO** • Cloud dashboard setup and data visualization
8	Case study on advance topic -**Smart Energy Meter using IoT** • Measure voltage, current, and send data to cloud
9	Case study of recent development in the subject -**IoT-Based Health Monitoring System** • Integrate heartbeat, SpO2, and temperature sensors with cloud display

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Term-Work:	
1	Term work should consist of 10 experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks (Experiments: 15-marks, Term work Assessment: 10-marks)

COURSE NAME: - ARTIFICIAL INTELLIGENCE FOR HEALTHCARE

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NOE501	Artificial Intelligence for Healthcare (Theory)	03	---	01	03	---	01	04
Total Credits								04

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NOE501	Artificial Intelligence for Healthcare (Theory)	03	---	01	03	---	01	04

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NOE501	Artificial Intelligence for Healthcare (Theory)	20	20	60	---	---	100

Course Prerequisite: Desire to learn Artificial Intelligence and machine learning. Knowledge of higher school level math	
Course Outcomes: After successful completion of the course students will be able to:	
1	To understand the fundamentals of artificial intelligence and machine learning and their applications in medicine.
2	To explore advanced AI techniques, including deep learning, reinforcement learning, and natural language processing.
3	To learn about the use of AI in medical imaging, diagnostics, disease prediction, and treatment planning.
4	To examine the ethical, legal, and social implications of AI in medicine, including issues of bias, privacy, and equity.
5	To gain hands-on experience with AI tools and platforms through practical exercises and projects.
6	To critically evaluate research studies and applications of AI in healthcare.

ARTIFICIAL INTELLIGENCE FOR HEALTHCARE (THEORY)

Module	Contents	Hrs
1	**Introduction to AI in Healthcare**	06
	Definition and scope of AI in healthcare, Role of AI in modern healthcare systems, AI-assisted diagnostics and treatments, Applications of AI in clinical decision support systems (CDSS), AI in medical research and drug discovery, Examples of AI-powered healthcare systems	
2	**AI for Medical Diagnostics and Imaging**	07
	Overview of Machine Learning and Deep Learning, Basics of medical image analysis, Image classification and segmentation using AI, Computer Vision applications in radiology and pathology, AI-assisted diagnosis for diseases, Introduction to Generative AI in medical imaging.	
3	**Predictive Analytics and Disease Management**	06
	AI models for disease prediction and prognosis, Predictive modeling for early disease detection, Personalized healthcare using AI, monitoring chronic diseases using AI-based wearable devices, Case studies on AI in disease management (e.g., Diabetes, Heart disease).	
4	**Natural Language Processing (NLP) in Healthcare**	07
	Fundamentals of NLP in medical data analysis, Clinical text processing and medical report analysis, Information extraction from Electronic Health Records (EHR), AI chatbots and virtual assistants for patient support Applications of NLP in medical analysis.	
5	**Data Mining and Big Data Analytics in Healthcare**	07
	Introduction to Data Mining in Healthcare, Techniques for data extraction, pre-processing, and cleansing, **Big Data Analytics in Healthcare:** Characteristics of big data in healthcare, Tools for big data management (e.g., Hadoop, Spark) **IBM Watson in Healthcare:** Watson's role in medical diagnostics and decision-making, Case studies of IBM Watson applications	
6	**Ethics, Challenges, and Future Trends in AI Healthcare**	06
	Ethical considerations in AI healthcare applications, Bias, fairness, and explainability in medical AI, Data privacy and security concerns (HIPAA, GDPR compliance),Regulatory frameworks for AI in healthcare, Emerging trends: Generative AI, Digital Twins, Federated Learning in healthcare.	
Total		**39**

Reference books:	
1	Russell, S. and Norvig, N. Artificial Intelligence: A Modern Approach. Prentice Hall Series in Artificial Intelligence 3.
2	AI-First Healthcare by Kerrie L. Holley, Siupo Becker Released April 2021, Publisher(s): O'Reilly Media, Inc.ISBN: 9781492063155.
3	AI and Machine Learning for Healthcare" – Arvind Rajan (O'Reilly).
4	Adam Gibson, Josh Patterson, Deep Learning, O'Reilly Media, Inc.
5	Machine Learning and AI for Healthcare: Big Data for Improved Health Outcomes" – by Arjun Panesar.
6	Healthcare Analytics Made Simple: Techniques in Healthcare Computing Using Machine Learning and Python" – by Vikas (Vik) Kumar

Internal Assessment:	
1	Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2	Mid Term test is to be conducted when approx. 50% syllabus is completed.
3	Duration of the midterm test shall be one hour.

Continuous Assessment:
Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon pertaining to the course.	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk/competition followed by a small report and certificate of participation relevant to the subject	05 marks
8	Multiple Choice Questions (Quiz)	05 marks
9	Literature review of papers/journals.	05 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks.
2	Question paper will have a total of five questions.
3	All questions have equal weightage and carry 20 marks each.
4	Any three questions out of five needs to be solved.

COURSE NAME: - GEOGRAPHIC INFORMATION SYSTEM

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NOE502	Geographic Information System (Theory)	03	---	01	03	---	01	04
Total Credits								04

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NOE502	Geographic Information System (Theory)	03	---	01	03	---	---	04

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NOE502	Geographic Information System (Theory)	20	20	60	---	---	100

	Course Objectives:
1	Provide fundamental understanding of Geographic Information Systems (GIS) and Remote Sensing (RS) technologies.
2	Introduce concepts of geospatial data, spatial data models, and data quality.
3	Teach spatial analysis methods and GIS data visualization techniques.
4	Explore principles of remote sensing, image interpretation, and sensor systems.
5	Familiarize students with map projections, coordinate systems, and cartographic Design.
6	Equip students with the knowledge to apply GIS in urban planning, infrastructure, disaster management, and environmental monitoring.
Course Outcomes: After successful completion of the course students will be able to:	
1	Define the core concepts of GIS and Remote Sensing, and explain their components, structure, and applications.
2	Differentiate between spatial data models and understand data input, storage, and quality issues.
3	Interpret geospatial data using map projections, coordinate systems, and cartographic principles.
4	Perform vector and raster-based spatial analyses including buffering, overlay, and spatial interpolation.
5	Explain the principles of remote sensing, energy interactions, satellite platforms, and image interpretation.

6	Apply GIS and RS techniques in real-world applications such as urban planning, environmental monitoring, and disaster management.

GEOGRAPHIC INFORMATION SYSTEM (THEORY)

Module	Contents	Hrs
1	**Introduction to GIS**	**05**
	Defining GIS, GIS-Systems, GIS Applications, Spatial data, Geoinformation, Understanding maps and data, Data layers, Spatial data types, Characteristics of spatial data, Metadata, Making great maps, Data visualization principles, GIS software, GIS architecture and functionality, Spatial Data Infrastructure (SDI), Spatial data handling and preparation, Spatial data storage and maintenance, Spatial query and analysis, Spatial data presentation, Linking GIS and DBMS, Spatial database functionality	
2	**Geospatial Data and Mapping Concepts**	**05**
	Geospatial data, Geographic coordinate system, Datum and reference systems, Map projections, commonly used map projections, UTM grid system, Map scale, Types of maps, Cartographic symbolization, Typography in maps, Map design principles, Map production techniques, Layout design, Cartographic generalization, Interpretation of topographic maps.	
3	**Data Models and Quality Issues**	**05**
	Vector data model, Topological models, Nontopological models, Attribute data entry, Vector data query, Field and attribute manipulation, Raster data model, Elements of raster structure, Types of raster data, Raster queries, Data compression, Data conversion, Raster-vector integration, Data input methods, Data editing techniques, Data quality components, Accuracy, Precision, Resolution, Consistency, Completeness, Common sources of error in GIS.	
4	**GIS Data Analysis and Spatial Modelling**	**06**
	Data exploration, Descriptive statistics, Graphical data representation, Dynamic graphics, Vector data analysis, Buffering, Overlay, Distance measurement, Pattern analysis, Map manipulation, Raster data analysis, Local operations, Neighbourhood operations, Zonal operations, Data extraction, Data generalization, Comparison of raster and vector analysis, Spatial interpolation, Global interpolation methods, Local interpolation methods, Slope analysis, Aspect analysis, Terrain mapping.	
5	**GIS Project Planning and Applications**	**06**
	Principles of remote sensing, Electromagnetic spectrum basics, Energy sources in remote sensing, Interaction of energy with Earth's surface,	

	Atmospheric interaction, Spectral reflectance characteristics, Remote sensing platforms, Satellite systems, Sensor parameters, Imaging sensors, Earth resource satellites, Meteorological satellites, Remote sensing data formats, Standard products, Image interpretation, Elements of image interpretation.	
6	**GIS Project Planning and Applications**	**05**
	GIS project planning, Project implementation stages, Project management in GIS, Case study of GIS application, Multimedia GIS, Internet GIS, Web-based GIS, Mobile GIS, GIS in urban planning, GIS in municipal applications, GIS for infrastructure development, GIS for disaster management, GIS for environmental monitoring.	
Total		**39**

Textbooks:	
1	Introduction to Geographic Information Systems by Kang-tsung Chang, published by Tata McGraw- Hill, 3rd Edition.
2	Remote Sensing and Geographical Information Systems by M. Anji Reddy, published by B.S. Publications, 2nd Edition.
3	Remote Sensing and GIS by Basudeb Bhatta, published by Oxford University Press, 2nd Edition.
4	An Introduction to Geographical Information Systems by Ian Heywood, Sarah Cornelius, and others, published by Pearson Education, 2nd Edition.
Reference books:	
1	Concepts and Techniques of Geographic Information Systems by C.P. Lo and Albert K.W. Yeung, published by Prentice Hall, 2nd Edition.
2	Geographic Information Systems and Science by Paul A. Longley, Michael F. Goodchild, David J. Maguire, and David W. Rhind, published by Wiley, 3rd Edition.
3	Manual of Remote Sensing – Vol. 1 & 2 edited by Robert A. Ryerson and Andrew N. Rencz, published by American Society for Photogrammetry and Remote Sensing (ASPRS).
Access to Online material:	
1	https://github.com/PacktPublishing/Learning-Geospatial-Analysis-with-Python-Third Edition.
2	https://dstiget.in/understandinggis/
3	https://www.gisresources.com/wpcontent/uploads/2013/09/anji-reddy_GIS.pdf
4	http://nextgis.github.io/webgis_course/
5	https://dstiget.in/remote-sensing/
6	https://webapps.itc.utwente.nl/librarywww/papers_2009/general/principlesremotesensing.pdf

7	https://www.gisresources.com/wpcontent/uploads/2013/09/anji-reddy_GIS.pdf
8	https://dst-iget.in/trendsin-gis/
9	https://docs.qgis.org/3.34/en/docs/index.html

Internal Assessment:	
1	Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2	Mid Term test is to be conducted when approx. 50% syllabus is completed.
3	Duration of the midterm test shall be one hour.

Continuous Assessment:

Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon pertaining to the course.	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk/competition followed by a small report and certificate of participation relevant to the subject	05 marks
8	Multiple Choice Questions (Quiz)	05 marks
9	Literature review of papers/journals.	05 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks.
2	Question paper will have a total of five questions.
3	All questions have equal weightage and carry 20 marks each.
4	Any three questions out of five needs to be solved.

COURSE NAME: - CYBER LAWS & DIGITAL FORENSICS

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NOE503	Cyber Laws & Digital Forensics (Theory)	03	---	01	03	---	01	04
Total Credits								04

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NOE503	Cyber Laws & Digital Forensics (Theory)	03	---	01	03	---	01	04

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NOE503	Cyber Laws & Digital Forensics (Theory)	20	20	60	---	---	100

Course Prerequisite: Computer Communication Networks, CSS.	
Course Objectives:	
1	To understand various cyber-attacks and different categories of Cybercrime.
2	To discuss the need of digital forensics and procedure for the same along with understanding Incident Response Methodology.
3	To explore the procedures for identification, preservation, and extraction of digital evidence.
4	To explore techniques and tools used in digital forensics for system investigation.
5	To discuss the investigation process of network and host-based system intrusions.
6	To understand the laws related to Cybercrime.
Course Outcomes: After successful completion of the course students will be able to:	
1	Study the various cybercrimes and its prevention methods.
2	Discuss the phases of Digital Forensics and methodology to handle the computer security incident.
3	Understand the process of collection, analysis and recovery of the digital evidence.
4	Explore various tools to perform the investigation of the crime scenario.
5	Investigate the process of monitoring and analysis of computer network traffic for network investigation.
6	Discuss the legal issues associated with the cyber laws.

CYBER LAWS & DIGITAL FORENSICS (THEORY)

Module	Contents	Hrs
1	**Introduction to Cybercrime and Hacking**	**08**
1.1	Cybercrime, Categories of Cybercrime (Cybercrime against people, Cybercrime Against property, Cybercrime Against Government). Types of cybercrime (Violent- Cyber terrorism, Assault by Threat, Cyberstalking, Child Pornography, Nonviolent - Cybertrespass, Cyber Theft, Cyber Fraud, Destructive Cybercrimes), Computers' role in crimes.	
1.2	Hacking, Life cycle of Hacking, Types of Hackers (White Hat hackers, Black Hat hackers, Grey Hat hackers), Hacking techniques Passive and Active Attacks, Social Engineering, Attacks vs Vulnerabilities, Prevention of Cybercrime	
1.3	Self-learning topics: Distinction between computer crimes and conventional crimes.	
2	**Introduction to Digital Forensics**	**07**
2.1	Objectives of digital forensics, Process of digital forensics, Types of digital forensics, Challenges faced by digital forensics,	
2.2	Incident Response - Introduction to Incident Response, Computer Security Incident, Goals of Incident Response, CSIRT, Incident Response Methodology, Phases after incident notification and Detection.	
2.3	Self-learning topics: Distinction between Computer virus, worm, Trojan horse and trap door, IOT Security, Forensic Linguistics.	
3	**Digital Evidence and Forensics Duplication**	**07**
3.1	Digital evidence, Admissibility of evidence, Challenges in evidence handling, collecting digital evidence, Preserving digital evidence, Documenting evidence.	
3.2	Necessity of forensic duplication, Forensic duplicates as admissible evidence, Forensic image formats, Forensic duplication techniques, Disk imaging.	
4	**System Investigation**	**08**
4.1	Live/volatile data collection from Windows and Unix Systems.	
4.2	Investigating Windows systems, Investigating UNIX systems, Investigating applications, Web browsers.	
4.3	Recovering digital evidence, Acquiring, Analyzing and duplicating data: dd, dcfldd, foremost, scalpel (Demonstration).	
4.4	Self-learning topics: Methods of storing data (RAM and Hard disk).	
5	**Network Forensics**	**05**
5.1	Introduction to intrusion detection systems, Types of IDS, Understanding network intrusion and attacks.	

5.2	Analyzing network traffic, collecting network-based evidence, Evidence handling, Investigating routers.	
6	**Laws related to Cyber Crime**	**04**
6.1	Constitutional law, Criminal law, Civil law, Levels of law: Local laws, State laws, Federal laws, international laws. Levels of culpability: Intent, Knowledge, Recklessness, Negligence. CFAA, DMCA, CAN Spam.	
6.2	Indian National Cyber Law: Various sections in National Cyber Law to mitigate Cyber Crime, National Cyber Security Policy, IT Act 2000, Digital personal Data Protection Act 2023 (DPDPA-23)	
6.3	Self-learning topics: Relevant law to combat computer crime –Information Technology Act, **Cyber Regulations Appellate Tribunal (CRAT)**	
Total		**39**

Textbooks:	
1	Kevin Mandia, Chris Prosise, "Incident Response and computer forensics", Tata McGrawHill, 2006.
2	Scene of the Cybercrime: Computer Forensics" Handbook 1st Edition, Kindle Edition.
3	Digital Forensics", Nilakshi Jain & Kalbande, Wiley Publication.
4	Cyber Security", Nina Godbole, Sunit Belapure, Wiley Publication
Reference books:	
1	Bill Nelson, Amelia Phillips, Christopher Steuart, "Guide to Computer Forensics and Investigations" . Cengage Learning, 2014.
2	Debra Littlejohn Shinder Michael Cross "Scene of the Cybercrime: Computer Forensics Handbook", 2nd Edition Syngress Publishing, Inc.2008.
3	Marjie T. Britz, Computer Forensics and Cyber Crime, Pearson, Third Edition.
Suggested MOOCs for Self-Learning:	
1	Course on "Ethical Hacking" https://nptel.ac.in/courses/106/105/106105217/
2	Course on "Digital Forensics" https://onlinecourses.swayam2.ac.in/cec20_lb06/preview
3	Course on "Computer Forensics" https://www.edx.org/course/computer-forensics
4	Course on Cyber Incident Response https://www.coursera.org/learn/incident-response
5	Course on "Penetration Testing, Incident Responses and Forensics" https://www.coursera.org/learn/ibm-penetration-testing-incident-response-forensics

6	Comparison of Cyber Security (Case Study by PWC) https://www.pwc.com/id/en/pwc-publications/services-publications/legal publications/acomparison-of-cybersecurityregulations india.html#:~:text=Overviews,aspects%20of%20cybersecurity%20as%20follows:

Internal Assessment:	
1	Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2	Mid Term test is to be conducted when approx. 50% syllabus is completed.
3	Duration of the midterm test shall be one hour.

Continuous Assessment:
Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon pertaining to the course.	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk/competition followed by a small report and certificate of participation relevant to the subject	05 marks
8	Multiple Choice Questions (Quiz)	05 marks
9	Literature review of papers/journals.	05 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks.
2	Question paper will have a total of five questions.
3	All questions have equal weightage and carry 20 marks each.
4	Any three questions out of five needs to be solved.

COURSE NAME: - SOCIAL MEDIA ANALYTICS

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NOE504	Social Media Analytics (Theory)	03	---	01	03	---	01	04
Total Credits								04

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NOE504	Social Media Analytics (Theory)	03	---	01	03	---	01	04

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NOE504	Social Media Analytics (Theory)	20	20	60	---	---	100

Course Objectives:	
1	To introduce and familiarize learners with the basics of social networks (nodes, edges, graphs, paths).
2	To Introduce various fundamental measures in social networks (centrality, density, clustering).
3	To Explore various community detection and network clustering techniques.
4	To Familiarize the learners with concepts of link analysis and prediction.
5	Familiarize the learner with advanced social network topics like text analytics and social information filtering.
6	To introduce the concept of social media analytics and its various applications across popular social media.
Course Outcomes: After successful completion of the course students will be able to:	
1	Understand the concept of Social networks and how to represent them.
2	Analyze and interpret social networks using different Social network measures.
3	Detect and analyze communities in Social networks.
4	Implement and design algorithms for Link analysis and link prediction in Social networks.
5	Analyze the effectiveness of social media for business applications.
6	Interpret the social media landscape and implement projects for real life social media applications.

SOCIAL MEDIA ANALYTICS (THEORY)

Module	Contents	Hrs
1	**Introduction to Social Networks/Media**	06
	Overview and Basic Concepts Definition and importance of Social Networks and Social Network Analysis. (SNA) Historical background and evolution of SNA. Three Levels of SNA, Applications and tools. Preliminaries and Basic concepts: nodes, edges, graphs, networks. Graph Visualisation Tools. Social Media Analytics (SMA) Cycle, Challenges to Social Media Analytics, SMA Tools.	
2	**Network Measures**	08
	Network Basics - Degree and Degree Distributions, Paths, Clustering Coefficient, Connected Components **Node Centrality** – Degree centrality, Closeness Centrality, Betweenness centrality, Edge Betweenness centrality, Assortative, Transitivity and Reciprocity, Similarity. **Properties of Real-World Networks –**High Average Local Clustering Coefficient, Small world Property, Scale-free Property. **Random Network Model**- Degree Distribution of Random Network, Evolution of a Random Network, Average Path Length, Clustering Coefficient, Random Network vs. Real-world Network	
3	**Community Structure in Networks**	07
	Definition of Communities in social networks, Applications of Community Detection, Types of Communities. **Community Detection Methods:** Disjoint Community Detection- Node-Centric Community Detection, Modularity and Community Detection- Louvain Algorithm, Girvan Newman; Overlapping Community Detection: Clique Percolation, Link Partition; Local Community Detection.	
4	**Link Analysis**	06
	Applications of Link Analysis, **Signed Networks** - Balance Theory of Undirected Signed Networks, Status Theory of Signed Networks, Triad Balance Vs Status, **Strong and Weak Ties** - Strength of a Ties, Triadic Closure, Dunbar Number, Local Bridges and Importance of Weak Ties. **Link Prediction**-Applications of Link Prediction, Temporal Changes in a Network, Heuristic Models, Probabilistic Models, Latest Trends in Link Prediction.	

5	**Social Information Filtering**	**04**
	Social Media Text Analytics- Types of Social Media Text, Purpose of Text Analytics, Steps in Text Analytics, Social Media Text Analysis. **Social Information Filtering**- Social Sharing and filtering, Automated Recommendation systems, Traditional Vs Social Recommendation Systems. Understanding social media and Business Alignment Social Media KPI, formulating a Social Media Strategy, Managing Social Media Risks.	
6	**Social Media Analytics and Applications**	**08**
	Introduction to popular social media platforms, (Facebook, Twitter, Instagram, LinkedIn etc). Key characteristics of social media data, (unstructured, large-scale, user-generated). Differences between traditional data and social media data. Tools for Social Media Analytics. Applications of Social media Analytics with Case studies - Mining Twitter (X), Facebook, Instagram, LinkedIn, GitHub.	
Total		**39**

Textbooks:	
1	Social Network Analysis, Tanmoy Chakraborty, Wiley Publications 2021.
2	Mining the Social Web, 3rd Edition, by Matthew A. Russell, Mikhail Klassen.
3	Analyzing the Social Web 1st Edition by Jennifer Golbeck.
Reference books:	
1	P.M., Krishna & Mohan, Ankith & Srinivasa, K. Practical Social Network Analysis with Python. Springer.
2	Mining the Social Web, 3rd Edition, by Matthew A. Russell, Mikhail Klassen.
3	Social Media Analytics: Techniques and Insights for Extracting Business Value Out of Social Media, Matthew Ganis, Avinash Kohirkar, IBM Press.
4	Python Social Media Analytics: Analyze and visualize data from Twitter, YouTube, GitHub, and more Kindle Edition by Siddhartha Chatterjee , Michal Krystyanczuk.
5	Learning Social Media Analytics with R, by Raghav Bali, Dipanjan Sarkar, Tushar Sharma.
Suggested MOOCs for Self-Learning:	
1	https://cse.iitkgp.ac.in/~pawang/courses/SC16.html
2	https://onlinecourses.nptel.ac.in/noc20_cs78/preview
3	https://nptel.ac.in/courses/106106146

4	https://www.cs.cornell.edu/home/kleinber/networks-book
5	https://networksciencebook.com/ - Albert-László Barabási

Internal Assessment:	
1	Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2	Mid Term test is to be conducted when approx. 50% syllabus is completed.
3	Duration of the midterm test shall be one hour.

Continuous Assessment:
Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
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5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk/competition followed by a small report and certificate of participation relevant to the subject	05 marks
8	Multiple Choice Questions (Quiz)	05 marks
9	Literature review of papers/journals.	05 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks.
2	Question paper will have a total of five questions.
3	All questions have equal weightage and carry 20 marks each.
4	Any three questions out of five needs to be solved.

COURSE NAME: - MOBILE APP DEVELOPMENT

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NOE505	Mobile App Development (Theory)	03	---	01	03	---	01	04
Total Credits								04

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NOE505	Mobile App Development (Theory)	03	---	01	03	---	01	04

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NOE505	Mobile App Development (Theory)	20	20	60	---	---	100

Course Objectives:	
1	Learn the basics of the Flutter framework.
2	Develop the App UI by incorporating widgets, layouts, gestures and animation.
3	Create a production ready Flutter App by including files and firebase backend service.
4	To equip learners with skills to implement effective unit, widget, and integration testing in Flutter applications, ensuring code reliability and maintainability.
5	To provide hands-on knowledge of deploying Flutter apps to Android and iOS platforms, configuring CI/CD pipelines, and managing post-deployment analytics.
6	To introduce Flutter Web development, focusing on responsive UI, state management, performance optimization, and deployment on modern hosting platforms.
Course Outcomes: After successful completion of the course students will be able to:	
1	Understand cross platform mobile application development using Flutter framework.
2	Design and Develop interactive Flutter App by using widgets, layouts, gestures and animation.
3	Analyze and Build production ready Flutter App by incorporating backend services and deploying on Android / iOS.
4	Learners will be able to design, write, and automate Flutter tests across various levels, analyze failures, and improve code quality using modern testing tools and practices.
5	Learners will be capable of preparing production-ready Flutter apps, deploying them to app stores, automating releases with CI/CD tools, and handling real-time user feedback.
6	Learners will gain the ability to build and deploy responsive, performant Flutter web applications with PWA features, API integrations, and SEO considerations.

MOBILE APP DEVELOPMENT (THEORY)

Module	Contents	Hrs
1	**Cross-Platform Development**	07
	Understanding Flutter: Introduction of Flutter, Understanding Widget Lifecycle Events, Dart Basics, Widget Tree and Element Tree, Basics of Flutter installation, Flutter Hello World App. **Dart Programming:** main () function, Dart Variables, Dart Data Types, Dart Conditional Operators, Control Flow & Loops. Dart Functions - Functions, Function Structure, creating a Function, Function Returning Expression. Object-Oriented Programming (OOP) - Creating a Class, Adding Methods to Classes, Class — Getters and Setters, Class Inheritance, Abstract Class.	
2	**Developing Flutter UI: Widgets, Layouts, Gestures, Animation**	07
	USING COMMON WIDGETS: Safe Area, Appbar, Column, Row, Container, Buttons, Text, Rich text, Form, Images and Icon. BUILDING LAYOUTS: high level view of layouts, Creating the layout, Types of layout widgets APPLYING GESTURES: Setting Up Gesture Detector, Implementing the Draggable and Drag target Widgets, Using the Gesture Detector for Moving and Scaling ADDING ANIMATION TO AN APP: Using Animated Container, Using Animated Crossfade, Using Animated Opacity, Using Animation Controller, Using Staggered Animation CREATING AN APP'S NAVIGATION: Using the Navigator, Using the Named Navigator Route, Using the Bottom Navigation Bar, Using the TabBar and TabBarView.	
3	**Creating Production Ready Apps**	06
	Working with files: Including libraries in your Flutter app, including a file with your app, Reading/Writing to files, Using JSON. Using Firebase with Flutter: Adding the Firebase and Fire store Backend, Configuring the Firebase Project, adding a Cloud Fire store Database and Implementing Security Testing and Deploying of Flutter Application: Widget testing, Deploying Flutter Apps on Android / iOS	
4	**Flutter Testing: Introduction to Testing in Flutter**	05
	Testing in App Development, Types of Testing: Unit, Widget, and Integration, Setting Up Flutter Testing Environment **Unit Testing:** Writing Unit Tests for Dart Functions and Classes, using test package, Mocking Dependencies using Mockito, Best Practices in Unit Testing **Widget Testing:** Testing Widgets in Isolation, using flutter test Package, Simulating User Interactions, Golden Tests for UI validation **Integration Testing:** Setting Up Integration Tests, using integration test	

	Package, Running Tests on Emulators and Real Devices, Automating Tests with CI/CD Pipelines (GitHub Actions/GitLab CI) **Debugging and Coverage:** Analyzing Test Failures, Improving Test Coverage, Using Code Coverage Tools like lcov and flutter coverage	
5	**Flutter Deployment**	**07**
	Preparing for Deployment: Preparing for Deployment, App Versioning and Build Flavors, Managing Secrets & Environment Variables, Generating Keystore for Android, Setting up iOS Certificates and Profiles. **Android Deployment:** Building APKs and AABs, Signing & Obfuscating Builds, uploading to Google Play Store, Using Play Console Features (Testing Tracks, Release Management) **iOS Deployment:** Building and Signing iOS Apps, Using Xcode for Archive and Distribution, uploading to App Store using Transporter or Xcode, TestFlight for Beta Testing. **CI/CD for Flutter Deployment**: Automating Build and Release (Codemagic, GitHub Actions, Bitrise), Integrating Fastlane for Flutter Projects **Post-Deployment:** Crash Reporting & Analytics (Firebase Crashlytics), In-App Updates, Feedback Collection.	
6	**Flutter for Web**	**07**
	Introduction to Flutter Web: Flutter Web Architecture, Differences from Mobile Development, Setting up for Web Development. **Building Web UI:** Responsive Design with Flutter, Navigation with go router or Navigator 2.0, Web-specific Widgets and Customizations, **State Management:** Choosing the Right State Management for Web (Provider, River pod, Bloc), Web Performance Optimization Techniques **Web Deployment:** Building for Web (flutter build web), Hosting on Firebase Hosting, GitHub Pages, Netlify, Vercel, SEO Considerations for Flutter Web **Advanced Topics, Progressive Web App (PWA) with Flutter:** Offline Support and Caching, Integrating REST APIs and WebSockets.	
Total		**39**

Textbooks:	
1	Beginning Flutter, a Hands-on Guide to App Development, Marco L. Napoli, Wiley, 2020.
2	Beginning App Development with Flutter: Create Cross-Platform Mobile Apps, By Rap Payne, 2019.
Reference books:	
1	Google Flutter Mobile Development Quick Start Guide.Packt,2019.
Access to software and virtual labs:	

1	Google Cloud Labs & Qwiklabs: Access to Android Studio, Firebase, TensorFlow Lite via cloud-based labs.
2	AWS Educate/AWS Academy : Free credits for AWS Amplify, Lambda, and IoT integrations.
Industry articles and case studies:	
1	Article: Rise of Flutter in FinTech – Insights on why Flutter is chosen for fast MVP development and lower maintenance in financial startups.
2	Trends Report – Mobile App Development Trends (e.g., Flutter vs. React Native, Kotlin Multiplatform Mobile).
Any other (Access to AI tools / Data driven insights (if applicable) or any other):	
1	AI-powered Mobile App Features: Hands-on modules using Google ML Kit for image labeling, text recognition, barcode scanning, and language translation in Android apps.
2	Chatbot Integration Labs: Building intelligent chatbots using Dialog Flow and integrating with Android/Flutter frontends.
3	Analytics with Firebase and Google Analytics: Gain data-driven insights on user engagement, retention, crash reports, and app performance.
4	Recommendation Engines: Introduction to building simple recommendation models in apps (e.g., product or content recommendations).
5	AI Tools: Exposure to tools like OpenAI APIs for generating text-based content within apps or integrating natural language features.

Internal Assessment:	
1	Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2	Mid Term test is to be conducted when approx. 50% syllabus is completed.
3	Duration of the midterm test shall be one hour.

Continuous Assessment:
Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon pertaining to the course.	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk/competition followed by a small report and certificate of participation relevant to the subject	05 marks

8	Multiple Choice Questions (Quiz)	05 marks
9	Literature review of papers/journals.	05 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks.
2	Question paper will have a total of five questions.
3	All questions have equal weightage and carry 20 marks each.
4	Any three questions out of five needs to be solved.

Semester VI
Syllabus

Department of Electronics and Computer Science

Semester VI Teaching Scheme								
Course Type	**Course Name**	**Teaching Scheme (Contact hours)**			**Credits Assigned**			
		TH	**PR**	**TUT**	**TH**	**PR**	**TUT**	**TOTAL**
NECPC61	Analog VLSI	3	2	---	3	1	---	4
NECPC62	Computer Communication and Networking	3	2	---	3	1	---	4
NECPC63	Project-I	---	4	---	---	2	---	2
NECPE26X	Program Elective 2*	3	2	---	3	1	---	4
NECPE36X	Program Elective 3**	3	2	---	3	1	---	4
NECMM64	IIoT & Industry 4.0	2	---	---	2	---	---	2
NECVS 61	ASIC Design Lab	---	2	1	---	1	1	2
Total Credits								**22**

Semester VI Marks Scheme							
Course Type	**Course Name**	**TH**	**MT**	**CA**	**TW**	**PR/OR**	**TOTAL**
NECPC61	Analog VLSI	60	20	20	25	25	150
NECPC62	Computer Communication and Networking	60	20	20	25	25	150
NECPC63	Project-I	---	---	---	50	50	100
NECPE26X	PEC 2*	60	20	20	25	25	150
NECPE36X	PEC 3 **	60	20	20	25	25	150
NECMM 64	IIoT & Industry 4.0	60	20	20	---	---	100
NECVS 61	ASIC Design Lab	---	---	---	25	25	50
Total Marks							**850**

Program Electives (PEC)

PEC 2	PEC 3
NECPE261: Software Testing and Quality Assurance	**NECPE361**: Digital Image Processing
NECPE262: Machine Learning	**NECPE362**: Micro Electro-Mechanical Systems
NECPE263: Data Warehouse and Mining	**NECPE363**: Principles of Control System

COURSE NAME: - ANALOG VLSI

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NECPC61	Analog VLSI (Theory)	03	---	---	03	---	---	03
NECPCL61	Analog VLSI (Lab)	---	02	---	---	01	---	01
Total Credits								04

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NECPC61	Analog VLSI (Theory)	03	---	---	03	---	---	03

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NECPC61	Analog VLSI (Theory)	20	20	60	---	---	100

Course Prerequisite:
Digital System Design (NECPC32), Electronic Devices and Circuits, (NECPC41), Digital VLSI (NECPC51).

Course Objectives:

1	To know importance of Mixed Signal VLSI design in the field of Electronics.
2	To understand various methodologies for analysis and design of fundamental CMOS analog and mixed signal Circuits.
3	To learn various issues associated with high performance Mixed Signal VLSI Circuits.
4	To design, implement and verify various mixed signal VLSI circuits using open source tools like Ngspice and Magic.

Course Outcomes:
After successful completion of the course students will be able to:

1	Know operation of the various building blocks of analog and mixed signal VLSI circuits.
2	Demonstrate the understanding of various building blocks and their use in design of analog and mixed signal circuits.
3	Derive expression for various performance measures of analog and mixed signal circuits in terms of parameters of various building blocks used to build the circuit.
4	Analyze and relate performance of analog and mixed signal VLSI circuits in terms of design parameters.
5	Evaluate and select appropriate circuit/configuration for given application.
6	Design analog and mixed signal VLSI circuits for given application.

ANALOG VLSI (THEORY)

Module	Contents	Hrs
1	**Integrated Circuit Biasing Techniques**	**06**
1.1	Simple current mirror, Cascode current mirror.	
1.2	Current and voltage references, Band gap reference generator.	
2	**Single Stage MOS Amplifiers**	**10**
2.1	Common-source stage (with resistive load, diode connected load, current-source load, triode load, source degeneration), source follower, common-gate stage, Cascode stage, folded Cascode stage.	
2.2	Single-ended operation, differential operation, basic differential pair, large-signal and small-signal behavior, common-mode response, differential pair with MOS loads.	
3	**Noise in MOS Circuits**	**04**
3.1	Noise spectrum, correlated and uncorrelated noise sources, thermal noise, flicker noise, shot noise.	
3.2	Representation of noise in circuits, noise in single stage CS.	
4	**CMOS Operational Amplifier**	**06**
4.1	Design of Current Mirror Load Differential Amplifier,	
4.2	Design of two stage Operational Transconductance Amplifier, Opamp Compensation Techniques.	
5	**Data Converter Fundamentals**	**04**
5.1	ADC parameters, Sample and Hold amplifier.	
5.2	Mixed signal Layout issues, Floor planning, Power supply and Ground issues.	
6	**Data Converter Architectures**	**09**
6.1	Charge scaling DACs, Cyclic DAC, Pipeline DAC.	
6.2	Flash ADC, Single Slope Integrating ADC, and Successive approximation ADC	
Total		**39**

Textbooks:	
1	B. Razavi, ―Design of Analog CMOS Integrated Circuits, first edition, McGraw Hill, 2001.
2	P.E.Allen and D R Holberg, ―CMOS Analog Circuit Design, second edition, Oxford University Press, 2002.
3	R. Jacob Baker, ―CMOS Circuit Design, Layout and Simulation, Wiley, 2nd Edition, 2013
Reference books:	
1	Adel S. Sedra, Kenneth C. Smith, A.N. Chandorkar, ―Microelectronics Circuits Theory and Applications, Fifth Edition, Oxford University Press.
2	Gray, Meyer, Lewis and Hurst ―Analysis and design of Analog Integrated Circuits, 4th Edition Willey International, 2002
3	Tony Chan Carusone, David Johns, Kenneth Martin, ― Analog Circuit Design, Second Edition, Wiely

Internal Assessment:	
1	Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2	Mid Term test is to be conducted when approx. 50% syllabus is completed.
3	Duration of the midterm test shall be one hour.

Continuous Assessment:

Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon pertaining to the course.	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk/competition followed by a small report and certificate of participation relevant to the subject	05 marks
8	Multiple Choice Questions (Quiz)	05 marks
9	Literature review of papers/journals.	05 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks.
2	Question paper will have a total of five questions.
3	All questions have equal weightage and carry 20 marks each.
4	Any three questions out of five needs to be solved.

ANALOG VLSI (LAB)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tut	Total
NECPCL61	Analog VLSI Lab	---	02	---	---	01	---	01

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NECPCL 61	Analog VLSI Lab	---	---	---	25	25	50

Lab Prerequisite: Basic VLSI Design (NECPC51)	
Lab Outcomes: After successful completion of the lab course students will be able to:	
1	Design and simulate single stage amplifier circuits.
2	Design and simulate different types of current mirror circuits.
3	Design and simulate differential amplifier and OPAMP.
4	Design and simulate mixed mode circuits.

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr.No.	**Name of the Experiments**
1	Use of Online Tools to study analog VLSI circuits
2	Analysis of MOSFETs for analog performance
3	Design and simulate various types of current mirror circuits
4	Design and simulate various common source amplifier circuits
5	Design and simulate various types of single stage amplifiers
6	Design and simulate differential amplifier
7	Design and simulate operational transconductance amplifier
8	Design and simulate mixed mode circuit
9	Generate layout for the simple and Cascode current mirror
10	Generate layout for common source amplifier

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Term-Work:	
1	Term work should consist of 10 experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks (Experiments: 15-marks, Term work Assessment: 10-marks)

COURSE NAME: - COMPUTER COMMUNICATION AND NETWORKING

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NECPC62	Computer Communication and Networking (Theory)	03	---	---	03	---	---	03
NECPCL62	Computer Communication and Networking (Lab)	---	02	---	---	01	---	01
Total Credits								04

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NECPC62	Computer Communication and Networking (Theory)	03	---	---	03	---	---	03

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NECPC62	Computer Communication and Networking (Theory)	20	20	60	---	---	100

Course Prerequisite: Communication System.	
Course Objectives:	
1	To understand the fundamental concepts of computer networking, protocols, architectures, and applications.
2	To study the multiple layer design issues, services, and state-of-the-art protocols of TCP/IP and OSI based Architectures.
3	To help students to acquire knowledge of address in the configuration of various scales of networks.
4	To be conversant with the principles of Network Application Programming.
Course Outcomes: After successful completion of the course students will be able to:	
1	Enumerate the layers of OSI model and TCP/IP model and describe their functions.
2	Identify the characteristics of network devices and media used to design networks.
3	Demonstrate the knowledge of networking protocols at various layers of TCP/IP model.
4	Classify the routing protocols and analyse how to assign the IP addresses for a given network.
5	Design and configure the networks using IP addressing and sub-netting / super-netting schemes.
6	Explain the functions of Application layer and Presentation layers, their paradigms and Protocols.

COMPUTER COMMUNICATION AND NETWORKING (THEORY)

Module	Contents	Hrs
1	**Introduction to Data Communications and Networking**	**05**
1.1	Introduction to computer networks, Layers and services, Network topologies, protocol hierarchies, design issues for the layers, connection oriented and connectionless services.	
1.2	Reference models: Layer details of OSI, TCP/IP models. Communication between layers.	
2	**Transmission Media: Physical Layer**	**06**
2.1	Twisted pair, Coaxial, Fiber optics, Wireless transmission media.	
2.2	Circuit and packet Switching.	
2.3	Network Devices –Repeater, HUB, switch, routers and gateways.	
3	**Data Link Layer**	**08**
3.1	DLL Design Issues - Services, Framing, Error Control, Flow Control, Error Detection and Correction Elementary Data Link protocols, Stop and Wait, Sliding Window - Go Back N, Selective Repeat.	
3.2	Medium Access Control sublayer: Channel Allocation problem, Multiple access Protocol (Aloha, Carrier Sense Multiple Access (CSMA/CD), Local Area Networks - Ethernet (802.3), Introduction to wireless LAN: 802.11x	
4	**Network layer**	**08**
4.1	Network Layer design issues, Communication Primitives: Unicast, Multicast, broadcast. Network Layer Protocols: IPv4 Datagram Format, IPv4 Addresses, IPv4 Addressing (classfull and classless), Sub-netting and Super-netting design problems, IPv4 Protocol, IPv6 Packet Format, IPv6 Addressing, Transition from IPv4 to IPv6.	
4.2	Routing algorithms: Intra-domain Routing -Shortest Path, Distance Vector Algorithms, Link State Routing, Inter-domain Routing Protocols.	
4.3	Congestion control algorithms: Open loop congestion control, Closed loop congestion control, QoS parameters.	
5	**Transport Layer**	**07**
5.1	The Transport Service: Transport service primitives, Berkeley Sockets, Connection management (Handshake), UDP, TCP, TCP state transition, TCP timers.	
5.2	TCP Flow control (sliding Window), TCP Congestion Control: Slow Start	
6	**Application layer**	**05**

6.1	Application layer Paradigms, Client-Server Paradigm: Application Programming Interface.	
6.2	Standard Client Server applications: World Web and HTTP, FTP, Electronic Mail, Domain Name System (DNS).	
Total		**39**

Textbooks:	
1	Andrew S Tanenbaum, Computer Networks -, 4th Edition, Pearson Education
2	Behrouz A. Forouzan, Forouzan Mosharrat, Computer Networks A Top-Down Approach, McGraw Hill education
3	Ranjan Bose, Information Theory, Coding and Cryptography, Ranjan Bose, Tata McGraw Hill, Second Edition.
Reference books:	
1	James F. Kurose, K. W. Ross, Computer Networking: A Top-Down Approach Featuring the Internet, 3rd Edition, Pearson Education.
2	S. Keshav, An Engineering Approach to Computer Networks, 2nd Edition, Pearson Education.
3	W. A. Shay, Understanding communications and Networks, 3rd Edition, W. A. Shay, Cengage Learning.
4	L. L. Peterson and B. S. Davie, Computer Networks: A Systems Approach, 4th Ed, Elsevier India.

Internal Assessment:	
1	Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2	Mid Term test is to be conducted when approx. 50% syllabus is completed.
3	Duration of the midterm test shall be one hour.

Continuous Assessment:		
Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:		
Sr. No	**Rubrics**	**Marks**
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon pertaining to the course.	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk/competition followed by a small report and certificate of participation relevant to the subject	05 marks
8	Multiple Choice Questions (Quiz)	05 marks
9	Literature review of papers/journals.	05 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks.
2	Question paper will have a total of five questions.
3	All questions have equal weightage and carry 20 marks each.
4	Any three questions out of five needs to be solved.

COMPUTER COMMUNICATION AND NETWORKING (LAB)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tut	Total
NECPCL62	Computer Communication and Networking (Lab)	---	02	---	---	01	---	01

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NECPCL62	Computer Communication and Networking (Lab)	---	---	---	25	25	50

Lab Objectives:	
1	To study and understand basic network hardware components and network configurations using Linux and Windows platforms.
2	To simulate and analyze client-server communication using TCP and UDP protocols in NS-2 and NetSim environments.
3	To capture, inspect, and interpret network traffic using Wireshark and apply packet sniffing techniques for network analysis.
4	To configure and manage routing tables, IP forwarding, and firewalls (IPTables) on Linux and Windows operating systems.
5	To design, simulate, and evaluate wireless network technologies (WiMAX, ZigBee, Bluetooth) in NS-2, and compare their performance based on throughput, range, and power consumption.
6	To implement and analyze Wireless Sensor Networks (WSNs) using LEACH protocol in NS-2 with emphasis on energy efficiency, network lifetime, and packet delivery under varying network conditions.
Lab Outcomes: After successful completion of the lab course students will be able to:	

1	Students will be able to identify key network hardware components and configure network settings using Linux and Windows tools.
2	Students will develop and simulate client-server communication models using TCP and UDP protocols in NS-2 and NetSim.
3	Students will demonstrate the ability to capture, analyze, and interpret network traffic using Wireshark and apply packet sniffing techniques.
4	Students will configure routing tables, manage IP forwarding, and set up firewalls using IPTables on both Linux and Windows platforms.
5	Students will simulate and evaluate the performance of wireless networks (WiMAX, ZigBee, Bluetooth) based on parameters like throughput, range, and power consumption.
6	Students will implement Wireless Sensor Networks using the LEACH protocol in NS-2 and analyze the impact of node density and clustering on energy consumption and network lifetime.

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr.No.	**Name of the Experiments**
1	To study network components.
2	To build a simple client-server model in NS-2, demonstrating TCP or UDP-based communication.
3	To study the working of wireshark, a packet sniffing tool, and analyze network traffic using sniffing technique.
4	To understand and implement socket programming using NetSim for communication between client and server.
5	To view, add, delete, and modify routing tables and configure IP forwarding using IP tables in Windows operating systems.
6	Use a tool (Eg. NS2) to implement a specific Network topology with respect to the given number of nodes and physical configuration and do: ● Graphical simulation of network with Routing Protocols and traffic consideration (TCP, UDP) ● Analysis of network performance for quality parameters such as packet-delivery-ratio, delay, and throughput
7	Set up and configuration of firewalls in Linux/windows (Use IP Tables)
8	To install and configure the WiMAX module in NS-2 and study how varying the symbol rate (low vs. high) affects throughput, latency, and packet loss.
9	Use basic networking commands in Linux (ping, tracert, nslookup, netstat, ARP, RARP,ip, ifconfig, dig, route, etc) and set up a network environment with multiple IP addresses and configuration of ARP tables. Set up a network environment in Windows platform also.
10	Working with routing in Linux: ● View the current routing table ● Add and delete routes ● Change default gateway Perform IP Tables for IP forwarding.
11	Configure and simulate either a Bluetooth or ZigBee network in NS-2.

	To compare key performance metrics (throughput, range, power consumption) with other wireless technologies (Wi-Fi, MANET). To examine how different topologies (star, mesh) and superframe structures (in ZigBee) influence network behavior.
12	To implement and analyze a Wireless Sensor Network using the LEACH protocol in NS-2. To study energy consumption, network lifetime, and packet delivery under various node densities and clustering scenarios. To explore the "new" wireless trace file format in NS-2 for gathering detailed WSN simulation metrics.

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Term-Work:	
1	Term work should consist of 10 experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks (Experiments: 15-marks, Term work Assessment: 10-marks)

COURSE NAME: - SOFTWARE TESTING and QUALITY ASSURANCE

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NECPE261	Software Testing and Quality Assurance (Theory)	03	---	---	03	---	---	03
NECPE2L61	Software Testing and Quality Assurance (Lab)	---	02	---	---	01	---	01
Total Credits								04

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NECPE261	Software Testing and Quality Assurance (Theory)	03	---	---	03	---	---	03

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NECPE261	Software Testing and Quality Assurance (Theory)	20	20	60	---	---	100

Course Prerequisite: Fundamentals of Programming (NES14), Software Engineering (NECPC53).	
Course Objectives:	
1	To provide students with knowledge in Software Testing techniques.
2	To provide knowledge of Black Box and White Box testing techniques.
3	To provide skills to design test case plans for testing software.
4	To prepare test plans and schedules for testing projects.
5	To understand how testing methods can be used in a specialized environment.
6	To understand how testing methods can be used as an effective tool in providing quality assurance concerning software.
Course Outcomes: After successful completion of the course students will be able to:	
1	Investigate the reason for bugs and analyse the principles in software testing to prevent and remove bugs.
2	Understand various software testing methods and strategies.
3	Design test planning.
4	Manage the test process.
5	Apply the software testing techniques in the commercial environment.
6	Use practical knowledge of a variety of ways to test software and quality attributes

SOFTWARE TESTING and QUALITY ASSURANCE (THEORY)

Module	Contents	Hrs
1	**Testing Methodology**	**08**
1.1	Introduction to Software Testing: Introduction, Goals of Software Testing, Software Testing Definitions, Model for Software Testing, Effective Software Testing vs Exhaustive Software Testing, Software Failure Case Studies.	
1.2	Software Testing Terminology and Methodology: Software Testing Terminology, Software Testing Life Cycle (STLC), Software Testing methodology.	
1.3	Verification and Validation: Verification, Verification requirements, Validation.	
2	**Testing Techniques**	**09**
2.1	Black Box testing: boundary value analysis, equivalence class testing, state table-based testing, cause-effect graphing based testing, error guessing.	
2.2	White box Testing Techniques: need, logic coverage criteria, basis path testing, graph matrices, loop testing, data flow testing, mutation testing, Static Testing.	
2.3	Validation Activities: Unit validation, Integration, Function, System, Acceptance Testing.	
2.4	Regression Testing: Progressive vs. Regressive	
3	**Managing the Test Process**	**07**
3.1	Test Management: test organization, structure and of testing group, test planning, detailed test design and test specification.	
3.2	Software Metrics: need, definition and classification of software matrices.	
3.3	Efficient Test Suite Management: minimizing the test suite and its benefits	
4	**Test Automation**	**04**
4.1	Automation and Testing Tools: need, categorization, selection and cost in testing tool.	
4.2	Guidelines for testing tools.	
5	**Testing for specialized environment**	**05**
5.1	Agile Testing, Agile Testing Life Cycle, Challenges in Agile Testing.	
5.2	Testing Object-Oriented Software: OOT Basics, Object-oriented Testing.	
6	**Quality Management**	**06**
6.1	Software Quality Management, McCall's quality factors and Criteria	
Total		**39**

Textbooks:	
1	Software Testing Principles and Practices, Naresh Chauhan, Oxford Higher Education.
2	Software Testing and quality assurance theory and practice, Kshirasagar Naik, Priyadarshi Tripathy, Wiley Publication
Reference books:	
1	Effective Methods for Software Testing, Willam E. Perry, Wiley Publication, third edition.
2	Software Testing Concepts and Tools, Nageswara Rao Pusuluri, Dreamtech press.

Internal Assessment:	
1	Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2	Mid Term test is to be conducted when approx. 50% syllabus is completed.
3	Duration of the midterm test shall be one hour.

Continuous Assessment:

Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon pertaining to the course.	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk/competition followed by a small report and certificate of participation relevant to the subject	05 marks
8	Multiple Choice Questions (Quiz)	05 marks
9	Literature review of papers/journals.	05 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks.
2	Question paper will have a total of five questions.
3	All questions have equal weightage and carry 20 marks each.
4	Any three questions out of five needs to be solved.

SOFTWARE TESTING and QUALITY ASSURANCE (LAB)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tut	Total
NECPE2L61	Software Testing and Quality Assurance (Lab)	---	02	---	---	01	---	01

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NECPE2L61	Software Testing and Quality Assurance (Lab)	---	---	---	25	25	50

Lab Prerequisite: Programming Language (C++, Java), Software Engineering.	
Lab Objectives:	
1	To understand the core principles, terminology, and lifecycle of software testing through practical implementation.
2	To analyze software systems for potential failures and apply verification and validation techniques.
3	To design and execute test cases using both black box (e.g., boundary value analysis) and white box (e.g., basis path testing) techniques.
4	To gain hands-on experience with test management tools like Qase and defect tracking tools like JIRA.
5	To automate test cases using modern tools such as Selenium and understand their integration in a real-time testing framework.
6	To apply software testing metrics and quality models to evaluate and enhance software product quality.

Lab Outcomes: After successful completion of the lab course students will be able to:	
1	Demonstrate an understanding of different testing methodologies, software failures, and their causes through case study analysis.
2	Design effective test cases using black box and white box testing techniques and execute them manually.
3	Create and interpret control flow graphs for conducting basis path and loop testing.
4	Use tools such as Selenium, Qase, and JIRA for automating and managing the software testing process.
5	Analyze and report software defects, regression scenarios, and test coverage using appropriate metrics.
6	Apply agile testing techniques and quality models to ensure high-quality deliverables in agile environments.

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr.No.	**Name of the Experiments**
1	To study software testing fundamentals and analyze real-world software failure case studies.
2	Write a program for any one function of the selected system. Introspect the causes for its failure and write down the possible reasons for its failure.
3	Study the system, requirement specifications and designing the system.
4	To implement white box testing techniques like basis path testing and loop testing using control flow graphs.
5	Select the test cases (positive and negative scenarios) for the selected system.
6	Design Test cases for the system using boundary value analysis or equivalent class partitioning.
7	Manual execution of test cases and prepare defect reports.
8	Identify regression scenarios for automation for any one/two test case.
9	To identify and compute relevant software testing metrics such as defect density and code coverage.
10	To use a test automation tool (e.g., Selenium) for automating test cases on a web application.
11	Study of any test management tool (e.g. Qase).
12	Writing down test cases and execution using tools (e.g. Qase).
13	Study defect management (e.g. JIRA)
14	Design quality matrix for your system.
15	To perform agile testing practices and prepare test cases in an agile project environment.

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the

fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Term-Work:	
1	Term work should consist of 10 experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks (Experiments: 15-marks, Term work Assessment: 10-marks)

COURSE NAME: - MACHINE LEARNING

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NECPE262	Machine Learning (Theory)	03	---	---	03	---	---	03
NECPE2L62	Machine Learning (Theory)	---	02	---	---	01	---	01
Total Credits								04

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NECPE262	Machine Learning (Theory)	03	---	---	03	---	---	03

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NECPE262	Machine Learning (Theory)	20	20	60	---	---	100

Course Prerequisite: Data Structures (NECPC31), Statistics for Engineers (PEC1), Design and Analysis of Algorithms (PEC1)	
Course Objectives:	
1	To introduce Machine learning concepts.
2	To develop mathematical concepts required for Machine learning algorithms.
3	To understand various Regression techniques.
4	To understand Clustering techniques.
5	To develop Neural Network based learning models.
Course Outcomes: After successful completion of the course students will be able to:	
1	Comprehend basics of Machine Learning.
2	Build Mathematical foundation for machine learning.
3	Understand various Machine learning models.
4	Select suitable Machine learning models for a given problem.
5	Build Neural Network based models.
6	Apply Dimensionality Reduction techniques.

MACHINE LEARNING (THEORY)

Module	Contents	Hrs
1	**Introduction to Machine Learning**	**06**
1.1	Introduction to Machine Learning, Issues in Machine Learning, Application of Machine Learning, Steps of developing a Machine Learning Application.	
1.2	Supervised and Unsupervised Learning: Concepts of Classification, Clustering and prediction, Training, Testing and validation dataset, cross validation, overfitting and under fitting of model	
1.3	Performance Measures: Measuring Quality of model- Confusion Matrix, Accuracy, Recall, Precision, Specificity, F1 Score, RMSE	
2	**Mathematical Foundation for ML**	**09**
2.1	System of Linear equations, Norms, Inner products, Length of Vector, Distance between vectors, Orthogonal vectors	
2.2	Symmetric Positive Definite Matrices, Determinant, Trace, Eigenvalues and vectors, Orthogonal Projections, Diagonalization, SVD and its applications.	
3	**Liner models**	**07**
3.1	The least-squares method, Multivariate Linear Regression, Regularised Regression, Using Least-Squares Regression for classification	
3.2	Introduction to SVM.	
4	**Clustering**	**04**
4.1	Hebbian Learning rule	
4.2	Expectation -Maximization algorithm for clustering	
5	**Classification models**	**12**
5.1	Introduction, Fundamental concept, Evolution of Neural Networks, Biological Neuron, Artificial Neural Networks, NN architecture, McCulloch-Pitts Model. Designing a simple network, non-separable patterns, Perceptron model with Bias. Activation functions, Binary, Bipolar, continuous, Ramp.	
5.2	Perceptron Learning Rule. Delta Learning Rule (LMS-Widrow Hoff), Multi-layer perceptron network. Adjusting weights of hidden layers. Error back propagation algorithm.	
5.3	Logistic regression	
6	**Dimensionality Reduction**	**06**
6.1	Curse of Dimensionality.	
6.2	Feature Selection and Feature Extraction	
6.3	Dimensionality Reduction Techniques, Principal Component Analysis.	

	Total	**39**
Textbooks:		
1	Nathalie Japkowicz & Mohak Shah, "Evaluating Learning Algorithms: A Classification Perspective", Cambridge.	
2	Marc Peter Deisenroth, Aldo Faisal, Cheng Soon Ong, "Mathematics for machine learning"	
3	Samir Roy and Chakraborty, "Introduction to soft computing", Pearson Edition.	
4	Ethem Alpaydın, "Introduction to Machine Learning", MIT Press.	
5	Peter Flach, "Machine Learning", Cambridge University Press.	
Reference books:		
1	Tom M. Mitchell, "Machine Learning", McGraw Hill.	
2	Kevin P. Murphy, "Machine Learning — A Probabilistic Perspective", MIT Press.	
3	Stephen Marsland, "Machine Learning an Algorithmic Perspective", CRC Press.	
4	Shai Shalev-Shwartz, Shai Ben-David, "Understanding Machine Learning", Cambridge University Press.	
5	Peter Harrington, "Machine Learning in Action", DreamTech Press.	

Internal Assessment:	
1	Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2	Mid Term test is to be conducted when approx. 50% syllabus is completed.
3	Duration of the midterm test shall be one hour.

Continuous Assessment:

Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon pertaining to the course.	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk/competition followed by a small report and certificate of participation relevant to the subject	05 marks
8	Multiple Choice Questions (Quiz)	05 marks
9	Literature review of papers/journals.	05 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks.
2	Question paper will have a total of five questions.
3	All questions have equal weightage and carry 20 marks each.
4	Any three questions out of five needs to be solved.

MACHINE LEARNING (LAB)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tut	Total
NECPE2L62	Machine Learning (Lab)	---	02	---	---	01	---	01

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NECPE2L62	Machine Learning (Lab)	---	---	---	25	25	50

Lab Objectives:	
1	To provide hands-on experience in applying machine learning algorithms to real-world datasets.
2	To understand and implement key performance evaluation metrics for various ML models.
3	To develop skills in applying mathematical foundations such as vector operations and linear algebra in ML tasks.
4	To enable students to build, train, and evaluate supervised and unsupervised learning models.
5	To implement dimensionality reduction techniques to improve model performance and visualization.
6	To introduce neural network architectures and train basic models using perceptron and backpropagation algorithms.
Lab Outcomes: After successful completion of the lab course students will be able to:	
1	Students will be able to build end-to-end machine learning models and analyze their performance.
2	Students will demonstrate the ability to apply appropriate evaluation metrics based on the problem context.

3	Students will apply mathematical concepts like eigen decomposition, vector norms, and SVD in ML tasks.
4	Students will be able to implement and differentiate between various classification, regression, and clustering algorithms.
5	Students will understand the challenges of high-dimensional data and apply PCA and feature selection techniques.
6	Students will design and implement neural networks for simple classification problems using perceptron and MLP.

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr.No.	**Name of the Experiments**
1	To understand and implement a basic machine learning pipeline using a standard dataset.
2	To demonstrate cross-validation and analyze overfitting and underfitting in machine learning models.
3	To evaluate the performance of classification models using confusion matrix and other performance metrics.
4	To perform vector operations and compute distances between vectors using Python.
5	To compute eigenvalues, eigenvectors, and perform Singular Value Decomposition (SVD) of a matrix.
6	To implement linear regression on a real-world dataset and interpret model coefficients.
7	To compare regularized regression techniques (Ridge and Lasso) and observe their effect on model performance.
8	To implement Support Vector Machine (SVM) for binary classification using different kernels.
9	To apply K-Means clustering algorithm and visualize cluster separation.
10	To implement Expectation-Maximization (EM) algorithm for Gaussian Mixture Models and analyze results.
11	To implement a single-layer perceptron for classifying linearly separable data.
12	To build and train a multi-layer perceptron using backpropagation algorithm.
13	To implement logistic regression for binary classification using a real-world dataset.
14	To apply Principal Component Analysis (PCA) for dimensionality reduction and data visualization.
15	To perform feature selection and analyze its impact on model performance.

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Term-Work:	
1	Term work should consist of 10 experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks (Experiments: 15-marks, Term work Assessment: 10-marks)

COURSE NAME: - DATA WAREHOUSING and MINING

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NECPE263	Data Warehousing and Mining (Theory)	03	---	---	03	---	---	03
NECPE2L63	Data Warehousing and Mining (Lab)	---	02	---	---	01	---	01
Total Credits								04

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NECPE263	Data Warehousing and Mining (Theory)	03	---	---	03	---	---	03

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NECPE263	Data Warehousing and Mining (Theory)	20	20	60	---	---	100

Course Prerequisite:
Data Structures (NECPC31), Database Management System (NECPC42), Design and Analysis of Algorithm (PEC1).

Course Objectives:

1	To identify the scope and understand the fundamentals of Data Warehousing and Mining.
2	To understand the importance of data warehouse that would assist in providing business insights for data mining applications.
3	To instigate research interest towards advances in Data Mining.

Course Outcomes:
After successful completion of the course students will be able to:

1	Understand Data Warehousing fundamentals and Dimensionality modelling principles.
2	Understand the use of ETL techniques and apply OLAP operations.
3	Perceive the importance of data pre-processing and basics of data mining techniques.
4	Relate to the concepts of market basket analysis in real world applications.
5	Apply classification algorithms in real world dataset for classification and prediction.
6	Visualize the concept of clustering and its applications.

DATA WAREHOUSING and MINING (THEORY)

Module	Contents	Hrs
1	**Data Warehousing and Dimension Modelling**	**08**
1.1	Introduction to Data Warehouse, Characteristics of Data Warehouse	
1.2	Components of Data warehouse Architecture, Data warehouse architecture	
1.3	Data warehouses versus Data Marts.	
1.4	E-R Modelling versus Dimensional Modelling,	
1.5	Data Warehouse Schemas; Star Schema, Snowflake Schema, Fact Less Fact Table, Fact Constellation Schema.	
1.6	Inside Dimensional Table, Inside Fact Table.	
1.7	OLTP Systems versus OLAP.	
2	**ETL and OLAP**	**06**
2.1	Major steps in ETL process, Data Extraction Methods	
2.2	Data Transformation; Basic Tasks in Transformation, Major Data Transformation Types	
2.3	Data Loading Techniques.	
2.4	What is Multidimensional Data, OLAP Models: MOLAP, ROLAP.	
2.5	OLAP operations: Slice, Dice, Rollup, Drilldown and Pivot.	
3	**Data Mining and Data pre-processing**	**07**
3.1	Introduction to data mining, Architecture for Data Mining.	
3.2	KDD process, Data Mining Functionalities, Interestingness Measures.	
3.3	Classification of data mining system, major issues in data mining.	
3.4	Data Summarization, Data Cleaning, Data Integration and Transformation,	
3.5	Data Reduction, Data Discretization and Concept Hierarchy Generalization.	
4	**Mining frequent patterns and associations**	**05**
4.1	Market Basket Analysis, Frequent Item, Closed Item sets, & Association Rule	
4.2	Frequent Pattern Mining, Efficient and Scalable Frequent Item set Mining Methods: Apriori Algorithm.	
5	**Classification and Prediction**	**07**
5.1	Definition, Decision tree induction	
5.2	Bayesian classification	
5.3	Introduction to prediction, Linear and logistic regression techniques	
5.4	Accuracy and error measures.	
6	**Cluster analysis**	**06**
6.1	Definition, Distance Measures,	
6.2	Clustering Algorithms: Partitioning- K means and K-medoids	
Total		**39**

Textbooks:	
1	Paulraj Ponniah, "Data Warehousing: Fundamentals for IT Professionals‖", Wiley India.
2	Han, Kamber, "Data Mining Concepts and Techniques", Morgan Kaufmann.
3	Reema Theraja," Data warehousing, Oxford University Press.
4	M.H. Dunham, "Data Mining Introductory and Advanced Topics", Pearson Education.
Reference books:	
1	Ian H. Witten, Eibe Frank and Mark A. Hall, "Data Mining ", 3rd Edition Morgan Kaufmann publisher.
2	Pang-Ning Tan, Michael Steinbach and Vipin Kumar, Introduction to Data Mining", Person Publisher.

Useful Links:	
1	https://onlinecourses.nptel.ac.in/noc21_cs06/preview
2	https://www.coursera.org/specializations/data-mining
3	https://www.udemy.com/course/data-mining-python/

Internal Assessment:	
1	Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2	Mid Term test is to be conducted when approx. 50% syllabus is completed.
3	Duration of the midterm test shall be one hour.

Continuous Assessment:

Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon pertaining to the course.	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk/competition followed by a small report and certificate of participation relevant to the subject	05 marks
8	Multiple Choice Questions (Quiz)	05 marks
9	Literature review of papers/journals.	05 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks.
2	Question paper will have a total of five questions.
3	All questions have equal weightage and carry 20 marks each.
4	Any three questions out of five needs to be solved.

DATA WAREHOUSING AND MINING (LAB)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tut	Total
NECPE2L63	Data Warehousing and Mining (Lab)	---	02	---	---	01	---	01

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NECPE2L63	Data Warehousing and Mining (Lab)	---	---	---	25	25	50

Lab Outcomes: After successful completion of the lab course students will be able to:	
1	Understand data transformation and visualization.
2	Perform OLAP operations for multidimensional data analysis.
3	Apply classification techniques.
4	Implement association and decision tree algorithms.
5	Develop predictive models using linear and multiple regression.
6	Perform clustering using K-Means algorithm.

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr.No.	**Name of the Experiments**
1	One case study on building Data warehouse/Data Mart • Write Detailed Problem statement and design dimensional modelling (creation of star and snowflake schema) • Implementation of all dimension table and fact table
2	To Perform Data Processing and Visualization using open-source tool like Power Bi / Tableau etc..
3	To perform data transformation and OLAP operations using open-source tool like Power Bi / Tableau etc...
4	To perform classification using the Random Forest algorithm using open-source tool (WEKA, R tool, XL Miner, Orange etc.)
5	To perform classification using the Naïve Bayes algorithm using open-source tool (WEKA, R tool, XL Miner, Orange etc.)
6	To implement the Apriori algorithm using open-source tool (WEKA, R tool, XL Miner, Orange etc.)
7	To implement the ID3 algorithm for decision tree learning using Python/Java.
8	To implement the Naïve Bayes classification algorithm using Python/Java.
9	To implement Linear Regression for predictive analysis using Python/Java
10	To implement Multiple Regression for predictive analysis using Python/Java
11	To implement the K-Means Clustering algorithm using Python/Java.
12	Demo on any cloud-based data warehousing process which gives a holistic view of Data Warehouse

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Data sets available for download:	
1	Datasets for data mining "http://www.inf.ed.ac.uk/teaching/courses/dme/html/datasets0405.html"
2	Datasets for data mining "https://www.kdnuggets.com/datasets/index.html"
3	Datasets for data mining "https://www.kdnuggets.com/datasets/index.html"
4	Kaggle datasets
Term-Work:	
1	Term work should consist of 10 experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks

	(Experiments: 15-marks, Term work Assessment: 10-marks)

COURSE NAME: - DIGITAL IMAGE PROCESSING

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NECPE361	Digital Image Processing (Theory)	03	---	---	03	---	---	03
NECPE3L61	Digital Image Processing (Lab)	---	02	---	---	01	---	01
Total Credits								04

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NECPE361	Digital Image Processing (Theory)	03	---	---	03	---	---	03

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NECPE361	Digital Image Processing (Theory)	20	20	60	---	---	100

Course Prerequisite: Digital Signal Processing (NECPC52)	
Course Objectives:	
1	To learn the fundamental concepts of image processing for image enhancement.
2	To learn image compression, segmentation techniques with practical applications.
3	To provide basic concepts of computer vision and its applications.
Course Outcomes: After successful completion of the course students will be able to:	
1	Represent image in its numerical and graphical form.
2	Perform different image enhancement approaches for improving image quality.
3	Elucidate the mathematical modelling of image segmentation and morphology.
4	Apply the concept of image compression.
5	Understand computer vision system elements.
6	Develop a computer vision system based on requirement.

DIGITAL IMAGE PROCESSING (THEORY)

Module	Contents	Hrs
1	**Fundamentals of Digital Image Processing**	**04**
1.1	Introduction of image processing, Different types of images, Visual perception, Image sensing and Acquisition, Quantization, Sampling, color image processing, Revision of Mathematical concepts for image processing.	
2	**Enhancement in Spatial and Frequency domain**	**06**
2.1	Intensity transformation, Filtering in spatial and Frequency domain: Image negatives, Log transformations, Histogram processing, Spatial filter: smoothing and Sharpening, Discrete Fourier transform, properties of 2-D DFT, Image smoothing and Sharpening in Fourier domain.	
3	**Image transforms**	**05**
3.1	Two-dimensional orthogonal and Unitary transforms, Properties of Unitary transforms, 2D DFT, Cosine transforms, Hadamard transforms, Comparison of image transforms.	
4	**Edge Detection and Wavelet transform**	**10**
4.1	Gradient and Laplacian based edge detection, Diffusion based edge detection: Isotropic and anisotropic diffusion.	
4.2	Wavelet transform for Image Processing: Multi resolution expansion, Wavelet functions, Wavelet Series expansion, Discrete Wavelet transforms, Wavelet transforms for two-dimensional signals (images), Applications of wavelet transforms for edge extraction, noise suppression.	
5	**Image Segmentation and Restoration**	**09**
5.1	Thresholding, region-based Morphological Watersheds, Bayesian based image segmentation.	
5.2	Image restoration and reconstruction: Models of image degradation, noise models, Spatial and Frequency domain based approaches for image restoration, Wiener Filtering.	
6	**Image Compression**	**05**
6.1	Spatial and Temporal redundancy, Basic image compression models, compression standards, basic compression methods: Huffman coding, Run-length coding, Block transform coding, Predictive coding	
Total		**39**

Textbooks:	
1	Rafael C. Gonzalez and Richard E.Woods, "Digital Image Processing," Pearson Education, edition 4, 2018.
2	Anil K.Jain, "Fundamentals of Digital Image Processing," Pearson Education, 2010.
3	S. Jayaraman, T. Veerakumar, A. Esakkirajan, "Digital Image Processing," First Edition, McGraw Hill Education, 2017
4	Robert J. Schallkoff , "Digital Image Processing and Computer Vision", John Wiley and Sons, 1989.
5	J. R. Parker, "Algorithms for Image Processing and Computer Vision" John Wiley and Sons, 1997.
Reference books:	
1	Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003.
2	B.Chanda and D.Dutta Majumder, "Digital Image Processing and Analysis," Prentice Hall of India, 2002
3	William K. Pratt, "Digital Image Processing," John Wiley & Sons, 2nd edition, 2004
4	Alan C. Bovik, "Handbook of Image and Video Processing," Elsevier Science Publishing Co Inc, 2009
5	Richard Szeliski, "Computer Vision: Algorithms and Applications," 2nd edition, The University of Washington, 2022
6	Kenneth R. Castleman, "Digital Image Processing," Pearson Education, 2006.

Internal Assessment:	
1	Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2	Mid Term test is to be conducted when approx. 50% syllabus is completed.
3	Duration of the midterm test shall be one hour.

Continuous Assessment:		
Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:		
Sr. No	**Rubrics**	**Marks**
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon pertaining to the course.	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk/competition followed by a small report and certificate of participation relevant to the subject	05 marks
8	Multiple Choice Questions (Quiz)	05 marks
9	Literature review of papers/journals.	05 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks.
2	Question paper will have a total of five questions.
3	All questions have equal weightage and carry 20 marks each.
4	Any three questions out of five needs to be solved.

DIGITAL IMAGE PROCESSING (LAB)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tut	Total
NECPE3L61	Digital Image Processing (Lab)	---	02	---	---	01	---	01

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NECPE 3L61	Digital Image Processing (Lab)	---	---	---	25	25	50

Lab Outcomes: After successful completion of the lab course students will be able to:	
1	Describe digital image representation, manipulation and illustrate the use of histograms.
2	Use and Compare various Linear filtering methods.
3	Applying various Ideal filters in the frequency domain and understand the concept of edge detection.
4	Compose various Morphological operations on binary images and generate their transformed images.
5	Applying various Geometric transformations on image and Illustrate Two- dimensional Fourier transform.

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr.No.	**Name of the Experiments**
1	Simulation and Display of an Image, Negative of an Image (Binary & Gray Scale).
2	Contrast stretching of a low contrast image, Histogram, and Histogram Equalization.
3	Read an 8 bit image and then apply different image enhancement techniques: (a) Brightness improvement (b) Brightness reduction (c) Thresholding (d) Negative of an image (e) Log transformation (f) Power Law transformation.
4	Display of bit planes of an Image.
5	Computation of Mean, Standard Deviation, Correlation coefficient of the given Image.
6	Implement various Smoothing spatial filters. Write a program to implement various low pass filters and high pass filters in frequency domain.
7	Display of FFT (1-D & 2-D) of an image.
8	Implement and study the effect of Different Mask (Sobel, Prewitt and Roberts).
9	Implementation of image sharpening filters and Edge Detection using Gradient Filters.
10	Implement different interpolation techniques on image.
11	Implement Image compression using DCT Transform.
12	Write a program for erosion and dilation, opening & closing using inbuilt and without inbuilt function.

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Term-Work:	
1	Term work should consist of 10 experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks (Experiments: 15-marks, Term work Assessment: 10-marks)

COURSE NAME: - MICRO ELECTRO-MECHANICAL SYSTEMS

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NECPE362	Micro Electro-Mechanical Systems (Theory)	03	---	---	03	---	---	03
NECPE3L62	Micro Electro-Mechanical Systems (Lab)	---	02	---	---	01	---	01
Total Credits								04

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NECPE362	Micro Electro-Mechanical Systems (Theory)	03	---	---	03	---	---	03

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NECPE362	Micro Electro-Mechanical Systems (Theory)	20	20	60	---	---	100

Course Prerequisite: NECPC 41: Electronic Devices and Circuits, NECMM 42: Embedded Systems and RTOS	
Course Objectives:	
1	To provide knowledge of MEMS fabrication steps.
2	To provide knowledge of MEMS Materials with respect to applications.
3	To demonstrate the use of semiconductor-based fabrication processes for sensors and actuators.
4	To provide an understanding of basic design and operation of MEMS sensors, actuators and passive structures.
Course Outcomes: After successful completion of the course students will be able to:	
1	Understand the different MEMS devices and their working principles.
2	To use materials for common micro components and devices.
3	Develop different concepts of MEMS sensors and actuators for real-world applications.
3	Develop different concepts of MEMS sensors and actuators for real-world applications.
4	Understand the rudiments of Micro-fabrication techniques.
5	Understand the basic principles and application of Cantilever structure, Micro heaters, Accelerometers, Pressure Sensor etc.
6	Understand reliability and various failure mechanisms for MEMS devices.

MICRO ELECTRO-MECHANICAL SYSTEMS (THEORY)

Module	Contents	Hrs
1	**Introduction to MEMS**	**04**
1.1	Introduction to MEMS and Microelectronics Technologies.	
1.2	MEMS in Real world applications such as Air-Bag, DMD, Pressure Sensors, MEMS Challenges, MEMS Sensors in Internet of Things (IoT), Bio-medical applications.	
2	**MEMS Materials and Their Properties**	**07**
2.1	Use of Si, SiO_2, SiN, SiC, Cr, Au, Al, Ti, SU8, PMMA, Pt in building MEMS applications.	
2.2	Material properties such as Young modulus, Poisson's ratio, density, piezo resistive coefficients, TCR, Thermal Conductivity, Thermoelectricity.	
3	**MEMS Sensors and Actuators**	**07**
3.1	Types of MEMS Sensing (Capacitive, Piezoelectric, Piezo resistive).	
3.2	Micro Actuation principles: Electrothermal, Piezoelectric and Electrostatic.	
3.3	Micro Actuation tools: Micro Grippers, Micro Gears, Micro Motors, Micro Valves, Micro Pumps.	
4	**MEMS Fabrication Processes**	**09**
4.1	Understanding MEMS Processes & Process parameters for: Cleaning, Growth & Deposition, Ion Implantation & Diffusion, Annealing.	
4.2	Lithography:X-Ray Lithography, Photolithography, PVD,CVD,Wet etching, Dry etching, Plasma etching, DRIE, Etch Stop Techniques, Die, Wire & Wafer Bonding, Dicing, Packaging.	
5	**MEMS Devices**	**09**
5.1	Construction and working and applications of basic Cantilever structure, Micro heaters, Accelerometers, Pressure Sensor, Micromirrors in DMD, Inkjet printer, Steps involved in fabrication of above devices.	
6	**MEMS Reliability**	**03**
6.1	Reliability and various failure mechanisms for MEMS devices.	
6.2	Reliability curve.	
Total		**39**

Textbooks:	
1	An Introduction to Micro-electromechanical Systems Engineering; 2nd Ed - by N. Maluf, K Williams; Publisher: Artech House Inc.
2	Micro-system Design - by S. Senturia; Publisher: Springer.
3	Introduction to Electromechanical system design –by James J Allen. Taylor & Francis Group, LLC publication.
Reference books:	
1	Fundamentals of Micro-fabrication - by M. Madou; Publisher: CRC Press; 2nd edition.
2	Micro machined Transducers Sourcebook - by G. Kovacs; Publisher: McGraw-Hill

Internal Assessment:	
1	Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2	Mid Term test is to be conducted when approx. 50% syllabus is completed.
3	Duration of the midterm test shall be one hour.

Continuous Assessment:

Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon pertaining to the course.	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk/competition followed by a small report and certificate of participation relevant to the subject	05 marks
8	Multiple Choice Questions (Quiz)	05 marks
9	Literature review of papers/journals.	05 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks.
2	Question paper will have a total of five questions.
3	All questions have equal weightage and carry 20 marks each.

4	Any three questions out of five needs to be solved.

MICRO ELECTRO-MECHANICAL SYSTEMS (LAB)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tut	Total
NECPE3L62	Micro Electro-Mechanical Systems (Lab)	---	02	---	---	01	---	01

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NECPE 3L62	Micro Electro-Mechanical Systems (Lab)	---	---	---	25	25	50

Lab Outcomes: After successful completion of the lab course students will be able to:	
1	Determine various parameters for MEMS devices.
2	Plot characteristics of MEMS devices.
3	Select a particular device for a specific application.
4	Observe the effect of device parameters variation on its performance.

Suggested Experiments: Students are required to complete at least 08 experiments.	
Sr.No.	**Name of the Experiments**
1	Simulate and analyse the characteristics of Cantilever.
2	Simulate and analyse the characteristics of Circular actuator.
3	Simulate and analyse the characteristics of Spring mass actuator.
4	Measure the temperature of heated membrane for a given voltage excitation.
5	Study the temperature of heated membrane to standard voltage profile.
6	Study the temperature of heated membrane to customized voltage profile.
7	Study the differential response of micro heater.
8	Modeling and simulation of MEMS devices.
9	Case study on advance topic.
10	Case study of recent development in the subject.

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Term-Work:	
1	Term work should consist of 10 experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks (Experiments: 15-marks, Term work Assessment: 10-marks)

COURSE NAME: - PRINCIPLES OF CONTROL SYSTEM

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NECPE363	Principles of Control System (Theory)	03	---	---	03	---	---	03
NECPE3L63	Principles of Control System (Lab)	---	02	---	---	01	---	01
Total Credits								04

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NECPE363	Principles of Control System (Theory)	03	---	---	03	---	---	03

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NECPE363	Principles of Control System (Theory)	20	20	60	---	---	100

Course Prerequisite: Fundamentals of Engineering Mathematics-1 (NBS11), Fundamentals of Engineering Mathematics-2 (NBS21).	
Course Objectives:	
1	To develop the understanding of fundamental principles of control systems.
2	To disseminate the basic methods for time-domain and frequency-domain analysis of control systems.
3	To develop the concept of stability and its assessment for linear-time-invariant systems.
4	To introduce the basics of controllers.
5	To introduce the concepts of state space analysis.
Course Outcomes: After successful completion of the course students will be able to:	
1	Derive the mathematical models of physical systems.
2	Sketch various plots in time and frequency domain and analyse the system using the plots.
3	Evaluate the stability of control systems in the time domain.
4	Sketch various plots in the frequency domain and evaluate the stability of control systems in the frequency domain.
5	Understand and identify various types of controllers for a given system.

6	Analyse the control systems using state-space methods.

PRINCIPLES OF CONTROL SYSTEMS (THEORY)

Module	Contents	Hrs
1	**Introduction to the Control Systems**	**06**
1.1	Various Classification of Control System, Closed Loop Control Versus Open Loop Control, Feedback Characteristics: Types of feedback.	
1.2	Mathematical model of physical systems, transfer function.	
1.3	Block diagram and Signal Flow Graph (SFG) representation of control systems; Block diagram reductions; Mason's gain formula.	
2	**Time response analysis**	**07**
2.1	Standard test signals: Time response of 1st. order systems to unit step and unit ramp inputs. Time response of second order systems to unit step input. Time response specifications for second order system	
2.2	Application of initial and final value theorem; Steady state error and Error constants of different types of control systems	
3	**Stability analysis in time domain**	**07**
3.1	Concepts of stability: Necessary conditions of stability, Hurwitz stability criterion, Routh stability criterion, application of Routh stability criterion to linear feedback systems, Relative stability Analysis.	
3.2	Root locus techniques: Root locus concepts, rules for construction of root loci, determination of roots from root locus.	
4	**Frequency Response Analysis**	**07**
4.1	Introduction to frequency response; Polar plots, Bode plots, determination of stability from Bode plots, Performance specifications in frequency domain.	
4.2	Nyquist stability criterion, application of Nyquist stability criterion to linear feedback systems.	
5	**Introduction to Controllers**	**05**
5.1	Controllers: Introduction, Proportional, derivative and integral control actions, PD, PI and PID controllers and their applications to feedback control systems.	
5.2	Zeigler- Nichols method of tuning PID controllers for known dynamic models of the plant.	
6	**State-space Analysis**	**04**
6.1	Concept of state variables; State-space model; Canonical forms.	
6.2	Solution of state-space equation; Eigen-values and eigenvectors; Stability in state-space.	
6.3	Concept of controllability and observability.	

	Total	**39**
Textbooks:		
1	M. Gopal, "Control Systems: Principles and Design", 3rd edition, Tata McGraw Hill, 2008.	
2	Richard Dorf, Robert Bishop, "Modern Control Systems", 11th edition, Pearson Education, 2008.	
Reference books:		
1	Golnaraghi Farid, B. C. Kuo, "Automatic Control Systems", 10th edition, McGraw Hill, 2017	
2	K. Ogata, "Modern Control Engineering", 6th edition, Prentice Hall, 2010.	
3	I.J. Nagrath, M. Gopal, "Control System Engineering", New Age International, 2009	
4	Norman Nise, "Control Systems Engineering", Wiley, 8th edition, 2019.	

Internal Assessment:	
1	Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2	Mid Term test is to be conducted when approx. 50% syllabus is completed.
3	Duration of the midterm test shall be one hour.

Continuous Assessment:

Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon pertaining to the course.	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk/competition followed by a small report and certificate of participation relevant to the subject	05 marks
8	Multiple Choice Questions (Quiz)	05 marks
9	Literature review of papers/journals.	05 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks.
2	Question paper will have a total of five questions.

3	All questions have equal weightage and carry 20 marks each.
4	Any three questions out of five needs to be solved.

PRINCIPLES OF CONTROL SYSTEMS (LAB)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tut	Total
NECPE3L63	Principles of Control Systems (Lab)	---	02	---	---	01	---	01

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NECPE 3L63	Principles of Control Systems (Lab)	---	---	---	25	25	50

Lab Outcomes: After successful completion of the lab course students will be able to:	
1	Analyze a control system in time and frequency domain.
2	Design a performance specification-based controller in time and frequency domain.
3	Develop and tune PID controllers for a given control system.
4	Evaluate controllability and observability of a control system.

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr.No.	**Name of the Experiments**
1	To perform the time response of a first-order and second-order system to standard input signals.
2	To perform the frequency response of a second-order system to standard input signals
3	To solve a differential equation model using simulation software.
4	To perform the steady-state errors for type-0, 1 and 2 systems
5	To perform stability analysis of several control systems using Nyquist plots.
6	To perform controllability and observability of control systems.
7	To analyze the frequency response of first- and second-order systems using Bode plots
8	To introduce the P/PI/PD/PID controller and its tuning.
9	To plot the root locus of a given open-loop transfer function and analyze the movement of system poles with varying gain.
10	Model systems in state space form and evaluate responses.

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Term-Work:	
1	Term work should consist of 10 experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks (Experiments: 15-marks, Term work Assessment: 10-marks)

COURSE NAME: - IIOT & INDUSTRY 4.0

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NECMM 64	IIoT & Industry 4.0 (Theory)	02	---	---	02	---	---	02
Total Credits								02

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NECMM 64	IIoT & Industry 4.0 (Theory)	02	---	---	02	---	---	02

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NECMM 64	IIoT & Industry 4.0 (Theory)	20	20	60	---	---	100

Course Prerequisite: Web Technology (NOE401), Internet of Things (MDM1).	
Course Objectives:	
1	To learn and understand the importance of IoT in Industrial applications.
2	To understand how IoT has become a game changer in the new economy where the customers are looking for integrated value.
3	To apply the IoT concepts in building solutions to Industrial problems.
4	To learn and understand the tools and techniques that enable IoT solutions and Security aspects.
Course Outcomes: After successful completion of the course students will be able to:	
1	Discover key IIoT concepts including identification, sensors, localization, wireless protocols, data storage and security
2	Explore IoT technologies, architectures, standards and regulation
3	Apply IoT Protocols for Industrial automation/applications
4	Explain the need of IoT in Industrial environment & Security aspects of IoT
5	Explain the new concepts for data logging and analytics
6	Understand various application of IIoT.

IIOT & INDUSTRY 4.0 (THEORY)

Module	Contents	Hrs
1	**Introduction & Architecture**	**03**
1.1	What is IIoT and the Connected world?	
1.2	SCADA Vs. IoT	
1.3	Architecture of IIoT	
1.4	IoT node, Challenges of IIoT	
2	**IIoT Components**	**05**
2.1	Fundamentals of Control System: Introduction, Components, Closed loop & Open loop system.	
2.2	Sensors and Interfacing: Introduction to Sensors, Classification, Role of Sensors in IIoT, Various types of Sensors, Special requirements for IIoT sensors.	
2.3	Role of Actuators, Types of Actuators.	
2.4	Hardwire the sensors with different protocols such as HART, MODBUS-Serial & Parallel, Ethernet, BACnet, Current, M2M etc..	
3	**Implementation and Deployment Challenges in Industrial IoT**	**06**
3.1	Interoperability and Compatibility: Challenges in achieving seamless interoperability, Standardization issues across platforms, API integration and communication protocols	
3.2	Security Concerns: Common security vulnerabilities, Threat detection and mitigation strategies, Secure authentication and access controls	
3.3	Cybersecurity Risks: Emerging threats in the digital landscape, Role of encryption and secure data transmission, Risk assessment frameworks	
3.4	Data Privacy: Compliance with data protection regulations (e.g., GDPR, PDPB), Data anonymization and protection techniques, Ethical concerns in data handling	
3.5	System Scalability: Vertical vs. horizontal scaling strategies, Cloud vs. on premise scalability considerations, Resource optimization techniques	
3.6	Legacy Systems Integration: Challenges in modernizing legacy systems, Hybrid approaches for smooth transition, Cost vs. benefit analysis of upgrading vs. replacing.	
4	**Communication Protocols**	**04**
4.1	Importance of using MODBUS in IIOT Applications.	
4.2	MQTT vs. MQTTS .	

4.3	Cloud / Server architectural requirements for IIOT Applications.	
5	**Control & Supervisory Level of Automation**	**04**
5.1	Programmable logic controller (PLC)	
5.2	Control signal introduction, Digital I/O, Analog I/O, 4-20mA systems	
5.3	Supervisory Control & Data Acquisition (SCADA)	
5.4	Need of Human machine Interface (HMI) in Automation	
5.5	Basics of Enterprise Resource Planning (ERP) System & Manufacturing Execution System (MES)	
6	**Applications of IIOT**	**04**
6.1	Case study of Chemical Tank Level Monitoring application through HMI	
6.2	Case study on IIOT cloud integration with Microsoft Azure, AWS & other cloud services like Ubidots or Thingspeak,	
6.3	Case study on AWS Industrial IoT Predictive Maintenance	
Total		**26**

Textbooks:	
1	Introduction to Industrial Internet of Things and Industry 4.0, 1st Edition, Sudip Misra, CRC Press.
2	Practical Industrial Internet of Things Security: A practitioner's guide to securing connected Industries, Sravani Bhattacharjee.
3	Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications, by Daniel Minoli, Bernd Scholz-Reiter, Florian, Willy Publication.
4	Architecting the Internet of Things, by Florian Michahelles, Springer, 2011.
Reference books:	
1	The Internet of Things in the Industrial Sector, Mahmood, Zaigham (Ed.), Springer Publication.
2	Industrial Internet of Things: Cyber manufacturing System, Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat , Springer Publication.
3	Industrial IoT Challenges, Design Principles, Applications, and Security by Ismail Butun (Editor), Springer Publications.

Useful additional resources:	
1	https://aws.amazon.com/iot/solutions/industrial-iot/
2	Security of the Internet of Things:Vulnerabilities, Attacks and Countermeasures by Ismail Butun, Member, IEEE, Patrik Osterberg, ¨Member, IEEE, and Houbing Song, Senior Member, IEEE.

Internal Assessment:	
1	Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2	Mid Term test is to be conducted when approx. 50% syllabus is completed.
3	Duration of the midterm test shall be one hour.

Continuous Assessment:

Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon pertaining to the course.	10 marks
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4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk/competition followed by a small report and certificate of participation relevant to the subject	05 marks
8	Multiple Choice Questions (Quiz)	05 marks
9	Literature review of papers/journals.	05 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks.
2	Question paper will have a total of five questions.
3	All questions have equal weightage and carry 20 marks each.
4	Any three questions out of five needs to be solved.

ASIC FLOW DESIGN (LAB)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tut	Total
NECVS 61	ASIC Flow Design (Lab)	---	02	---	---	01	---	01

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NECVS 61	ASIC Flow Design (Lab)	---	---	---	25	25	50

Course Prerequisites: Basic Course on Digital Circuits (typically taught in the first/second year of UG Program)	
Lab Objectives:	
1	Familiarize students with each stage of the ASIC/SoC physical design flow.
2	Teach the use of industry-standard EDA tools for synthesis, floor planning, placement, clock tree synthesis (CTS), and routing.
3	Emphasize timing, power, and area optimization techniques.
4	Develop problem-solving skills related to practical physical design challenges and design rule compliance.
Lab Outcomes: After successful completion of the lab course students will be able to:	
1	Understand the RTL-to-GDSII flow in modern digital IC design and explain the purpose of each stage in the VLSI backend process.

2	Perform synthesis from RTL to gate-level netlist using synthesis tools, optimizing for area, power, and performance.
3	Execute floorplanning and placement while understanding power planning, pin assignment, and congestion issues.
4	Implement Clock Tree Synthesis (CTS) and optimize timing parameters such as skew and latency.
5	Carry out routing and physical verification including DRC, LVS, and antenna checks.
6	Apply industry-standard tools (like Cadence, Synopsys, or Siemens EDA) to complete a physical design project from RTL to GDSII.

Suggested Experiments:	
Sr.No.	**Name of the Experiments**
1	Overview of Digital ASIC Design Flow, Introduction to LINUX.
2	RTL Coding in Verilog, Simulation.
3	Test Bench Design , Verification and Testing.
4	RTL Synthesis, Introduction to TCL, TCL Scripting for synthesis.
5	Start of Physical Design: Import, Floorplan, IO fillers, and Power plan.
6	Logical Equivalence Checking , post synthesis simulations.
7	Placement, Clock Tree Synthesis and STA.
8	Routing, std. cell fillers, Block level DRC, Dummy Fill, Chip level DRC, Antenna DRC and LVS etc ECO post route.
9	Post Route netlist simulations, Power Analysis.
10	Export GDS, Miniproject Specification.
11	Miniproject Implementation.

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

References:	
1	Link: http://www.vlsi-expert.com/p/static-timing-analysis.html
2	https://c2s.gov.in/Completed_Training.jsp
3	RTL to GDS CVN REDDY SEELAM
4	Link: https://archive.nptel.ac.in/courses/106/105/106105161/
5	Link: https://www.udemy.com/course/vlsi-academy-sta-checks/
6	Link: https://www.udemy.com/course/vlsi-academy-physical-design-flow/
7	Link: https://www.youtube.com/c/Vlsi-expert/playlists
8	Link: https://www.vlsisystemdesign.com/inception-content-vsd/

9	Book for STA: Static Timing Analysis for Nanometer Designs: A Practical Approach by Jayaram Bhasker and Rakesh Chadha
10	Book: Advanced ASIC Chip Synthesis Using Synopsys Tools by Himanshu Bhatnagar
11	Book: Constraining Designs for Synthesis and Timing Analysis: A Practical Guide to Synopsys Design by Sridhar Gangadharan & Sanjay Churiwala
12	Book: Physical design essentials: an ASIC design implementation perspective by Khosrow Golshan
13	Book: Algorithms for VLSI Physical Design Automation by Sherwani, N. A.

Term-Work:	
1	Term work should consist of 10 experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks (Experiments: 15-marks, Term work Assessment: 10-marks)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NECPCP61	Project – I	---	4#	---	---	02	---	02

 # indicate workload of learner not faculty

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NECPCP61	Project – I	---	---	---	50	50	100

Course Objectives:	
1	To acquaint with the process of identifying the needs and converting it into the problem.
2	To familiarize the process of solving the problem in a group.
3	To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4	To inculcate the process of self-learning and research.
Course Outcomes: After successful completion of the course students will be able to:	
1	Identify problems based on societal /research needs.
2	Apply knowledge and skill to solve societal problems in a group.
3	Develop interpersonal skills to work as member of a group or leader.
4	Draw the proper inferences from available results through theoretical/experimental/simulations.
5	Analyze the impact of solutions in societal and environmental context for sustainable development.

6	Use standard norms of engineering practices.
7	Excel in written and oral communication.
8	Demonstrate capabilities of self-learning in a group, which leads to life-long learning.
9	Demonstrate project management principles during project work

Guidelines for Project	
1	Students should form groups with minimum 2(two) and not more than 4 (four)
2	Students should do survey and identify needs, which shall be converted into problem statement for major project in consultation with faculty supervisor/head of department/internal committee of faculties.
3	Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of the project.

Log book	
1	A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
2	Faculty supervisor may give inputs to students during major project activity; however, focus shall be on self-learning.
3	Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
4	Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
5	The solution to be validated with proper justification and report to be compiled in standard format.
6	With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Projects.

Guidelines for Assessment of the Project-I:

Term Work

1	The review/ progress monitoring committee shall be constituted by head of departments. The progress of project to be evaluated on continuous basis, minimum two reviews in the semester.
2	In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

Distribution of Term work marks for both semesters shall be as below;

1	In VI semester entire theoretical solution shall be ready, including components/system selection and cost analysis.
2	Two reviews will be conducted based on the presentation given by the student group.
3	First shall be for finalization of problem
4	Second shall be on finalization of proposed solution of problem.

Assessment criteria of Project-I
Project - I shall be assessed based on following criteria:

1	Quality of survey/ need identification.
2	Clarity of Problem definition based on need.
3	Innovativeness in solutions
4	Feasibility of proposed problem solutions and selection of best solution
5	Cost effectiveness
6	Societal impact
7	Innovativeness

Guidelines for Assessment of Project-I Practical/Oral Examination:

Report should be prepared as per the guidelines issued by the department.

Project-I shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations, having experience of more than five years approved by head of the Institute.
Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Project-I shall be assessed based on following points;

1	Quality of problem and Clarity
2	Innovativeness in solutions
3	Cost effectiveness and Societal impact

4	Full functioning of working model as per stated requirements
5	Effective use of diversified skill-set
6	Effective use of standard engineering practices & norms
7	Contribution of an individual's as a member or Leader
8	Clarity in written and oral communication