SEMESTER 3

ELECTRONICS & COMPUTER ENGINEERING

SEMESTER S3

Mathematics for Electrical Science and Physical Science – 3

(Common to B & C Groups)

Course Code	**GYMAT301**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	Basic knowledge in complex numbers.	**Course Type**	Theory

Course Objectives:

1. To introduce the concept and applications of Fourier transforms in various engineering fields.
2. To introduce the basic theory of functions of a complex variable, including residue integration and conformal transformation, and their applications

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fourier Integral, From Fourier series to Fourier Integral, Fourier Cosine and Sine integrals, Fourier Cosine and Sine Transform, Linearity, Transforms of Derivatives, Fourier Transform and its inverse, Linearity, Transforms of Derivative. **(Text 1: Relevant topics from sections 11.7, 11.8, 11.9)**	**9**
2	Complex Function, Limit, Continuity, Derivative, Analytic functions, Cauchy-Riemann Equations (without proof), Laplace's Equations, Harmonic functions, Finding harmonic conjugate, Conformal mapping, Mappings of *w*=z2, w=ez,*w*=1z, w=sinz. **(Text 1: Relevant topics from sections 13.3, 13.4, 17.1, 17.2, 17.4)**	**9**
3	Complex Integration: Line integrals in the complex plane (Definition & Basic properties), First evaluation method, Second evaluation method, Cauchy's integral theorem (without proof) on simply connected domain, Independence of	**9**

	path, Cauchy integral theorem on multiply connected domain (without proof), Cauchy Integral formula (without proof). **(Text 1: Relevant topics from sections 14.1, 14.2, 14.3)**	
4	Taylor series and Maclaurin series, Laurent series (without proof), Singularities and Zeros – Isolated Singularity, Poles, Essential Singularities, Removable singularities, Zeros of Analytic functions – Poles and Zeros, Formulas for Residues, Residue theorem (without proof), Residue Integration- Integral of Rational Functions of $\cos\theta$ and $\sin\theta$. **(Text 1: Relevant topics from sections 15.4, 16.1, 16.2, 16.3, 16.4)**	**9**

Course Assessment Method
(CIE: 40 marks , ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination-2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Determine the Fourier transforms of functions and apply them to solve problems arising in engineering.	**K3**
CO2	Understand the analyticity of complex functions and apply it in conformal mapping.	**K3**
CO3	Compute complex integrals using Cauchy's integral theorem and Cauchy's integral formula.	**K3**
CO4	Understand the series expansion of complex function about a singularity and apply residue theorem to compute real integrals.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Advanced Engineering Mathematics	Erwin Kreyszig	John Wiley & Sons	10th edition, 2016

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Complex Analysis	Dennis G. Zill, Patrick D. Shanahan	Jones & Bartlett	3rd edition, 2015
2	Higher Engineering Mathematics	B. V. Ramana	McGraw-Hill Education	39th edition, 2023
3	Higher Engineering Mathematics	B.S. Grewal	Khanna Publishers	44th edition, 2018
4	Fast Fourier Transform - Algorithms and Applications	K.R. Rao, Do Nyeon Kim, Jae Jeong Hwang	Springer	1st edition, 2011

SEMESTER S3

DATA STRUCTURES

Course Code	PCERT 302	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	UCEST105-Algorithmic thinking with python GBEST204 – Programming in C	Course Type	Theory

Course Objectives:

1. To impart a thorough understanding of linear data structures such as arrays, stacks, queues and linked lists and their applications.
2. To impart a thorough understanding of non-linear data structures such as trees, graphs and their applications.
3. To impart familiarity with various sorting, searching and hashing techniques and their performance comparison.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basic Concepts of Data Structures: Algorithms, Performance Analysis, Space Complexity, Time Complexity, Asymptotic Notations Arrays: Linear Search and Binary Search, Stacks, Queues-Circular Queues,Priority Queues, Double Ended Queues, Evaluation of Expressions	11
2	Linked List: Self-Referential Structures, Dynamic Memory Allocation, Singly Linked List- Operations on Linked List. Doubly Linked List, Circular Linked List, Stacks and Queues using Linked List, Polynomial representation using Linked List	11
3	Trees and Graphs: Trees, Binary Trees-Tree Operations, Binary Tree Representation, Tree Traversals, Binary SearchTrees- Binary Search Tree OperationsGraphs, Representation of Graphs, Depth First Search and Breadth First Search on Graphs, Applications of Graphs	11
4	Sorting and Hashing: Sorting Techniques – Selection Sort, Insertion Sort, Quick Sort, Merge Sort and Heap Sort	11

	Hashing- Hashing Techniques, Collision Resolution, Overflow handling, Hashing functions – Mid square, Division,Folding, Digit Analysis	

Course Assessment Method
(CIE: 40 marks,ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Compare performance of algorithms using asymptotic notations	**K2**
CO2	Solve real world problems efficiently using appropriate data structures like arrays, linked list, stacks and queues.	**K3**
CO3	Make use of nonlinear data structures like trees and graphs to design algorithms for various applications.	**K3**
CO4	Apply and compare various techniques for searching and sorting.	**K3**
CO5	Apply appropriate hash function to store and access a given dataset	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Fundamentals of Data Structures in C	Ellis Horowitz,SartajSahni and Susan Anderson-Freed	Universities Press	2/e,2008
2	Classic Data Structures	Samanta D	Prentice Hall India	2/e, 2009

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Data Structures: A Pseudocode Approach with C	Richard F. Gilberg, Behrouz A. Forouzan	Cengage Learning	2/e, 2007
2	Data Structures and Algorithms	Aho A. V., J. E. Hopcroft and J. D. Ullman	Pearson Publication	1983
3	Introduction to Data Structures with Applications	Tremblay J. P. and P. G. Sorenson	Tata McGraw Hill	1995
4	Advanced Data Structures	Peter Brass	Cambridge University Press	2008
5	Theory and Problems of Data Structures	Lipschuts S.	Schaum's Series	1986

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/106102064 https://youtu.be/zWg7U0OEAoE https://youtu.be/g1USSZVWDsY https://youtu.be/PGWZUgzDMYI
2	https://nptel.ac.in/courses/106102064 https://youtu.be/PGWZUgzDMYI
3	https://nptel.ac.in/courses/106102064 https://youtu.be/tORLeHHtazM https://youtu.be/eWeqqVpgNPg https://youtu.be/9zpSs845wf8
4	https://youtu.be/KW0UvOW0XIo https://youtu.be/gtWw_8VvHjk

SEMESTER S3

DIGITAL SYSTEM DESIGN USING VERILOG

Course Code	**PCERT 303**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	**ESE Marks**	60
Credits	4	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	Digital Electronics	**Course Type**	Theory

Course Objectives:

1. This course enables students to design/model Digital systems, consisting of combinational and sequential circuits, using Verilog HDL.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Verilog HDL: Evolution of CAD, emergence of HDLs, typical HDL-based design flow, Importance of Verilog HDL, trends in HDLs. Hierarchical Modelling Concepts -Top-down and bottom-up design methodology. Basic Concepts of Lexical conventions, data types.	**10**
2	Verilog for Digital Logic Design: Dataflow, behavioural, structural modelling. Verilog implementation of basic gates &combinational circuits (Half adder& full adder, Half subtractor & full subtractor, decoder, encoder, multiplexer, demultiplexer), simple test bench for combinational circuits. Modelling of flipflops in Verilog (with test bench).	**12**
3	Finite State machine: State diagram, State Table, State assignments, state graphs, capabilities and limitations of FSM. Mealy and Moore machines, Modelling of clocked synchronous circuits as Mealy and Moore machines: Serial binary adder, sequence detector design examples.	**12**

4	Introduction to FPGAs: Evolution of Programmable Devices, what is an FPGA - Logic Blocks, Interconnection Resources, Applications of FPGAs, Implementation Process. Programming Technologies - Static RAM Programming Technology, Anti-fuse Programming Technology, EPROM and EEPROM Programming Technology. Xilinx FPGA - Xilinx XC2000. FPGA Design Flow Example.	**10**

Course Assessment Method
(CIE: 40 marks , ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Understand the programming concepts in Verilog HDL.	**K2**
CO2	Design and implement combinational and sequential digital circuits using Verilog HDL, incorporating test benches for verification.	**K3**
CO3	Apply the concepts of finite state machines (FSMs) to design synchronous digital circuits.	**K3**
CO4	Explain the fundamental principles of Field-Programmable Gate Arrays (FPGAs), including their architecture, programming technologies, and design flow.	**K2**

Note: *K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Fundamentals of Digital Design	Charles H. Roth	Thomson Press (India) Ltd	7th Edition, 2015
2	Verilog HDL A Guide to Digital Design & Synthesis	Samir Palitkar	Pearson	2nd Edition, 2003
3	Field-Programmable Gate Arrays	Stephen D. Brown	Springer	1st Edition, 2012
4	Digital Design with an Introduction to the Verilog HDL	Mano M.M, Ciletti M.D	Pearson	6th Edition, 2022

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to digital systems	Milos D. Ercegovac	John Wiley Sons	1/e 1998
2	Digital Fundamentals	Thomas L Floyd	Pearson Education	10th Edition, 2009
3	Digital Principles and Design	Donald D Givone	Tata McGraw Hill	1st Edition, 2003
4	Fundamentals of Digital Circuits	A. Ananthakumar	Prentice Hall	2nd Edition, 2016
5	Fundamentals of Digital Logic with Verilog HDL	S Brown & Z. Varanestic,	Mc Graw Hill.	2nd Edition, 2007

Video Links (NPTEL, SWAYAM…)	
Module No.	Link ID
1	NPTEL : Computer Science and Engineering - NOC: Hardware Modeling Using Verilog; Prof. Indranil Sen Gupta, IIT Kharagpur; Lecture 9 https://archive.nptel.ac.in/courses/106/105/106105165/
2	NPTEL : Electrical Engineering - NOC: Digital System Design; Prof. Neeraj Goel, IIT Ropar; Lecture 20 https://archive.nptel.ac.in/courses/108/106/108106177/
3	NPTEL : Electrical Engineering - NOC: Digital System Design; Prof. Neeraj Goel, IIT Ropar; Lecture 51 https://archive.nptel.ac.in/courses/108/106/108106177/
4	NPTEL : Electrical Engineering - NOC: Digital System Design; Prof. Neeraj Goel , IIT Ropar; Lecture 65 https://archive.nptel.ac.in/courses/108/106/108106177/

SEMESTER S3

ELECTRONIC DEVICES AND CIRCUITS

Course Code	**PBERT 304**	**CIE Marks**	60
Teaching Hours/Week (L: T:P: R)	3:0:0:1	**ESE Marks**	40
Credits	4	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To develop the skill of the design of various analog circuits.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Wave shaping circuits and Transistors:** First order RC low pass and high pass filters. First order RC differentiating and integrating circuits, Diode Clipping circuits. Diode Clamping circuits. Bipolar Junction Transistors: Review of BJT characteristics- Operating point of BJT – Factors affecting stability of Q-point. DC Biasing–Biasing circuits: fixed bias, collector to base bias, voltage divider bias. Stability factor. Transistor as switch	9
2	**BJT Amplifiers:** RC coupled amplifier (CE configuration)–need of various components and design, Concept of AC load lines, voltage gain and frequency response. Small signal analysis of CE configuration using small signal hybrid-pi model for mid frequency and low frequency. (Gain, input and output impedance). High frequency equivalent circuits of BJT Multistage amplifiers: Direct, RC, transformer coupled Amplifiers, Applications. Power amplifiers using BJT: Class A, Class B, Class AB, Class C and Class D. Conversion efficiency – Derivation (Class A and Class B). Distortion in power amplifiers.	9
3	**Wave Generating circuits: Multivibrator and Oscillator Circuits:**	9

	Multivibrators - Types of multivibrators (Astable and monostable) - Feedback concepts, Barkhausen's criterion for oscillation - Types of oscillators – RC phase shift, Wien bridge, crystal oscillators. (Analysis of RC phase shift and Wien bridge oscillator required)	
4	**Feedback amplifiers and Power supplies**: Effect of positive and negative feedback on gain, frequency response and distortion. The four basic feedback topologies, Analysis of discrete BJT circuits in voltage-series and voltage-shunt feedback topologies - voltage gain, input and output impedance. Regulated power supply: Shunt voltage regulator, series voltage regulator, Short circuit protection and fold back protection, Output current boosting, SMPS.	**9**

Suggestion on Project Topics

Course Assessment Method
(CIE: 60 marks, ESE: 40 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Project	Internal Ex-1	Internal Ex-2	Total
5	30	12.5	12.5	60

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 2 marks **(8x2 =16 marks)**	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 6 marks. **(4x6 = 24 marks)**	**40**

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Design analog signal processing circuits using diodes and first order RC circuits.	**K3**
CO2	Analyse various transistor biasing circuits and BJT amplifier circuits.	**K3**
CO3	Design and analyse the wave-shaping multivibrator and oscillator circuits using BJT	**K3**
CO4	Design and develop feedback amplifiers and regulated power supplies	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Electronic Devices and Circuit Theory	Robert Boylestad and L Nashelsky	Pearson	11/e, 2015
2	Microelectronic Circuits	Sedra A.S and K.C. Smith	Oxford University Press	6/e,2013
3	Electronic Circuits, Analysis and Design	Neamen D	TMH	3/e,2007

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Fundamentals of Microelectronics	Razavi B	Wiley	2015
2	Integrated Electronics	Millman J.andC.Halkias	McGraw-Hill	2/e, 2010.
3	Microelectronic Circuits- Analysis and Design	Rashid M.H.,	Cengage Learning	2/e, 2011
4	Electronic Devices and Circuits	David A Bell	Oxford University Press	2008.

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/117/103/117103063
2	https://archive.nptel.ac.in/courses/117/103/117103063
3	https://archive.nptel.ac.in/courses/117/103/117103063
4	https://archive.nptel.ac.in/courses/117/103/117103063

PBL Course Elements

L: Lecture (3 Hrs.)	**R: Project (1 Hr.), 2 Faculty Members**		
	Tutorial	**Practical**	**Presentation**
Lecture delivery	Project identification	Simulation/ Laboratory Work/ Workshops	Presentation (Progress and Final Presentations)
Group discussion	Project Analysis	Data Collection	Evaluation
Question answer Sessions/ Brainstorming Sessions	Analytical thinking and self-learning	Testing	Project Milestone Reviews, Feedback, Project reformation (If required)
Guest Speakers (Industry Experts)	Case Study/ Field Survey Report	Prototyping	Poster Presentation/ Video Presentation: Students present their results in a 2 to 5 minutes video

Assessment and Evaluation for Project Activity

Sl. No	Evaluation for	Allotted Marks
1	Project Planning and Proposal	5
2	Contribution in Progress Presentations and Question Answer Sessions	4
3	Involvement in the project work and Team Work	3
4	Execution and Implementation	10
5	Final Presentations	5
6	Project Quality, Innovation and Creativity	3
Total		**30**

1. Project Planning and Proposal (5 Marks)

- Clarity and feasibility of the project plan
- Research and background understanding
- Defined objectives and methodology

2. Contribution in Progress Presentation and Question Answer Sessions (4 Marks)

- Individual contribution to the presentation
- Effectiveness in answering questions and handling feedback

3. Involvement in the Project Work and Team Work (3 Marks)

- Active participation and individual contribution
- Teamwork and collaboration

4. Execution and Implementation (10 Marks)

- Adherence to the project timeline and milestones
- Application of theoretical knowledge and problem-solving
- Final Result

5. **Final Presentation (5 Marks)**
    - Quality and clarity of the overall presentation
    - Individual contribution to the presentation
    - Effectiveness in answering questions

6. **Project Quality, Innovation, and Creativity (3 Marks)**
    - Overall quality and technical excellence of the project
    - Innovation and originality in the project
    - Creativity in solutions and approaches

SEMESTER S3

INTRODUCTION TO ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

Course Code	**GNEST305**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	**ESE Marks**	60
Credits	4	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. Demonstrate a solid understanding of advanced linear algebra concepts, machine learning algorithms and statistical analysis techniques relevant to engineering applications, principles and algorithms.
2. Apply theoretical concepts to solve practical engineering problems, analyze data to extract meaningful insights, and implement appropriate mathematical and computational techniques for AI and data science applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to AI and Machine Learning**: Basics of Machine Learning - types of Machine Learning systems-challenges in ML- Supervised learning model example- regression models- Classification model example- Logistic regression-unsupervised model example- K-means clustering. Artificial Neural Network- Perceptron- Universal Approximation Theorem (statement only)- Multi-Layer Perceptron- Deep Neural Network- demonstration of regression and classification problems using MLP.(Text-2)	**11**
2	**Mathematical Foundations of AI and Data science**: Role of linear algebra in Data representation and analysis – Matrix decomposition- Singular Value Decomposition (SVD)- Spectral decomposition- Dimensionality reduction technique-Principal Component Analysis (PCA). (Text-1)	**11**

3	**Applied Probability and Statistics for AI and Data Science**: Basics of probability-random variables and statistical measures - rules in probability-Bayes theorem and its applications- statistical estimation-Maximum Likelihood Estimator (MLE) - statistical summaries- Correlation analysis-linear correlation (direct problems only)- regression analysis- linear regression (using least square method) (Text book 4)	11
4	**Basics of Data Science**: Benefits of data science-use of statistics and Machine Learning in Data Science- data science process - applications of Machine Learning in Data Science- modelling process- demonstration of ML applications in data science- Big Data and Data Science. (For visualization the software tools like Tableau, PowerBI, R or Python can be used. For Machine Learning implementation, Python, MATLAB or R can be used.)(Text book-5)	11

Course Assessment Method
(CIE: 40 marks , ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination-2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Apply the concept of machine learning algorithms including neural networks and supervised/unsupervised learning techniques for engineering applications.	**K3**
CO2	Apply advanced mathematical concepts such as matrix operations, singular values, and principal component analysis to analyze and solve engineering problems**.**	**K3**
CO3	Analyze and interpret data using statistical methods including descriptive statistics, correlation, and regression analysis to derive meaningful insights and make informed decisions.	**K3**
CO4	Integrate statistical approaches and machine learning techniques to ensure practically feasible solutions in engineering contexts.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Linear Algebra	Gilbert Strang	Wellesley-Cambridge Press	6th edition, 2023
2	Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow	Aurélien Géron	O'Reilly Media, Inc.	2nd edition,2022
3	Mathematics for machine learning	Deisenroth, Marc Peter, A. Aldo Faisal, and Cheng Soon Ong	Cambridge University Press	1st edition. 2020
4	Fundamentals of mathematical statistics	Gupta, S. C., and V. K. Kapoor	Sultan Chand & Sons	9th edition, 2020
5	Introducing data science: big data, machine learning, and more, using Python tools	Cielen, Davy, and Arno Meysman	Simon and Schuster	1st edition, 2016

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Data science: concepts and practice	Kotu, Vijay, and Bala Deshpande	Morgan Kaufmann	2nd edition, 2018
2	Probability and Statistics for Data Science	Carlos Fernandez-Granda	Center for Data Science in NYU	1st edition, 2017
3	Foundations of Data Science	Avrim Blum, John Hopcroft, and Ravi Kannan	Cambridge University Press	1st edition, 2020
4	Statistics For Data Science	James D. Miller	Packt Publishing	1st edition, 2019
5	Probability and Statistics -The Science of Uncertainty	Michael J. Evans and Jeffrey S. Rosenthal	University of Toronto	1st edition, 2009
6	An Introduction to the Science of Statistics: From Theory to Implementation	Joseph C. Watkins	chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.math.arizo	Preliminary Edition.

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/106/106106198/
2	https://archive.nptel.ac.in/courses/106/106/106106198/ https://ocw.mit.edu/courses/18-06-linear-algebra-spring-2010/resources/lecture-29-singular-value-decomposition/
3	https://ocw.mit.edu/courses/18-650-statistics-for-applications-fall-2016/resources/lecture-19-video/
4	https://archive.nptel.ac.in/courses/106/106/106106198/

SEMESTER S3/S4

ECONOMICS FOR ENGINEERS

Course Code	**UCHUT346**	**CIE Marks**	50
Teaching Hours/Week (L: T:P: R)	2:0:0:0	**ESE Marks**	50
Credits	2	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. Understanding of finance and costing for engineering operation, budgetary planning and control
2. Provide fundamental concept of micro and macroeconomics related to engineering industry
3. Deliver the basic concepts of Value Engineering.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basic Economics Concepts - Basic economic problems – Production Possibility Curve – Utility – Law of diminishing marginal utility – Law of Demand - Law of supply – Elasticity - measurement of elasticity and its applications – Equilibrium- Changes in demand and supply and its effects Production function - Law of variable proportion – Economies of Scale – Internal and External Economies – Cobb-Douglas Production Function	**6**
2	Cost concepts – Social cost, private cost – Explicit and implicit cost – Sunk cost - Opportunity cost - short run cost curves - Revenue concepts Firms and their objectives – Types of firms – Markets - Perfect Competition – Monopoly - Monopolistic Competition - Oligopoly (features and equilibrium of a firm)	**6**

3	Monetary System – Money – Functions - Central Banking –Inflation - Causes and Effects – Measures to Control Inflation - Monetary and Fiscal policies – Deflation Taxation – Direct and Indirect taxes (merits and demerits) - GST National income – Concepts - Circular Flow – Methods of Estimation and Difficulties - Stock Market – Functions- Problems faced by the Indian stock market-Demat Account and Trading Account – Stock market Indicators- SENSEX and NIFTY	**6**
4	Value Analysis and value Engineering - Cost Value, Exchange Value, Use Value, Esteem Value - Aims, Advantages and Application areas of Value Engineering - Value Engineering Procedure - Break-even Analysis - Cost-Benefit Analysis - Capital Budgeting - Process planning	**6**

Course Assessment Method
(CIE: 40 marks , ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Case Study/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the fundamentals of various economic issues using laws and learn the concepts of demand, supply, elasticity and production function.	**K2**
CO2	Develop decision making capability by applying concepts relating to costs and revenue, and acquire knowledge regarding the functioning of firms in different market situations.	**K3**
CO3	Outline the macroeconomic principles of monetary and fiscal systems, national income and stock market.	**K2**
CO4	Make use of the possibilities of value analysis and engineering, and solve simple business problems using break even analysis, cost benefit analysis and capital budgeting techniques.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Managerial Economics	Geetika, Piyali Ghosh and Chodhury	Tata McGraw Hill,	2015
2	Engineering Economy	H. G. Thuesen, W. J. Fabrycky	PHI	1966
3	Engineering Economics	R. Paneerselvam	PHI	2012

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Engineering Economy	Leland Blank P.E, Anthony Tarquin P. E.	Mc Graw Hill	7^{TH} Edition
2	Indian Financial System	Khan M. Y.	Tata McGraw Hill	2011
3	Engineering Economics and analysis	Donald G. Newman, Jerome P. Lavelle	Engg. Press, Texas	2002
4	Contemporary Engineering Economics	Chan S. Park	Prentice Hall of India Ltd	2001

SEMESTER S3/S4
ENGINEERING ETHICS AND SUSTAINABLE DEVELOPMENT

Course Code	UCHUT347	**CIE Marks**	50
Teaching Hours/Week (L: T:P: R)	2:0:0:0	**ESE Marks**	50
Credits	2	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. Equip with the knowledge and skills to make ethical decisions and implement gender-sensitive practices in their professional lives.
2. Develop a holistic and comprehensive interdisciplinary approach to understanding engineering ethics principles from a perspective of environment protection and sustainable development.
3. Develop the ability to find strategies for implementing sustainable engineering solutions.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Fundamentals of ethics** - Personal vs. professional ethics, Civic Virtue, Respect for others, **Profession and Professionalism,** Ingenuity, diligence and responsibility, Integrity in design, development, and research domains, Plagiarism, a balanced outlook on law - challenges - case studies, **Technology and digital revolution**-Data, information, and knowledge, Cybertrust and cybersecurity, Data collection & management, **High technologies: connecting people and places**-accessibility and social impacts, **Managing conflict**, Collective bargaining, **Confidentiality**, Role of confidentiality in moral integrity, **Codes of Ethics**. **Basic concepts in Gender Studies** - sex, gender, sexuality, gender spectrum: beyond the binary, gender identity, gender expression, gender stereotypes, **Gender disparity and discrimination in education**, employment and everyday life, History of women in	**6**

	Science & Technology, Gendered technologies & innovations**, Ethical values and practices in connection with gender** - equity, diversity & gender justice, **Gender policy and women/transgender empowerment initiatives.**	
2	**Introduction to Environmental Ethics:** Definition, importance and historical development of environmental ethics, key philosophical theories (anthropocentrism, biocentrism, ecocentrism). **Sustainable Engineering Principles:** Definition and scope, triple bottom line (economic, social and environmental sustainability), life cycle analysis and sustainability metrics. **Ecosystems and Biodiversity:** Basics of ecosystems and their functions, Importance of biodiversity and its conservation, Human impact on ecosystems and biodiversity loss, An overview of various ecosystems in Kerala/India, and its significance. **Landscape and Urban Ecology:** Principles of landscape ecology, Urbanization and its environmental impact, Sustainable urban planning and green infrastructure.	**6**
3	**Hydrology and Water Management:** Basics of hydrology and water cycle, Water scarcity and pollution issues, Sustainable water management practices, Environmental flow, disruptions and disasters. **Zero Waste Concepts and Practices:** Definition of zero waste and its principles, Strategies for waste reduction, reuse, reduce and recycling, Case studies of successful zero waste initiatives. **Circular Economy and Degrowth:** Introduction to the circular economy model, Differences between linear and circular economies, degrowth principles, Strategies for implementing circular economy practices and degrowth principles in engineering. **Mobility and Sustainable Transportation:** Impacts of transportation on the environment and climate, Basic tenets of a Sustainable Transportation design, Sustainable urban mobility solutions, Integrated mobility systems, E-Mobility, Existing and upcoming models of sustainable mobility solutions.	**6**
4	**Renewable Energy and Sustainable Technologies:** Overview of renewable energy sources (solar, wind, hydro, biomass), Sustainable	**6**

	technologies in energy production and consumption, Challenges and opportunities in renewable energy adoption. **Climate Change and Engineering Solutions:** Basics of climate change science, Impact of climate change on natural and human systems, Kerala/India and the Climate crisis, Engineering solutions to mitigate, adapt and build resilience to climate change. **Environmental Policies and Regulations:** Overview of key environmental policies and regulations (national and international), Role of engineers in policy implementation and compliance, Ethical considerations in environmental policy-making. **Case Studies and Future Directions:** Analysis of real-world case studies, Emerging trends and future directions in environmental ethics and sustainability, Discussion on the role of engineers in promoting a sustainable future.	

Course Assessment Method
(CIE: 50 marks , ESE: 50)

Continuous Internal Evaluation Marks (CIE):

Continuous internal evaluation will be based on individual and group activities undertaken throughout the course and the portfolio created documenting their work and learning. The portfolio will include reflections, project reports, case studies, and all other relevant materials.

- The students should be grouped into groups of size 4 to 6 at the beginning of the semester. These groups can be the same ones they have formed in the previous semester.
- Activities are to be distributed between 2 class hours and 3 Self-study hours.
- The portfolio and reflective journal should be carried forward and displayed during the 7th Semester Seminar course as a part of the experience sharing regarding the skills developed through various courses.

Sl. No.	Item	Particulars	Group /Individual (G/I)	Marks
1	Reflective Journal	Weekly entries reflecting on what was learned, personal insights, and how it can be applied to local contexts.	I	5
2	Micro project (Detailed documentation of the project, including methodologies, findings, and reflections)	1 a) Perform an Engineering Ethics Case Study analysis and prepare a report 1 b) Conduct a literature survey on 'Code of Ethics for Engineers' and prepare a sample code of ethics	G	8
		2. Listen to a TED talk on a Gender-related topic, do a literature survey on that topic and make a report citing the relevant papers with a specific analysis of the Kerala context	G	5
		3. Undertake a project study based on the concepts of sustainable development* - Module II, Module III & Module IV	G	12
3	Activities	2. One activity* each from Module II, Module III & Module IV	G	15
4	Final Presentation	A comprehensive presentation summarising the key takeaways from the course, personal reflections, and proposed future actions based on the learnings.	G	5
		Total Marks		**50**

*Can be taken from the given sample activities/projects

Evaluation Criteria:

- **Depth of Analysis**: Quality and depth of reflections and analysis in project reports and case studies.
- **Application of Concepts**: Ability to apply course concepts to real-world problems and local contexts.
- **Creativity**: Innovative approaches and creative solutions proposed in projects and reflections.
- **Presentation Skills**: Clarity, coherence, and professionalism in the final presentation.

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Develop the ability to apply the principles of engineering ethics in their professional life.	**K3**
CO2	Develop the ability to exercise gender-sensitive practices in their professional lives	**K4**
CO3	Develop the ability to explore contemporary environmental issues and sustainable practices.	**K5**
CO4	Develop the ability to analyse the role of engineers in promoting sustainability and climate resilience.	**K4**
CO5	Develop interest and skills in addressing pertinent environmental and climate-related challenges through a sustainable engineering approach.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

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

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Ethics in Engineering Practice and Research	Caroline Whitbeck	Cambridge University Press & Assessment	2nd edition & August 2011
2	Virtue Ethics and Professional Roles	Justin Oakley	Cambridge University Press & Assessment	November 2006
3	Sustainability Science	Bert J. M. de Vries	Cambridge University Press & Assessment	2nd edition & December 2023
4	Sustainable Engineering Principles and Practice	Bhavik R. Bakshi,	Cambridge University Press & Assessmen	2019
5	Engineering Ethics	M Govindarajan, S Natarajan and V S Senthil Kumar	PHI Learning Private Ltd, New Delhi	2012
6	Professional ethics and human values	RS Naagarazan	New age international (P) limited New Delhi	2006.
7	Ethics in Engineering	Mike W Martin and Roland Schinzinger,	Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi	4" edition, 2014

Suggested Activities/Projects:

Module-II

- Write a reflection on a local environmental issue (e.g., plastic waste in Kerala backwaters or oceans) from different ethical perspectives (anthropocentric, biocentric, ecocentric).
- Write a life cycle analysis report of a common product used in Kerala (e.g., a coconut, bamboo or rubber-based product) and present findings on its sustainability.
- Create a sustainability report for a local business, assessing its environmental, social, and economic impacts
- Presentation on biodiversity in a nearby area (e.g., a local park, a wetland, mangroves, college campus etc) and propose conservation strategies to protect it.
- Develop a conservation plan for an endangered species found in Kerala.
- Analyze the green spaces in a local urban area and propose a plan to enhance urban ecology using native plants and sustainable design.
- Create a model of a sustainable urban landscape for a chosen locality in Kerala.

Module-III

- Study a local water body (e.g., a river or lake) for signs of pollution or natural flow disruption and suggest sustainable management and restoration practices.
- Analyse the effectiveness of water management in the college campus and propose improvements - calculate the water footprint, how to reduce the footprint, how to increase supply through rainwater harvesting, and how to decrease the supply-demand ratio
- Implement a zero waste initiative on the college campus for one week and document the challenges and outcomes.
- Develop a waste audit report for the campus. Suggest a plan for a zero-waste approach.
- Create a circular economy model for a common product used in Kerala (e.g., coconut oil, cloth etc).
- Design a product or service based on circular economy and degrowth principles and present a business plan.
- Develop a plan to improve pedestrian and cycling infrastructure in a chosen locality in Kerala

Module-IV

- Evaluate the potential for installing solar panels on the college campus including cost-benefit analysis and feasibility study.
- Analyse the energy consumption patterns of the college campus and propose sustainable alternatives to reduce consumption - What gadgets are being used? How can we reduce demand using energy-saving gadgets?
- Analyse a local infrastructure project for its climate resilience and suggest improvements.
- Analyse a specific environmental regulation in India (e.g., Coastal Regulation Zone) and its impact on local communities and ecosystems.
- Research and present a case study of a successful sustainable engineering project in Kerala/India (e.g., sustainable building design, water management project, infrastructure project).
- Research and present a case study of an unsustainable engineering project in Kerala/India highlighting design and implementation faults and possible corrections/alternatives (e.g., a housing complex with water logging, a water management project causing frequent floods, infrastructure project that affects surrounding landscapes or ecosystems).

SEMESTER S3

DATA STRUCTURES LAB

Course Code	PCERL307	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	GBEST204: Programming in C	Course Type	Lab

Course Objectives:

1. To implement various linear data structures and applications using them
2. To implement various non-linear data structures and applications using them
3. To implement algorithms for various sorting techniques

Details of Experiment

Expt. No	Experiment
1	Implementation of linear search and binary search *
2	Implementation of Stack and linear Queue using arrays *
3	Implementation of Priority Queues, DEQUEUE and Circular Queues using arrays *
4	Conversion of expression from one notation to another notation *
5	Implementation of various operations on singly linked list *
6	Implementation of stack and queue using linked list *
7	Polynomial addition using linked list *
8	Polynomial multiplication using linked list.
9	Implementation of binary search tree – creation, insertion, deletion, search *
10	Implementation of tree traversals – inorder, preorder, postorder
11	Implementation of sorting algorithms bubble sort, insertion sort and selection sort *
12	Implementation of Merge sort *
13	Implementation of Quick sort *
14	Implementation of BFS and DFS on graph *

**Mandatory programs*

Course Assessment Method (CIE: 50 Marks, ESE 50 Marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work, experiments, Viva and Timely completion of Lab Reports / Record. (Continuous Assessment)	Internal Exam	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

Mandatory requirements for ESE:

- Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.
- Endorsement by External Examiner: The external examiner shall endorse the record.

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Implement and analyze various searching and sorting algorithms, evaluating their efficiency and applicability in different scenarios.	K3
CO2	Efficiently implement array-based data structures and perform expression notation conversions, demonstrating proficiency in algorithmic design and data structure utilization.	K3
CO3	Effectively utilize linked lists for implementing various operations such as stacks, queues, and polynomial manipulations, demonstrating practical skills in data structure application and algorithmic problem-solving.	K3
CO4	Master the implementation of binary search trees, tree traversals, and graph traversal algorithms, demonstrating proficiency in fundamental data structure operations and algorithmic techniques.	K3

K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table

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

1: Slight (Low),2: Moderate (Medium),3: Substantial (High), : No Correlation

Text Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fundamentals of Data Structures in C	Ellis Horowitz,Sartaj Sahni and Susan Anderson-Freed	Universities Press	2e, 2008
2	Classic Data Structures	Samanta D	Prentice Hall India	2/e, 2009

Reference Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Data Structures: A Pseudocode Approach with C	Richard F. Gilberg, Behrouz A. Forouzan	Cengage Learning	2/e, 2005
2	Data Structures and Algorithms	Aho A. V., J. E. Hopcroft and J. D. Ullman	Pearson Publication	1983
3	Introduction to Data Structures with Applications	Tremblay J. P. and P. G. Sorenson	Tata McGraw Hill	1995
4	Advanced Data Structures	Peter Brass	Cambridge University Press	2008

Video Links (NPTEL, SWAYAM…)

Sl. No.	Link ID
1	https://nptel.ac.in/courses/106102064

Continuous Assessment (25 Marks)

1. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (7 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (6 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (5 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. Procedure/Preliminary Work/Design/Algorithm (10 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.

- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. **Conduct of Experiment/Execution of Work/Programming (15 Marks)**

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. **Result with Valid Inference/Quality of Output (10 Marks)**

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. **Viva Voce (10 Marks)**

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. **Record (5 Marks)**

- Completeness, clarity, and accuracy of the lab record submitted

SEMESTER S3

DIGITAL SYSTEM DESIGN LAB

Course Code	**PCERL 308**	**CIE Marks**	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	**ESE Marks**	50
Credits	2	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Lab

Course Objectives:

1. Familiarize with the implementation of Logic Circuits using basiclogic gates ICs.
2. Familiarize with the Verilog HDL based Digital Design Flow.

Details of Experiment

Expt. No	Experiment
1	Familiarization of logic gates
2	Realization of functions using basic and universal gates (SOP and POS forms).
3	Half adder and full adder using NAND
4	Realization of 8:1 MUX and 1:8 DEMUX
5	Flip-flop circuits (SR, JK,T,D &Master slave)
6	Asynchronous up/down counter
7	Familiarization of FPGA devices and Verilog HDL
8	Implementation of basic gates using Verilog & simulate the result using test bench
9	Implementation of half adder & full adder using Verilog & simulate the result using test bench
10	Implementation of MUX & DEMUX using Verilog & simulate the result using test bench
11	Implementation of encoder & decoder using Verilog & simulate the result using test bench
12	Implementation of flip-flops using Verilog & simulate the result using test bench

Course Assessment Method (CIE: 50 Marks, ESE 50 Marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work, experiments, Viva and Timely completion of Lab Reports / Record. (Continuous Assessment)	Internal Exam	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

Mandatory requirements for ESE:

- Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.
- Endorsement by External Examiner: The external examiner shall endorse the record.

Course Outcomes (COs)

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

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Realize digital circuits with Logic Gates and Hardware Description Language	Apply (K3)
CO2	Design and implement combinational logic circuits.	Apply (K3)
CO3	Design and implement sequential logic circuits.	Apply (K3)

K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table

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

1: Slight (Low),2: Moderate (Medium),3: Substantial (High), : No Correlation

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Verilog HDL: A Guide to Digital Design and Synthesis	Samir Palnitkar	Pearson	2nd Edition, 2003
2	A Verilog HDL Primer	Bhasker J	BS Publication	
3	Modern digital Electronics	R.P. Jain	Tata McGraw Hill	4th edition, 2009
4	Fundamentals of Digital Circuits	A. Ananthakumar	Prentice Hall	2nd edition, 2016

Continuous Assessment (25 Marks)

5. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

6. Conduct of Experiments (7 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.

- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

7. **Lab Reports and Record Keeping (6 Marks)**

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

8. **Viva Voce (5 Marks)**

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

6. **Procedure/Preliminary Work/Design/Algorithm (10 Marks)**

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

7. **Conduct of Experiment/Execution of Work/Programming (15 Marks)**

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

8. **Result with Valid Inference/Quality of Output (10 Marks)**

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

9. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

10. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted

SEMESTER 4

ELECTRONICS AND COMPUTER ENGINEERING

SEMESTER S4

MATHEMATICS FOR ELECTRICAL SCIENCE – 4

(B Group)

Course Code	**GBMAT401**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2Hrs. 30 Min.
Prerequisites (if any)	Basic calculus	**Course Type**	Theory

Course Objectives:

1. To familiarize students with the foundations of probabilistic and statistical analysis mostly used in varied applications in engineering and science.
2. To expose the students to the basics of random processes essential for their subsequent study of analog and digital communication

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Random variables, Discrete random variables and their probability distributions, Cumulative distribution function, Expectation, Mean and variance, Binomial distribution, Poisson distribution, Poisson distribution as a limit of the binomial distribution, Joint pmf of two discrete random variables, Marginal pmf, Independent random variables, Expected value of a function of two discrete variables. **[Text 1: Relevant topics from sections 3.1 to 3.4, 3.6, 5.1, 5.2]**	**9**
2	Continuous random variables and their probability distributions, Cumulative distribution function, Expectation, Mean and variance, Uniform, Normal and Exponential distributions, Joint pdf of two Continuous random variables, Marginal pdf, Independent random variables, Expectation value of a function of two continuous variables. **[Text 1: Relevant topics from sections 3.1, 4.1, 4.2, 4.3, 4.4, 5.1, 5.2]**	**9**

3	Confidence Intervals, Confidence Level, Confidence Intervals and One-side confidence intervals for a Population Mean for large and small samples (normal distribution and *t*-distribution), Hypotheses and Test Procedures, Type I and Type II error, *z* Tests for Hypotheses about a Population Mean (for large sample), *t* Test for Hypotheses about a Population Mean (for small sample), Tests concerning a population proportion for large and small samples. **[Text 1: Relevant topics from 7.1, 7.2, 7.3, 8.1, 8.2, 8.3, 8.4]**	**9**
4	Random process concept, classification of process, Methods of Description of Random process, Special classes, Average Values of Random Process, Stationarity- SSS, WSS, Autocorrelation functions and its properties, Ergodicity, Mean-Ergodic Process, Mean-Ergodic Theorem, Correlation Ergodic Process, Distribution Ergodic Process. **[Text 2: Relevant topics from Chapter 6]**	**9**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the concept, properties and important models of discrete random variables and to apply in suitable random phenomena.	**K3**
CO2	Understand the concept, properties and important models of continuous random variables and to apply in suitable random phenomena.	**K3**
CO3	Estimate population parameters, assess their certainty with confidence intervals, and test hypotheses about population means and proportions using *z*-tests and the one-sample *t*-test.	**K3**
CO4	Analyze random processes by classifying them, describing their properties, utilizing autocorrelation functions, and understanding their applications in areas like signal processing and communication systems.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Probability and Statistics for Engineering and the Sciences	Devore J. L	Cengage Learning	9th edition, 2016
2	Probability, Statistics and Random Processes	T Veerarajan	The McGraw-Hill	3rd edition, 2008

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Probability, Random Variables and Stochastic Processes,	Papoulis, A. & Pillai, S.U.,	McGraw Hill.	4^{th} edition, 2002
2	Introduction to Probability and Statistics for Engineers and Scientists	Ross, S. M.	Academic Press	6^{th} edition, 2020
3	Probability and Random Processes	Palaniammal, S.	PHI Learning Private Limited	3^{rd} edition, 2015
4	Introduction to Probability	David F. Anderson, Timo, Benedek	Cambridge	1^{st} edition, 2017

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/117/105/117105085/
2	https://archive.nptel.ac.in/courses/117/105/117105085/
3	https://archive.nptel.ac.in/courses/117/105/117105085/

SEMESTER S4

COMPUTER ORGANIZATION AND ARCHITECTURE

Course Code	**PCERT 402**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	**ESE Marks**	60
Credits	4	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	PCERT 205 Digital Electronics	**Course Type**	Theory

Course Objectives:

1. Discuss the basic concepts and structure of computers.
2. Describe the various addressing modes and memory structure kinds.
3. Define interrupts and their role in managing I/O operations and system events.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Basic Structure of computers** –functional units - basic operational concepts - bus structures. Memory locations and addresses - memory operations, Instructions and instruction sequencing, addressing modes. **Basic processing unit** – fundamental concepts – instruction cycle – execution of a complete instruction - single bus and multiple bus organization.	10
2	**Register transfer logic:** Inter register transfer – arithmetic, logic and shift micro-operations. **Processor logic design:** - processor organization – Arithmetic logic unit - design of arithmetic circuit - design of logic circuit – Design of arithmetic logic unit - status register – design of shifter - processor unit – design of accumulator (Basic Concept Only).	11
3	**Control Logic Design:** Hardwired control-microprogrammed control-Microinstructions, Microprogram Sequencing. **Arithmetic algorithms:** Signed-Operand multiplication, Booth Algorithm,	12

	fast multiplication-bit pair recoding of multipliers. **Pipelining:** Basic principles**,** classification of pipeline processors, instruction and arithmetic pipelines (Design examples not required), hazard detection and resolution.	
4	**Memory system:** Types of memory (**Concepts only),** Virtual memory**,** Content addressable memory, cache memories - mapping functions. **I/O organization:** Characteristics of I/O devices, Data transfer schemes - Programmed controlled I/O transfer, Interrupt controlled I/O transfer. Organization of interrupts - vectored interrupts – Servicing of multiple input/output devices – Polling and daisy chaining schemes. Direct memory accessing (DMA)	11

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
● 2 Questions from each module. ● Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	● Each question carries 9 marks. ● Two questions will be given from each module, out of which 1 question should be answered. ● Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand Functional Units and Basic Operational Concepts	**K2**
CO2	Describe various micro-operations including arithmetic, logic, and shift operations.	**K2**
CO3	Analyze existing processor architectures to understand the implementation of pipelining and control strategies.	**K3**
CO4	Define interrupts and their role in handling I/O operations and system events.	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping od Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Computer Organization	Hamacher C., Z. Vranesic and S. Zaky	McGraw Hill	5/e,2011
2	Digital Logic & Computer Design	Mano M. M	PHI	2004
3	Computer System Architecture	Mano M. M	PHI	2007

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Computer Organization and Design	Patterson D.A. and J. L. Hennessy	Morgan Kaufmann Publishers	5/e,2013
2	Computer Organization and Architecture: Designing for Performance	William Stallings	Pearson,	9/e, 2013.
3	Computer Organization and Design	Chaudhuri P	Prentice Hall	2/e, 2008.

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://www.youtube.com/watch?v=msqxkEKFg8I&list=PLgHucKw979AvcnTpPNZMZyORdL5HvTr9m,, https://www.youtube.com/watch?v=k_QgyvsqtwA&list=PLgHucKw979AvcnTpPNZMZyORdL5HvTr9m&index=12
2	https://www.youtube.com/watch?v=0B-y1RPDXjs&list=PL59E5B57A04EAE09C&index=17
3	https://www.youtube.com/watch?v=AgoC0mlL6eQ&list=PLdS3u59E0DKjUKPcnCYxVxssEkX2zo-kV&index=8 https://www.youtube.com/watch?v=6CCwWCstDGc&list=PL1A5A6AE8AFC187B7&index=9https://www.youtube.com/watch?v=IQql2ojVzsU&list=PLEAYkSg4uSQ3dmkbCah82ek0KJnpz_DxL&index=5
4	https://www.youtube.com/watch?v=Wfau1WC5m4c

SEMESTER S4

COMPUTER NETWORKS

Course Code	PCERT403	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3-1-0-0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To acquire practical skills in network design, configuration, and management which include learning about different network topologies, transmission media, routing algorithms, and quality of service techniques.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction – Uses of computer networks, Network hardware, Network Software. Reference models – The OSI reference model, The TCP/IP reference model, Comparison of OSI and TCP/IP reference models. Physical Layer – Modes of communication, Physical topologies, Transmission media.	8
2	Data link layer - design issues, Error detection and correction, Sliding window protocols, High-Level Data Link Control (HDLC) protocol. Medium Access Control (MAC) sublayer –Channel allocation problem, Multiple access protocols, Ethernet, Wireless LANs - 802.11. Repeaters, Hubs, Bridges, Switches, Routers and Gateways.	10
3	Network layer Services. Routing algorithms - Shortest path routing, Flooding, Distance Vector Routing, Link State Routing, Congestion control algorithms. Quality of Service (QoS) - requirements, Techniques for achieving good QoS. Internet Protocols - IPv4-IPv4 addresses-IPv6 -The Internet Control	14

	Message Protocol - The Address Resolution Protocol-The Dynamic Host Configuration Protocol - Network Address Translation - Internet multicasting.	
4	Transport service – Services provided to the upper layers, Transport service primitives. User Datagram Protocol (UDP). Transmission Control Protocol (TCP) – Overview of TCP, TCP segment header, Connection establishment & release, Connection management modelling, TCP retransmission policy, TCP congestion control. Application Layer –File Transfer Protocol (FTP), Domain Name System (DNS), Electronic Mail (SMTP), Simple Network Management Protocol (SNMP), World Wide Web(WWW), Multimedia in the Internet, Real time interactive protocols-RTP,RTCP,SIP.	**12**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the uses of computer networks, their hardware, software, and different reference models.	**K2**
CO2	Analyze data link layer design issues, error detection, correction and various medium access control protocols.	**K3**
CO3	Design and evaluate network layer solutions characterized by routing and congestion control algorithms and implement IP protocols.	**K2**
CO4	Comprehend the concepts of TCP/UDP protocols and connection management including congestion control and retransmission policy.	**K2**
CO5	Understand the application layer protocols and techniques for implementing web based applications.	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Computer Networks	Andrew S. Tanenbaum	PHI (Prentice Hall India)	4/e,2008
2	Data Communication and Networking	Behrouz A Forouzan	Tata McGraw Hill	5/e,2013

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Computer Networks – A Systems Approach	Larry L Peterson and Bruce S Dave	Morgan Kaufmann.	5/e,2011
2	Computer Networking and the Internet	Fred Halsall	Addison-Wesley.	5/e,2005
3	James F. Kurose, Keith W. Ross	Computer Networking: A Top-Down Approach	Pearson Education	6/e,2012
4	Computer Networking with Internet Protocols.	William Stallings	Prentice-Hall,	4/e,2004
5	Data Communications and Computer Networks A Business User's Approach	Curt M. White	Course Technology, Cengage Learning	7/e, 2013

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/106105183
2	https://nptel.ac.in/courses/106106091
3	https://onlinecourses.swayam2.ac.in/cec21_cs04/preview
4	https://onlinecourses.nptel.ac.in/noc22_cs19/preview

SEMESTER S4

INTEGRATED CIRCUITS

Course Code	PBERT 404	CIE Marks	60
Teaching Hours/Week (L: T:P: R)	3:0:0:1	ESE Marks	40
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PBERT 304 Electronics Devices and Circuits	Course Type	Theory

Course Objectives:

1. To introduce students about integrated circuits and teach them how to construct and analyze circuits with the help of op-amps and other specialized ICs.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Operational amplifiers** Introduction of op-amp – block diagram of op-amp –Basic information of op-amp (741 op-amp) - Power supply requirements. Characteristics of Operational Amplifiers Ideal op amp characteristics - DC characteristics - input bias current, input offset current, input offset voltage, thermal drift, CMRR, PSRR - AC characteristics - frequency response, slew rate. Basic applications-inverting amplifier, non-inverting amplifier.	9
2	**Applications of Operational amplifiers** Differential amplifier, summing amplifier, scale changer, voltage follower, V-I converter (grounded load type and floating load type), I-V converter. Instrumentation amplifier (3 op amp) - op amp integrator - op amp differentiator, precision rectifier (half and full wave), peak detector, sample and hold circuit, Comparator (inverting and non-inverting type) – applications of comparator - zero crossing detector, Schmitt trigger, window detector	9

3	**Waveform generators and Oscillators** Timer IC 555- Functional block diagram – Waveform generators – Astable and mono stable – Design and working (using 555 and 741). Triangular and sawtooth –RC phase shift and Wien bridge oscillators (No analysis required) Voltage regulator - Introduction, series op amp regulator -IC regulators - 78XX and 79XX characteristics - voltage regulator as current source using 7805, Low voltage and high voltage regulators using 723 general purpose IC.	**9**
4	**Filters, PLL and Data Converters** Types of filters, first and second order LPF and HPF. Phase Locked Loop – Operation, Lock and capture range (No analysis), PLL IC 565, Applications - frequency multiplier, frequency translation. Data Converters: Digital to Analog converters, Specifications, Weighted resistor type and R-2R Ladder type. Analog to Digital Converters: Specifications, ADC –Direct type – Flash type, counter type, successive approximation type - Integrating type ADC - Single slope type.	**9**

Suggestion on Project Topics

Course Assessment Method
(CIE: 60 marks, ESE: 40 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Project	Internal Ex-1	Internal Ex-2	Total
5	30	12.5	12.5	60

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 2 marks **(8x2 =16 marks)**	• 2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 6 marks. **(4x6 = 24 marks)**	**40**

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Describe basics of operational amplifier and characteristics of op-amps.	**K2**
CO2	Design linear and nonlinear circuits using op-amp.	**K3**
CO3	Design op-amp oscillators, waveform generators and voltage regulators.	**K3**
CO4	Design circuits using Filters, PLL, DAC and ADC.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Linear Integrated Circuits	D Roy Choudhury and Shail B Jain	New Age International Publishers	4/e, 2017
2	Op-Amps and Linear Integrated Circuits	Ramakant A. Gayakwad	Pearson	4/e, 2015

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Op-amps and Linear Integrated circuits	Coughlin & Driscoll	Prentice Hall	6/e, 2009
2	Design with operational Amplifiers & Analog Integrated Circuits	Sergio Franco	Mc Graw Hill India	4/e, 2016
3	Integrated Circuits	K R Botkar	Khanna Publishers	10/e, 2010

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/108/108/108108111
2	https://archive.nptel.ac.in/courses/108/108/108108111
3	https://archive.nptel.ac.in/courses/108/108/108108111
4	https://archive.nptel.ac.in/courses/108/106/108106184

PBL Course Elements

L: Lecture (3 Hrs.)	R: Project (1 Hr.), 2 Faculty Members		
	Tutorial	**Practical**	**Presentation**
Lecture delivery	Project identification	Simulation/ Laboratory Work/ Workshops	Presentation (Progress and Final Presentations)
Group discussion	Project Analysis	Data Collection	Evaluation
Question answer Sessions/ Brainstorming Sessions	Analytical thinking and self-learning	Testing	Project Milestone Reviews, Feedback, Project reformation (If required)
Guest Speakers (Industry Experts)	Case Study/ Field Survey Report	Prototyping	Poster Presentation/ Video Presentation: Students present their results in a 2 to 5 minutes video

Assessment and Evaluation for Project Activity

Sl. No	Evaluation for	Allotted Marks
1	Project Planning and Proposal	5
2	Contribution in Progress Presentations and Question Answer Sessions	4
3	Involvement in the project work and Team Work	3
4	Execution and Implementation	10
5	Final Presentations	5
6	Project Quality, Innovation and Creativity	3
Total		**30**

1. Project Planning and Proposal (5 Marks)

- Clarity and feasibility of the project plan
- Research and background understanding
- Defined objectives and methodology

2. Contribution in Progress Presentation and Question Answer Sessions (4 Marks)

- Individual contribution to the presentation
- Effectiveness in answering questions and handling feedback

3. **Involvement in the Project Work and Team Work (3 Marks)**
    - Active participation and individual contribution
    - Teamwork and collaboration
4. **Execution and Implementation (10 Marks)**
    - Adherence to the project timeline and milestones
    - Application of theoretical knowledge and problem-solving
    - Final Result
5. **Final Presentation (5 Marks)**
    - Quality and clarity of the overall presentation
    - Individual contribution to the presentation
    - Effectiveness in answering questions
6. **Project Quality, Innovation, and Creativity (3 Marks)**
    - Overall quality and technical excellence of the project
    - Innovation and originality in the project

Creativity in solutions and approaches

SEMESTER S4

COMMUNICATION ENGINEERING

Course Code	**PEERT411**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	GYEST104 Introduction to Electrical and Electronics Engineering	**Course Type**	Theory

Course Objectives:

1. To introduce the basic principles of analog and digital communication systems.
2. To familiarize with the satellite communication and cellular communication systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Analog Communication:** Introduction, elements of communication systems, need for modulation. Amplitude modulation: modulation index, average power, equation and spectrum of AM signal. Concept of DSB-SC and SSB. Angle modulation- frequency and phase modulation. FM frequency spectrum, modulation index, equation and spectrum of FM signal Narrow and wide band FM, Comparison of AM and FM.	9
2	**Digital Communication:** Principles of digital communication – sampling theorem, Nyquist criterion, quantization, encoding techniques-unipolar, bipolar and Manchester. Pulse modulation techniques- sampling process - PAM, PWM and PPM concepts, block diagram of PCM encoder and decoder.	9
3	**Satellite communication:** Introduction to satellite communication, types of satellite orbits. Space segment - introduction, power supply, Attitude and Orbit Control System (AOCS), thermal control subsystem, TT&C	9

	subsystem, transponders, antenna subsystem. Earth segment - types of earth station, Multiple Access (MA) techniques - FDMA, TDMA, CDMA, SDMA.	
4	**Cellular Communication:** Basic concepts, frequency reuse, interference, cell splitting, sectoring, cell system layout, Hand off-types and strategies, Bluetooth, Zig-Bee, GPS, Wi-Fi, Wi-Max based communication.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
● 2 Questions from each module. ● Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	● Each question carries 9 marks. ● Two questions will be given from each module, out of which 1 question should be answered. ● Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand basic elements of AM and FM communication systems.	**K2**
CO2	Understand the concepts of digital communication systems.	**K2**
CO3	Understand various subsystems and multiple access techniques used in satellite communication systems	**K2**
CO4	Understand various aspects of frequency reuse, Handoffs, cell splitting and channel assignment	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping od Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Electronic Communication Systems	Kennedy G.	McGraw-Hill, New York,	6th edition, 2017
2	Digital Communications	Bernard Sklar	Pearson	2nd edition, 2009
3	Satellite Communication	Dennis Roddy	McGraw-Hill	4th edition 2017
4	Wireless Communication Principles and practice	Theodore S Rappaport	Pearson	2nd edition, 2010

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Electronic Communication Systems	William Scheweber	Prentice Hall of India LTD, New Delhi	4^{th} edition, 2004
2	Electronic Communication Systems	Wayne Tomasi	Prentice Hall of India LTD, New Delhi, 2004.	5^{th} edition, 2003
3	Electronic Communication	Roody and Coolen	Prentice Hall of India	4^{th} edition, 2008
4	Communication Systems	Simon Haykins	John Wiley	4^{th} edition, 2006

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	http://acl.digimat.in/nptel/courses/video/117105143/L16.html
2	https://nptel.ac.in/courses/117101051
3	https://archive.nptel.ac.in/courses/117/105/117105131
4	https://nptel.ac.in/courses/106106167

SEMESTER S4

BASIC VLSI DESIGN

Course Code	PEERT 412	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To bring circuits and system views on design together.
2. To understand the design of digital VLSI circuits for hardware design.
3. To develop the skill to design various VLSI circuits.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Overview of CMOS device fundamentals (Pre-requisite). The CMOS inverter: - Voltage Transfer Characteristics, Static Behavior - Switching Threshold - Noise Margins, Dynamic behavior - Device Capacitances - Propagation Delay - Power Consumption-SPICE code of an Inverter	9
2	CMOS fabrication Processes: -N-Tub, P-Tub and Twin Tub.Layout design of static MOS circuits -MOS Circuit Layout – Use of Stick diagrams, Layout design rules, Transistor layout - PMOS and NMOS, Gate Layout - Inverter, NAND, NOR.	9
3	Combinational logic Circuits: - Static MOS - Complementary MOS - Ratioed logic - Pass Transistor logic - Differential Pass Transistor Logic - Transmission gate logic, Dynamic MOS - Basic Principles - Speed and power Dissipation, Domino Logic	9
4	Design of the Memory Core - Read Only Memories - Non-volatile Read Write Memories - Read Write memories - SRAM and DRAM. Scaling of MOS circuits: scaling models and scaling factors for device parameters.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Explain static and dynamic characteristics of CMOS Inverters	**K2**
CO2	Explain physical layout for various MOS Circuits	**K2**
CO3	Explain various Combinational Logic Circuits	**K2**
CO4	Explain various types of Memory Elements	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping od Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Integrated Circuits- A Design Perspective	J.M. Rabaey, A. Chandrakasan and B. Nikolic	Pearson	Second Edition, 2003
2	Basic VLSI Design	Douglas A. Pucknell& Kamran Eshraghian	PHI	Third Edition, 1995
3	CMOS digital integrated circuits: Analysis and design	Sung-Mo Kang, Yusuf Lablebici	TATA McGraw-Hill	Third Edition, 2002

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	CMOS Logic Circuit Design	John P. Uyemura	Springer India Pvt. Ltd	First Edition, 1999
2	CMOS VLSI Design, a Circuits and Systems Perspective	Neil H. E. Weste, David Money Harris	PEARSON	Fourth Edition, 2015

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/117106092
2	https://onlinecourses.nptel.ac.in/noc22_ee08/preview
3	https://nptel.ac.in/courses/117106092
4	https://onlinecourses.nptel.ac.in/noc22_ee08/preview

SEMESTER S4

BIOMEDICAL SIGNALS &TRANSDUCERS

Course Code	PEERT413	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. This course is intended to provide students an insight into cellular electrophysiology and variousbiomedical transducers used for signal acquisition

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Cell Potentials**: Cell membrane- Action potentials – ionic basis of generation – Nernst potential, Goldman Hodgkin Katz equation. Auto rhythmic cells - cardiac action potentials.Synapses&Neuronal Integration Synaptic potentials – EPSP & IPSP -Neurotransmitters – types	9
2	**Biosignals and Acquisition Methods:** ECG- Generation of cardiac action potentials -Characteristics of ECG Signal -Lead systems- Clinical applications of ECG. EEG- Brain action potentials- characteristics of signal- Electrode system - Clinical applications of EEG. EMG-Electrical activity of muscles –Characteristics of EMG signal- Clinical applications of EMG	9
3	**Biosensors:** Photochemistry of vision--Hearing- endo cochlear potentials. Biosensors-Types-Bio recognition elements in biosensors-immobilization methods-ISFET- Enzyme electrodes. Nanomaterial based biosensors- Applications of biosensors-Biosensors for clinical diagnostics **Biomedical Transducers and Electrodes**: Temperature transducers- Displacement &Pressure transducers- piezo electric transducers- Electrodes for biopotential measurement- catheter tip transducers	9
4	**Diagnostic Radiology**: Production of diagnostic X-ray-X-ray tubes-principle of image formation-Functional blocks of X-ray machine – tubes for various applications.	9

Course Assessment Method
(CIE: 40 marks,ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Understand the cellular mechanism of production of action potentials	**K2**
CO2	Understand the characteristics of bio signals and biomedical signal acquisition systems	**K2**
CO3	Understand the fundamentals of biosensors and its applications	**K2**
CO4	Apply the knowledge of electrodes& transducers for various biomedical measurements	**K3**
CO5	Understand the basic principles of diagnostic radiology	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Text book of Medical Physiology	Guyton and Hall:	Saunders, an imprint of Elsevier Inc.	12thedn, 2011
2	Principles of Biomedical Instrumentation and measurements	Richard Aston:		
3	Biosensors Fundamentals and Applications,	Bansi DharMalhotra, Chandra Mouleypandy:	Smithersrapra,	Ist edn,2017

Reference Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Biosensors an introductory text book,	JagrithiNarang, ChandrashekharPundir	Pan Stanford Publishing,	Istedn, 2017
2	Hand book of biomedical Instrumentation,	R S Khandpur:	Mc Graw Hill, 2nd edition	2nd edition
3	Principles of Applied Biomedical Instrumentation,	Geddes and Baker:	Wiley Inter science publications,	1989
4	A Manual of radiographic equipment,	Sybil M Stockly;	Churchil Living Stone,	, 1986

SEMESTER S4

FOUNDATIONS OF MACHINE LEARNING

Course Code	**PEERT 414**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. Understand the basic principles of machine learning
2. To study the basics of supervised and unsupervised learning.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Machine Learning-** Machine learning paradigms- supervised, semi-supervised, unsupervised, reinforcement learning. Features: Types of Data (Qualitative and Quantitative), Scales of Measurement (Nominal, Ordinal, Interval, Ratio), Concept of Feature, Feature Construction, Feature Selection and Transformation.	**9**
2	**Supervised Learning -** Classification: K-Nearest Neighbour, Naïve Bayes, Decision Tree algorithm ID3, Support Vector Machine,Regression: Linear regression, logistic regression, Neural Networks- The Perceptron, Activation Functions, Training Feed Forward Network by Back Propagation.	**9**
3	**Unsupervised Learning -** Clustering Methods - K-means clustering,Hierarchical Clustering Methods, Density based clustering.Dimensionality Reduction Techniques- Principal component analysis, Linear Discriminant Analysis.	**9**
4	**Evaluating model performance-**Confusion matrices, Precision and recall, Sensitivity and specificity, F-measure, ROC curves, Cross validation, K-fold cross validation, Bootstrap sampling. Improving model performance - Bagging, Boosting, Random forests.	**9**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Illustrate Machine Learning concepts (Cognitive Knowledge Level: Understand)	**K2**
CO2	Illustrate the concepts of classification methods (Cognitive Knowledge Level: Apply)	**K3**
CO3	analyze clusters using different methods (Cognitive Knowledge Level: Apply)	**K3**
CO4	Evaluate & improve the performance of machine learning classification models (Cognitive Knowledge Level: Apply)	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Machine Learning,	EthemAlphaydin	MIT Press	$3rd$ Edition, MIT Press,2014
2	Machine Learning	Mitchell, Tom	New York, NY: McGraw-Hill	1997. ISBN: 9780070428072

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Pattern Recognition and Machine Learning	Christopher M. Bishop	Springer	2006
2	Machine Learning: A Probabilistic Perspective	Kevin P. Murphy.	MIT Press	2012
3	Elements of Machine Learning,	P. Langley	Morgan Kaufmann	1995
4	Data Mining and Analysis: Fundamental Concepts and Algorithms	Mohammed J. Zaki and Wagner Meira	Cambridge University Press,	First South Asia edition, 2016
5	Introduction to Machine Learning with Python: A Guide for Data Scientists	Andreas Muller and Sarah Guido,	Shroff/O'Reilly	2016

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://www.youtube.com/watch?v=fC7V8QsPBec&list=PL1xHD4vteKYVpaIiy295pg6_SY5qznc77&index=2 https://www.youtube.com/watch?v=9vMpHk44XXo&list=PL1xHD4vteKYVpaIiy295pg6_SY5qznc77&index=5
2	https://www.youtube.com/watch?v=OTAR0kT1swg&list=PL1xHD4vteKYVpaIiy295pg6_SY5qznc77&index=3 https://www.youtube.com/watch?v=_M7Km1XZERU&list=PL1xHD4vteKYVpaIiy295pg6_SY5qznc77&index=9 https://www.youtube.com/watch?v=yG1nETGyW2E
3	https://www.youtube.com/watch?v=HTSCbxSxs-g https://www.youtube.com/watch?v=tlIv3IT_hHk
4	https://www.youtube.com/watch?v=sosZp0cUsIk&list=PL1xHD4vteKYVpaIiy295pg6_SY5qznc77&index=45 https://www.youtube.com/watch?v=9Iq6pz9XJ7w&list=PL1xHD4vteKYVpaIiy295pg6_SY5qznc77&index=46 https://www.youtube.com/watch?v=foWzsWFAmas&list=PL1xHD4vteKYVpaIiy295pg6_SY5qznc77&index=54 https://www.youtube.com/watch?v=NrdtKndsC1I&list=PL1xHD4vteKYVpaIiy295pg6_SY5qznc77&index=55 https://www.youtube.com/watch?v=6K48CbOm99Y&list=PL1xHD4vteKYVpaIiy295pg6_SY5qznc77&index=57

SEMESTER S4

OBJECT ORIENTED PROGRAMMING USING JAVA

Course Code	**PEERT416**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	GBEST204	**Course Type**	Theory

Course Objectives:

1. Understand and apply foundational object-oriented programming concepts in Java, including classes, objects, inheritance, polymorphism, encapsulation, and abstraction.
2. Design and implement Java applications that leverage OOP principles to achieve modularity, reusability, and scalability in software development.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basic Object-Oriented concepts, Introduction to Java - Java programming and Runtime Environment, Development Platforms- Java Virtual Machine (JVM), Java compiler, Bytecode, Java Buzzwords, Java program structure, Comments. Primitive Data types - Integers, Floating Point Types, Characters, Boolean. Literals, Operators - Arithmetic Operators, Bitwise Operators, Relational Operators, Boolean Logical Operators, Assignment Operator, Conditional (Ternary) Operator, Operator Precedence. Control Statements - Selection Statements, Iteration Statements and Jump Statements.	9
2	Object Oriented Programming in Java - Class Fundamentals, Declaring Objects, Introduction to Methods, Constructors, this Keyword, Method Overloading, Using Objects as Parameters, Returning Objects. Static Members, Final Variables, Inner Classes. Inheritance - Super Class, Sub Class, The Keyword super, protected Members, Calling Order of Constructors, Method Overriding, the Object class, Abstract Classes and Methods, using final with Inheritance.	9

	Packages and Interfaces - Defining Package, CLASSPATH, Access Protection, Importing Packages, Interfaces.	
3	Exception Handling - Checked Exceptions, Unchecked Exceptions, try Block and catch Clause, Multiple catch Clauses, Nested try Statements, throw, throws and finally. Java Library - String Handling – String Constructors, String Length, Special String Operations -Character Extraction, String Comparison, Searching Strings, Modifying Strings. Multithreaded Programming - The Java Thread Model, The Main Thread, Creating Thread, Creating Multiple Threads, Synchronization, Suspending, Resuming and Stopping Threads.	**9**
4	Event handling - Event Handling Mechanisms, Delegation Event Model, Event Classes, Sources of Events, Event Listener Interfaces. Swings fundamentals-Swing Controls, Components and Containers, Swing Packages, Event Handling in Swings, Swing Layout Managers, Exploring Swings –JFrame, JLabel , Swing Buttons, JText Field. Java Database Connectivity (JDBC) - JDBC overview, Creating and Executing Queries – create table, delete, insert, select.	**9**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Understand and apply fundamental Java programming concepts, including the runtime environment, primitive data types, operators, and control statements, to develop efficient and well-structured Java applications.	**K2**
CO2	Apply key object-oriented programming principles in Java, leveraging packages and interfaces effectively to design and implement Java applications.	**K3**
CO3	Confidently handle Java exceptions, manipulate strings effectively, and implement multithreaded programming techniques.	**K3**
CO4	Develop Java applications that integrate event handling, Swing-based graphical user interfaces, and JDBC database connectivity to create robust and user-friendly software solutions.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping od Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Java: The Complete reference	Herbert Schildt	Tata McGraw Hill	8/e, 2011.
2	Java How to Program, Early Objects	Paul Deitel, Harvey Deitel	Pearson	11/e, 2018

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Java Programming	Y. Daniel Liang	Pearson	7/e, 2013
2	Programming JAVA a Primer	Balagurusamy E	Tata McGraw Hill	5/e, 2014
3	Core Java: An Integrated Approach	Nageswararao R	Dreamtech Press	2008
4	Java in A Nutshell	Flanagan D	O'Reilly	5/e, 2005

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc24_cs105
2	https://onlinecourses.nptel.ac.in/noc24_cs105
3	https://onlinecourses.nptel.ac.in/noc24_cs105
4	https://onlinecourses.nptel.ac.in/noc24_cs105

SEMESTER 4

JAVA PROGRAMMING AND APPLICATION DEVELOPMENT

Course Code	**PEERT 415**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3-0-0-0	**ESE Marks**	60
Credits	5/3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	UCEST105: Algorithmic Thinking with Python GYEST204: Programming in C	**Course Type**	Theory

Course Objectives:

1. Understand and apply foundational object-oriented programming concepts in Java, including classes, objects, inheritance, polymorphism, encapsulation, and abstraction.
2. Design and implement Java applications that leverage OOP principles to achieve modularity, reusability, and scalability in software development.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basic Object-Oriented concepts, Introduction to Java - Java programming and Runtime Environment, Development Platforms- Java Virtual Machine (JVM), Java compiler, Bytecode, Java Buzzwords, Java program structure, Comments. Primitive Data types - Integers, Floating Point Types, Characters, Boolean. Literals, Operators - Arithmetic Operators, Bitwise Operators, Relational Operators, Boolean Logical Operators, Assignment Operator, Conditional (Ternary) Operator, Operator Precedence. Control Statements - Selection Statements, Iteration Statements and Jump Statements.	9
2	Object Oriented Programming in Java - Class Fundamentals, Declaring Objects, Introduction to Methods, Constructors, this Keyword, Method Overloading, Using Objects as Parameters, Returning Objects. Static	9

	Members, Final Variables, Inner Classes. Inheritance - Super Class, Sub Class, The Keyword super, protected Members, Calling Order of Constructors, Method Overriding, the Object class, Abstract Classes and Methods, using final with Inheritance. Packages and Interfaces - Defining Package, CLASSPATH, Access Protection, Importing Packages, Interfaces.	
3	Exception Handling - Checked Exceptions, Unchecked Exceptions, try Block and catch Clause, Multiple catch Clauses, Nested try Statements, throw, throws and finally. Java Library - String Handling – String Constructors, String Length, Special String Operations -Character Extraction, String Comparison, Searching Strings, Modifying Strings. Multithreaded Programming - The Java Thread Model, The Main Thread, Creating Thread, Creating Multiple Threads, Synchronization, Suspending, Resuming and Stopping Threads.	9
4	Event handling - Event Handling Mechanisms, Delegation Event Model, Event Classes, Sources of Events, Event Listener Interfaces. Swings fundamentals-Swing Controls, Components and Containers, Swing Packages, Event Handling in Swings, Swing Layout Managers, Exploring Swings –JFrame, JLabel, Swing Buttons, JText Field. Java Database Connectivity (JDBC) - JDBC overview, Creating and Executing Queries – create table, delete, insert, select.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	***Internal Ex***	***Evaluate***	***Analyse***	***Total***
5	**15**	**10**	**10**	**40**

Criteria for Evaluation(Evaluate and Analyse): 20 marks

Assignment: 20 Marks

Students should design and implement a real-world application using object-oriented programming principles, evaluate and refine their class structures and relationships, provide a conclusion on the effectiveness of their design, and demonstrate the functionality of their application using Java.

Criteria for evaluation:

1. ***Problem Definition (K4 - 4 points)***
    1. *Clearly defines the real-world problem.*
    2. *Examine and identifies relevant contextual factors (constraints, resources, objectives).*
2. ***Problem Analysis (K4 - 4 points)***
    1. *Break-down and presents a well-reasoned solution approach.*
    2. *Compare and justify the proposed solutions with evidence and logical reasoning.*
3. ***Evaluate (K5 - 4 points)***
    1. *Thoroughly evaluate the proposed solutions.*
    2. *Compares trade-offs, advantages, and disadvantages.*
    3. *Considers feasibility, scalability, and practical implications.*
4. ***Implementation (K5 - 4 points)***
    1. *Select the most feasible solution by implementing the proposed solutions.*
    2. *Successfully translates the chosen solution into code.*
    3. *Demonstrates proficiency in coding practices (readability, efficiency, error handling).*
5. ***Conclusion (K4- 2 points, K5 – 2 points)***
    1. *Summarizes findings and insights. State which solution is most appropriate for the problem.* ***(K4)***
    2. *Reflects critical thinking and informed decision-making.* ***(K5)***

Scoring:

1. ***Accomplished (4 points)****: Exceptional analysis, clear implementation, and depth of understanding.*
2. ***Competent (3 points)****: Solid performance with minor areas for improvement.*
3. ***Developing (2 points)****: Adequate effort but lacks depth or clarity.*
4. ***Minimal (1 point)****: Incomplete or significantly flawed.*

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• 2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 sub divisions. Each question carries 9 marks. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand and apply fundamental Java programming concepts, including the runtime environment, primitive data types, operators, and control statements, to develop efficient and well-structured Java applications.	Apply
CO2	Apply key object-oriented programming principles in Java, leveraging packages and interfaces effectively to design and implement Java applications.	Analysis
CO3	Confidently handle Java exceptions, manipulate strings effectively, and implement multithreaded programming techniques.	Apply
CO4	Develop Java applications that integrate event handling, Swing-based graphical user interfaces, and JDBC database connectivity to create robust and user-friendly software solutions.	Analysis
CO5	Evaluate any real-world problem and propose a solution using the concepts learned in this course.	Evaluate

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Java: The Complete reference	Herbert Schildt	Tata McGraw Hill	8/e, 2011.
2	Java How to Program, Early Objects	Paul Deitel, Harvey Deitel	Pearson	11/e, 2018

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Java Programming	Y. Daniel Liang	Pearson	7/e, 2013
2	Programming JAVA a Primer	Balagurusamy E	Tata McGraw Hill	5/e, 2014
3	Core Java: An Integrated Approach	Nageswararao R	Dreamtech Press	2008
4	Java in A Nutshell	Flanagan D	O'Reilly	5/e, 2005

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/105/106105191/
2	https://archive.nptel.ac.in/courses/106/105/106105191/
3	https://archive.nptel.ac.in/courses/106/105/106105191/
4	https://archive.nptel.ac.in/courses/106/105/106105191/

SEMESTER S3/S4

ECONOMICS FOR ENGINEERS

(Common to All Branches)

Course Code	**UCHUT346**	**CIE Marks**	50
Teaching Hours/Week (L: T:P: R)	2:0:0:0	**ESE Marks**	50
Credits	2	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. Understanding of finance and costing for engineering operation, budgetary planning and control
2. Provide fundamental concept of micro and macroeconomics related to engineering industry
3. Deliver the basic concepts of Value Engineering.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basic Economics Concepts - Basic economic problems – Production Possibility Curve – Utility – Law of diminishing marginal utility – Law of Demand - Law of supply – Elasticity - measurement of elasticity and its applications – Equilibrium- Changes in demand and supply and its effects Production function - Law of variable proportion – Economies of Scale – Internal and External Economies – Cobb-Douglas Production Function	6
2	Cost concepts – Social cost, private cost – Explicit and implicit cost – Sunk cost - Opportunity cost - short run cost curves - Revenue concepts Firms and their objectives – Types of firms – Markets - Perfect	6

	Competition – Monopoly - Monopolistic Competition - Oligopoly (features and equilibrium of a firm)	
3	Monetary System – Money – Functions - Central Banking –Inflation - Causes and Effects – Measures to Control Inflation - Monetary and Fiscal policies – Deflation Taxation – Direct and Indirect taxes (merits and demerits) - GST National income – Concepts - Circular Flow – Methods of Estimation and Difficulties - Stock Market – Functions- Problems faced by the Indian stock market-Demat Account and Trading Account – Stock market Indicators- SENSEX and NIFTY	**6**
4	Value Analysis and value Engineering - Cost Value, Exchange Value, Use Value, Esteem Value - Aims, Advantages and Application areas of Value Engineering - Value Engineering Procedure - Break-even Analysis - Cost-Benefit Analysis - Capital Budgeting - Process planning	**6**

Course Assessment Method
(CIE: 40 marks , ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/Case Study/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
10	**15**	**12.5**	**12.5**	**50**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• Minimum 1 and Maximum 2 Questions from each module. • Total of 6 Questions, each carrying 3 marks **(6x3 =18marks)**	• 2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. **(4x8 = 32 marks)**	**50**

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Understand the fundamentals of various economic issues using laws and learn the concepts of demand, supply, elasticity and production function.	**K2**
CO2	Develop decision making capability by applying concepts relating to costs and revenue, and acquire knowledge regarding the functioning of firms in different market situations.	**K3**
CO3	Outline the macroeconomic principles of monetary and fiscal systems, national income and stock market.	**K2**
CO4	Make use of the possibilities of value analysis and engineering, and solve simple business problems using break even analysis, cost benefit analysis and capital budgeting techniques.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Managerial Economics	Geetika, Piyali Ghosh and Chodhury	Tata McGraw Hill,	2015
2	Engineering Economy	H. G. Thuesen, W. J. Fabrycky	PHI	1966
3	Engineering Economics	R. Paneerselvam	PHI	2012

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Engineering Economy	Leland Blank P.E, Anthony Tarquin P. E.	Mc Graw Hill	7^{TH} Edition
2	Indian Financial System	Khan M. Y.	Tata McGraw Hill	2011
3	Engineering Economics and analysis	Donald G. Newman, Jerome P. Lavelle	Engg. Press, Texas	2002
4	Contemporary Engineering Economics	Chan S. Park	Prentice Hall of India Ltd	2001

SEMESTER S3/S4

ENGINEERING ETHICS AND SUSTAINABLE DEVELOPMENT

Course Code	UCHUT347	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	2:0:0:0	**ESE Marks**	50
Credits	2	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. Equip with the knowledge and skills to make ethical decisions and implement gender-sensitive practices in their professional lives.
2. Develop a holistic and comprehensive interdisciplinary approach to understanding engineering ethics principles from a perspective of environment protection and sustainable development.
3. Develop the ability to find strategies for implementing sustainable engineering solutions.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Fundamentals of ethics -** Personal vs. professional ethics, Civic Virtue, Respect for others, **Profession and Professionalism,** Ingenuity, diligence and responsibility, Integrity in design, development, and research domains, Plagiarism, a balanced outlook on law - challenges - case studies, **Technology and digital revolution**-Data, information, and knowledge, Cybertrust and cybersecurity, Data collection & management, **High technologies: connecting people and places**-accessibility and social impacts, **Managing conflict**, Collective bargaining, **Confidentiality**, Role of confidentiality in moral integrity, **Codes of Ethics**. **Basic concepts in Gender Studies** - sex, gender, sexuality, gender spectrum: beyond the binary, gender identity, gender expression, gender stereotypes, **Gender disparity and discrimination in education**, employment and everyday life, History of women in Science & Technology,	**6**

	Gendered technologies & innovations**, Ethical values and practices in connection with gender -** equity, diversity & gender justice, **Gender policy and women/transgender empowerment initiatives.**	
2	**Introduction to Environmental Ethics:** Definition, importance and historical development of environmental ethics, key philosophical theories (anthropocentrism, biocentrism, ecocentrism). **Sustainable Engineering Principles:** Definition and scope, triple bottom line (economic, social and environmental sustainability), life cycle analysis and sustainability metrics. **Ecosystems and Biodiversity:** Basics of ecosystems and their functions, Importance of biodiversity and its conservation, Human impact on ecosystems and biodiversity loss, An overview of various ecosystems in Kerala/India, and its significance. **Landscape and Urban Ecology:** Principles of landscape ecology, Urbanization and its environmental impact, Sustainable urban planning and green infrastructure.	**6**
3	**Hydrology and Water Management:** Basics of hydrology and water cycle, Water scarcity and pollution issues, Sustainable water management practices, Environmental flow, disruptions and disasters. **Zero Waste Concepts and Practices:** Definition of zero waste and its principles, Strategies for waste reduction, reuse, reduce and recycling, Case studies of successful zero waste initiatives. **Circular Economy and Degrowth:** Introduction to the circular economy model, Differences between linear and circular economies, degrowth principles, Strategies for implementing circular economy practices and degrowth principles in engineering. **Mobility and Sustainable Transportation:** Impacts of transportation on the environment and climate, Basic tenets of a Sustainable Transportation design, Sustainable urban mobility solutions, Integrated mobility systems, E-Mobility, Existing and upcoming models of sustainable mobility solutions.	**6**
4	**Renewable Energy and Sustainable Technologies:** Overview of renewable energy sources (solar, wind, hydro, biomass), Sustainable technologies in energy production and consumption, Challenges and opportunities in renewable energy adoption. **Climate Change and Engineering Solutions:** Basics of climate change science, Impact of climate change on natural and human systems, Kerala/India and the Climate crisis, Engineering solutions to mitigate, adapt and build resilience to climate change. **Environmental Policies and Regulations:** Overview of key environmental policies and	**6**

	regulations (national and international), Role of engineers in policy implementation and compliance, Ethical considerations in environmental policy-making. **Case Studies and Future Directions:** Analysis of real-world case studies, Emerging trends and future directions in environmental ethics and sustainability, Discussion on the role of engineers in promoting a sustainable future.	

Course Assessment Method
(CIE: 50 marks , ESE: 50)

Continuous Internal Evaluation Marks (CIE):

Continuous internal evaluation will be based on individual and group activities undertaken throughout the course and the portfolio created documenting their work and learning. The portfolio will include reflections, project reports, case studies, and all other relevant materials.

- The students should be grouped into groups of size 4 to 6 at the beginning of the semester. These groups can be the same ones they have formed in the previous semester.
- Activities are to be distributed between 2 class hours and 3 Self-study hours.
- The portfolio and reflective journal should be carried forward and displayed during the 7th Semester Seminar course as a part of the experience sharing regarding the skills developed through various courses.

Sl. No.	Item	Particulars	Group/ Individual (G/I)	Marks
1	Reflective Journal	Weekly entries reflecting on what was learned, personal insights, and how it can be applied to local contexts.	I	5
2	Micro project (Detailed documentation of the project, including methodologies, findings, and reflections)	1 a) Perform an Engineering Ethics Case Study analysis and prepare a report 1 b) Conduct a literature survey on 'Code of Ethics for Engineers' and prepare a sample code of ethics	G	8
		2. Listen to a TED talk on a Gender-related topic, do a literature survey on that topic and make a report citing the relevant papers with a specific analysis of the Kerala context	G	5
		3. Undertake a project study based on the concepts of sustainable development* - Module II, Module III & Module IV	G	12
3	Activities	2. One activity* each from Module II, Module III & Module IV	G	15
4	Final Presentation	A comprehensive presentation summarising the key takeaways from the course, personal reflections, and proposed future actions based on the learnings.	G	5
		Total Marks		**50**

*Can be taken from the given sample activities/projects

Evaluation Criteria:

- **Depth of Analysis**: Quality and depth of reflections and analysis in project reports and case studies.
- **Application of Concepts**: Ability to apply course concepts to real-world problems and local contexts.
- **Creativity**: Innovative approaches and creative solutions proposed in projects and reflections.
- **Presentation Skills**: Clarity, coherence, and professionalism in the final presentation.

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Develop the ability to apply the principles of engineering ethics in their professional life.	**K3**
CO2	Develop the ability to exercise gender-sensitive practices in their professional lives	**K4**
CO3	Develop the ability to explore contemporary environmental issues and sustainable practices.	**K5**
CO4	Develop the ability to analyse the role of engineers in promoting sustainability and climate resilience.	**K4**
CO5	Develop interest and skills in addressing pertinent environmental and climate-related challenges through a sustainable engineering approach.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

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

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Ethics in Engineering Practice and Research	Caroline Whitbeck	Cambridge University Press & Assessment	2nd edition & August 2011
2	Virtue Ethics and Professional Roles	Justin Oakley	Cambridge University Press & Assessment	November 2006
3	Sustainability Science	Bert J. M. de Vries	Cambridge University Press & Assessment	2nd edition & December 2023
4	Sustainable Engineering Principles and Practice	Bhavik R. Bakshi,	Cambridge University Press & Assessmen	2019
5	Engineering Ethics	M Govindarajan, S Natarajan and V S Senthil Kumar	PHI Learning Private Ltd, New Delhi	2012
6	Professional ethics and human values	RS Naagarazan	New age international (P) limited New Delhi	2006.
7	Ethics in Engineering	Mike W Martin and Roland Schinzinger,	Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi	4" edition, 2014

Suggested Activities/Projects:

Module-II

- Write a reflection on a local environmental issue (e.g., plastic waste in Kerala backwaters or oceans) from different ethical perspectives (anthropocentric, biocentric, ecocentric).
- Write a life cycle analysis report of a common product used in Kerala (e.g., a coconut, bamboo or rubber-based product) and present findings on its sustainability.
- Create a sustainability report for a local business, assessing its environmental, social, and economic impacts
- Presentation on biodiversity in a nearby area (e.g., a local park, a wetland, mangroves, college campus etc) and propose conservation strategies to protect it.
- Develop a conservation plan for an endangered species found in Kerala.
- Analyze the green spaces in a local urban area and propose a plan to enhance urban ecology using native plants and sustainable design.

- Create a model of a sustainable urban landscape for a chosen locality in Kerala.

Module-III

- Study a local water body (e.g., a river or lake) for signs of pollution or natural flow disruption and suggest sustainable management and restoration practices.
- Analyse the effectiveness of water management in the college campus and propose improvements - calculate the water footprint, how to reduce the footprint, how to increase supply through rainwater harvesting, and how to decrease the supply-demand ratio
- Implement a zero waste initiative on the college campus for one week and document the challenges and outcomes.
- Develop a waste audit report for the campus. Suggest a plan for a zero-waste approach.
- Create a circular economy model for a common product used in Kerala (e.g., coconut oil, cloth etc).
- Design a product or service based on circular economy and degrowth principles and present a business plan.
- Develop a plan to improve pedestrian and cycling infrastructure in a chosen locality in Kerala

Module-IV

- Evaluate the potential for installing solar panels on the college campus including cost-benefit analysis and feasibility study.
- Analyse the energy consumption patterns of the college campus and propose sustainable alternatives to reduce consumption - What gadgets are being used? How can we reduce demand using energy-saving gadgets?
- Analyse a local infrastructure project for its climate resilience and suggest improvements.
- Analyse a specific environmental regulation in India (e.g., Coastal Regulation Zone) and its impact on local communities and ecosystems.
- Research and present a case study of a successful sustainable engineering project in Kerala/India (e.g., sustainable building design, water management project, infrastructure project).
- Research and present a case study of an unsustainable engineering project in Kerala/India highlighting design and implementation faults and possible corrections/alternatives (e.g., a housing complex with water logging, a water management project causing frequent floods, infrastructure project that affects surrounding landscapes or ecosystems).

SEMESTER S4

COMPUTER NETWORKING LAB

Course Code	PCERL407	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	GBEST204	Course Type	Lab

Course Objectives:

1. To analyze and implement various network communication and flow control protocols.
2. To simulate network congestion control and routing mechanisms alongside studying traffic analysis to develop skills in identifying and mitigating network congestion issues in diverse network environments...

Expt. No.	Experiments
1	Familiarize and understand basics of network configuration files, networking commands and the functioning of system calls used for network programming in Linux.*
2	Implement client-server communication using socket programming and TCP as transport layer protocol*
3	Implement client-server communication using socket programming and UDP as transport layer protocol*
4	Implement the framing methods employed in Data link layer.* a. Bit stuffing Character stuffing
5	Simulate sliding window flow control protocols.* a. Stop and Wait b. Go back N Selective Repeat
6	Implement and simulate algorithm for Distance Vector Routing protocol.*
7	Implement Simple Mail Transfer Protocol.
8	Implement File Transfer Protocol.*

9	Understanding the Wireshark tool.*
10	Implement congestion control using a leaky bucket algorithm.*
11	Study of NS2 simulator*
12	Design and configure a network with multiple subnets with wired and wireless LANs using required network devices. Configure commonly used services in the network.

Course Assessment Method
(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)	Internal Examination	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- ***Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.***
- ***Endorsement by External Examiner:*** *The external examiner shall endorse the record*

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Familiarize the fundamentals of networking commands, configuration files and the use of system calls for network programming.	**K2**
CO2	Implement and interpret client-server communication through socket programming, employing TCP and UDP as transport layer protocols.	**K3**
CO3	Implement simulation of sliding window flow control protocols routing protocols and framing methods using programmatic approach.	**K3**
CO4	Implement and simulate file transfer protocols and congestion control algorithms for networking	**K3**
CO5	Familiarize network configuration tools for configuring network with multiple subnets.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

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

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Computer Networks	Andrew S. Tanenbaum	PHI (Prentice Hall India)	4/e,2008
2	Data Communication and Networking	Behrouz A Forouzan	Tata McGraw Hill	4/e,2007

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Computer Networking and the Internet	Fred Halsall	Addison-Wesley.	5/e,2005
2	James F. Kurose, Keith W. Ross	Computer Networking: A Top-Down Approach	Pearson Education	6/e,2012
3	TCP/IP Sockets in C	Michael J Donahoo	Morgan Kaufmann Publishers	2/e
4	Hands-On Network Programming with C	Lewis Van Winkle	Packt Publishing	2019

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/106105183
2	https://nptel.ac.in/courses/106106091
3	https://onlinecourses.swayam2.ac.in/cec21_cs04/preview
4	https://onlinecourses.nptel.ac.in/noc22_cs19/preview

Continuous Assessment (25 Marks)

1. **Preparation and Pre-Lab Work (7 Marks)**

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. **Conduct of Experiments (7 Marks)**

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.

- Teamwork: Collaboration and participation in group experiments.

3. **Lab Reports and Record Keeping (6 Marks)**

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. **Viva Voce (5 Marks)**

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. **Procedure/Preliminary Work/Design/Algorithm (10 Marks)**

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. **Conduct of Experiment/Execution of Work/Programming (15 Marks)**

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. **Result with Valid Inference/Quality of Output (10 Marks)**

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted

SEMESTER S4

INTEGRATED CIRCUITS LAB

Course Code	PCERL 408	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PBERT 304:Electronic Devices and Circuits	Course Type	Lab

Course Objectives:

1. To impart ability to handle the various electronic instruments and trouble shoot circuits.
2. To gain hands-on experience in designing electronic circuits using integrated circuits, transistors and diodes.

Expt. No.	Experiments
1	Measurement of current, voltage, frequency and phase shift of signal in a RC network using oscilloscope.
2	Rectifier circuits with and without C filter.
3	Clipping and clamping circuits using diodes.
4	RC coupled amplifier using BJT in CE Configuration-Measurement of gain, BW and plotting of frequency response.
5	Op-amp circuits – Design and set up of inverting and non-inverting amplifier
6	Op-amps circuits – adder, integrator, and differentiator.
7	Precision rectifier using Op-amps.
8	Phase shift oscillator and Wien's Bridge oscillator using Op-amps.
9	Waveform generation– Square, triangular and saw tooth waveform generation using Op-amps.
10	Basic comparator and Schmitt trigger circuits using Op-amp
11	Astable and Monostable circuits using 555 IC.
12	D/A Converters - R-2R ladder circuit.

Course Assessment Method
(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)	Internal Examination	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- ***Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.***
- ***Endorsement by External Examiner:** The external examiner shall endorse the record*

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Use the various electronic instruments for conducting experiments	Apply
CO2	Design and develop various electronic circuits using diodes.	Apply
CO3	Design and implement amplifier and oscillator circuits using BJT	Apply
CO4	Design and implement basic circuits using IC (OPAMP and 555 timers).	Apply

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

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

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Electronic Devices and Circuit Theory	R E Boylstead and L Nashelsky	Pearson Education	11/e, 2015
2	Pulse, digital and Switching Waveforms,	Millman and Taub	Tata McGraw Hill	2007
3	Opamps and Linear Integrated circuits	Coughlin & Driscoll	Prentice Hall	6/e, 2009
4	Linear Integrated Circuits,	Choudhury R.,	New Age International Publishers	4/e, 2017

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	archive.nptel.ac.in/courses/108/108/108108111

Continuous Assessment (25 Marks)

1. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. **Conduct of Experiments (7 Marks)**

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. **Lab Reports and Record Keeping (6 Marks)**

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. **Viva Voce (5 Marks)**

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. **Procedure/Preliminary Work/Design/Algorithm (10 Marks)**

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. **Conduct of Experiment/Execution of Work/Programming (15 Marks)**

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted

SEMESTER 5

ELECTRONICS & COMPUTER ENGINEERING

SEMESTER S5

DIGITAL SIGNAL PROCESSING

Course Code	PCERT 501	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To understand the various design techniques and realization methods of FIR and IIR filters.
2. To describe signals mathematically and understand how to perform mathematical operations on signals.
3. To understand the analytical tools such as Discrete Time Fourier Transforms, Discrete Fourier Transforms, Fast Fourier Transforms and Z-Transforms required for digital signal processing.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Signals, Systems and Digital Signal Processing:** Continuous and Discrete Time Signals, Generation of Discrete Time Signals – Sampling, Elementary Discrete Time Signals. Classification of signals (Continuous and Discrete) - Periodic and Non-Periodic Signals, Energy and Power Signals, Even and odd signals. Operations on Signals (Continuous and Discrete) - Shifting, Folding, Scaling. Discrete Time Systems-Properties of Discrete Time Systems-Linearity, Time invariance, Causality, Stability. Linear Time Invariant (LTI) Systems – Convolution sum, Impulse response. Difference Equation representation of LTI Systems. Z-transform-Properties of Z-transform, Inverse Z-transform, System Transfer function. Basic Elements of Digital Signal Processing (DSP) System, Typical DSP applications.	**11**
2	**Frequency Domain Representation of Discrete-Time Signals:** Discrete Time Fourier Transform (DTFT), Discrete Fourier Transform (DFT)-	**10**

	Properties. Circular convolution and its relationship with linear convolution; Relationship between DTFT and DFT Efficient Computation of DFT: Fast Fourier Transform (FFT) Algorithms-Radix-2 Decimation in Time (DIT) and Decimation in Frequency (DIF) FFT Algorithms, IDFT computation using Radix-2 FFT Algorithms	
3	**Design of Digital Filters:** Classification of Digital filters: FIR Filter, IIR Filter. Types of filters-LPF, HPF, BPF, BSF Design of FIR Filters: Linear Phase FIR filters-Symmetric and Anti-symmetric FIR Filters, Gibbs Phenomenon, Design of linear phase FIR filters using Window method (Rectangular, Hamming and Hanning). Design of IIR Digital Filters: Analog Filters (Butterworth), Analog Butterworth Prototype LPF filter design, IIR Filter Design using Impulse Invariance, and Bilinear Transformation, Frequency Transformations in the Analog domain (LPF and HPF only)	**11**
4	**Realization of Digital Filters:** Structures for the realization of Discrete Time Systems: Block diagram and signal flow graph representations of filters. FIR Filter Structures: Linear Phase realization, Direct Form, Cascade Form. IIR Filter Structures: Direct Form, Cascade Form and Parallel Form. **DSP architecture:** Introduction to TMS320C67xx digital signal processor, Functional Block Diagram and Description. Finite word length effects in DSP systems: Introduction (analysis not required), fixed-point and floating- point DSP arithmetic, ADC quantization noise, Round-off error	**12**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Summarize the fundamental concepts of discrete-time signals, systems, digital signal processing and obtain the transfer function of system using Z-transform.	**K2**
CO2	Illustrate the fundamental concepts of DFT and compute DFT and IDFT.	**K2**
CO3	Design FIR filters and IIR filters for the given specifications.	**K3**
CO4	Realize the various FIR and IIR filter structures for given the system function	**K2**
CO5	Explain the architecture ofTMS320C67xxDSPprocessorandthe finite word length effects in DSP systems.	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Signal Processing	Proakis J. G. and Manolakis D. G.	Pearson Education	4/e, 2007
2	Discrete-Time Signal Processing	Alan V Oppenheim, Ronald W. Schafer	Pearson Education	3/e, 2014
3	Digital Signal Processing: A Computer Based Approach	Mitra S. K.	McGraw Hill	4/e, 2014

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Signal Processing: A Practical Approach	Ifeachor E.C. and Jervis B. W	Pearson Education	2/e,2009
2	Understanding Digital Signal Processing	Lyons, Richard G.	Pearson Education	3/e,2004
3	Digital Signal Processing	Salivahanan S	McGraw - Hill Education	4/e,2019
4	DSP applications using C and the TMS320C6x DSK.	Chassaing, Rulph	John Wiley & Sons	2003
5	Digital Signal Processing	Vinay K. Ing1e, John G. Proakis	Thomson	2004

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc21_ee28/preview
2	https://nptel.ac.in/courses/117105134
3	https://nptel.ac.in/courses/117102060
4	https://onlinecourses.nptel.ac.in/noc22_ee99/preview

SEMESTER S5

THEORY OF COMPUTATION

Course Code	PCERT 502	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Design and implement Java applications that leverage OOP principles to achieve modularity, reusability, and scalability in software development.
2. Understand and apply foundational object-oriented programming concepts in Java, including classes, objects, inheritance, polymorphism, encapsulation, and abstraction.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to formal language theory – Alphabets, Strings, Concatenation of strings, Languages. Regular Languages - Deterministic Finite State Automata (DFA), Nondeterministic Finite State Automata (NFA), Equivalence of DFA and NFA (Proof not required), Regular Grammar (RG), Equivalence of RGs and DFA (Proof not required).	11
2	Regular Expression (RE), Equivalence of REs and DFA (proof not required), Pumping Lemma for regular languages. Closure Properties of Regular Languages, DFA state minimization (Myhill-Nerode Theorem). Applications of MNT	11
3	Context Free Grammar (CFG), derivation trees and ambiguity. Nondeterministic Pushdown Automata (PDA), Deterministic Pushdown Automata (DPDA). Pumping Lemma for Context-Free Languages (Proof not required), Closure Properties of Context Free Languages.	11

4	Context Sensitive Languages - Context Sensitive Grammar (CSG), Linear Bounded Automata. Turing Machines - Standard Turing Machine, Robustness, Recursive and Recursively Enumerable Languages. Chomsky classification of formal languages.	**11**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Design and analyze deterministic and nondeterministic finite automata and understand their equivalence with regular grammars.	**K2**
CO2	Apply regular expressions, finite automata, the pumping lemma, closure properties, and the Myhill-Nerode Theorem for DFA minimization.	**K3**
CO3	Understand and apply context-free grammars, derivation trees, and ambiguity resolution, along with the design and analysis of nondeterministic and deterministic pushdown automata, the pumping lemma, and closure properties of context-free languages.	**K3**
CO4	Understand and apply context-sensitive grammars, linear bounded automata, standard Turing machines, and the classification of formal languages, including recursive and recursively enumerable languages.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Automata and Computability	Dexter C. Kozen	Springer	2007

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Automata Theory, Languages, and Computation	John E Hopcroft, Rajeev Motwani and Jeffrey D Ullman,	Pearson Education	3/e, 2008
2	Introduction To Theory of Computation	Michael Sipser,	Cengage Publishers	2014

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/104/106104148/
2	https://archive.nptel.ac.in/courses/106/104/106104148/
3	https://archive.nptel.ac.in/courses/106/104/106104148/
4	https://archive.nptel.ac.in/courses/106/104/106104148/

SEMESTER S5

MICROCONTROLLERS AND INTERFACING

Course Code	**PCERT 503**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	PCERT 402 Computer Organization and Architecture	**Course Type**	Core

Course Objectives:

1. To introduce the students to the architectural features of microcontrollers, capabilities of microcontroller and their utilisation.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**8051 Microcontroller:** Introduction, comparison of Microprocessor and microcontroller, Evolution of microcontrollers from 4-bit to 32-bit, Selection of microcontrollers, Applications of microcontrollers. 8051 Architecture-Registers, Pin diagram, I/O ports functions, Internal Memory organization. External Memory (ROM & RAM) interfacing.	**9**
2	Addressing modes and accessing memory using various addressing modes, instruction set: Arithmetic, Logical, Simple bit, jump, loop and call instructions, Stack, Stack and Subroutine instructions. Assembly language program examples	**9**
3	Timers and Counters, Interrupts, interfacing seven segment displays, displaying information on an LCD, control of a stepper Motor, ADC, DAC. 8051 Serial Communication- Basics of Serial Data Communication, RS- 232 standard, 9 pin RS232 signals, Simple Serial Port programming to transmit a message and to receive data serially.	**9**

4	ARM processor fundamentals – Registers, Current Program Status Register, Pipeline, Exceptions, Interrupts, and the Vector Table, Core Extensions, Architecture Revisions. Introduction to ARM family, ARM7 register architecture, ARM programmer's model. Raspberry pi 4 board - Introduction and brief description.	**9**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Identify features of various microcontroller	**K2**
CO2	Write and execute assembly language programs for given application	**K3**
CO3	Interface microcontroller with hardware for given application	**K3**
CO4	Able to understand architecture of the ARM Processor	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	The 8051 Microcontroller and Embedded Systems – using assembly and C	Muhammad Ali Mazidi Janice Gillespie Mazidi and Rollin D. McKinlay	Pearson	**2e, 2007**
2	The 8051 Microcontroller	Kenneth J. Ayala	Cengage	**3e, 2007**
3	ARM System - on-chip Architecture	Steve Furber	Pearson Education	**2e, 2001**
4	ARM System Developer's guide	Andrew N. Sloss, Dominic Symes, Chris Wright	Morgan Kaufman	**2004**
5	Microcontrollers: Architecture, Programming, Interfacing and System Design	Raj Kamal	Pearson Education	**2005**

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	The 8051 Microcontroller Based Embedded Systems	Manish K Patel	McGraw Hill	**2014**

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/108/105/108105102/
2	https://archive.nptel.ac.in/courses/108/105/108105102/
3	https://archive.nptel.ac.in/courses/108/105/108105102/
4	https://archive.nptel.ac.in/courses/108/105/108105102/

SEMESTER S5

DATABASE MANAGEMENT SYSTEMS

Course Code	**PBERT504**	**CIE Marks**	60
Teaching Hours/Week (L: T:P: R)	3:0:0:1	**ESE Marks**	40
Credits	4	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)		**Course Type**	Theory

Course Objectives:

1. Gain a comprehensive understanding of database fundamentals, including the architecture, languages, and classification of database management systems (DBMS).
2. Develop skills in designing and implementing databases using the Entity-Relationship (ER) model and relational model, including translating ER diagrams into relational schema and performing normalization.
3. Acquire knowledge of database concepts such as transaction processing, concurrency control, recovery mechanisms, and the characteristics and types of NoSQL databases.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basics of Database - Introduction and applications of DBMS, Purpose of database, View of Data, Database Languages, Database architecture and Classification, Database users and Administrators. ER model - Entity Sets, Relationship Sets, Attributes, Constraints, Removing Redundant Attributes in Entity Sets, Entity-Relationship Diagrams. Introduction to Relational Model - Structure of Relational Databases, Database Schema, Keys, Schema Diagrams, Relational Query Languages, Relational Algebra, Synthesizing ER diagram to relational schema.	**10**
2	Introduction to Structured Query Language (SQL) - Overview of the SQL Query Language, SQL Data Definition, Basic Structure of SQL Queries, Additional Basic Operations, Set Operations, Null Values, Aggregate Functions, Nested Subqueries, Views, assertions, Triggers.	**9**

3	Relational Database Design - Different anomalies in designing a database, the idea of normalization, Functional dependency, Armstrong's Axioms (proofs not required), Closures and their computation, Equivalence of Functional Dependencies (FD), Minimal Cover (proofs not required). First Normal Form (1NF), Second Normal Form (2NF), Third Normal Form (3NF), Boyce Codd Normal Form (BCNF).	**8**
4	Transaction Processing Concepts - overview of concurrency control, Transaction Model, Significance of concurrency Control & Recovery, Transaction States, System Log, Desirable Properties of transactions. Serial schedules, Concurrent and Serializable Schedules, Conflict equivalence and conflict serializability, Recoverable and cascade-less schedules, Locking, Two-phase locking and its variations. Log-based recovery, check-pointing. NoSQL Databases - Introduction, properties of NoSQL Databases, types of No SQL Databases.	**9**

Course Assessment Method

(CIE: 60 marks, ESE: 40 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination-2 (Written)	Total
5	**30**	**12.5**	**12.5**	**60**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 2 marks **(8x2 =16 marks)**	• Each question carries 6 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x6 = 24 marks)**	**40**

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Comprehend and exemplify the fundamental nature and characteristics of database systems, and model real-world scenarios using Entity-Relationship diagrams.	Apply
CO2	Develop and execute efficient queries to create, manage, and retrieve data in relational databases.	Apply
CO3	Demonstrate the features of Normalization in database applications.	Apply
CO4	Discuss and compare the aspects of Concurrency Control and Recovery in Database systems.	Apply
CO5	Explain various types of NoSQL databases.	Understand

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Database Systems: Models, Languages, Design and Application Programming	Elmasri R. and S. Navathe	Pearson Education	6/e, 2013
2	Database System Concepts	Sliberschatz A., H. F. Korth and S. Sudarshan	McGraw Hil	6/e, 2011

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	NoSQL Data Models: Trends and Challenge	**Olivier Pivert (Editor)**	Wiley	2018
2	NoSQL for Dummies	Adam Fowler	John Wiley & Sons	**2015**

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/106105175
2	https://www.coursera.org/learn/sql-data-science
3	https://www.udemy.com/course/database-normalization-simplified
4	https://archive.nptel.ac.in/courses/106/104/106104135/

SEMESTER S5

WIRELESS SENSOR NETWORKS

Course Code	**PEERT 521**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	4/3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To understand the fundamentals of wireless sensor networks and its applications.
2. To study the various protocols at various layers.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction and Overview of Wireless Sensor Networks: Background of Sensor Network Technology – Application of Sensor Networks-Basic overview of the technology- Basic Sensor Network Architectural Elements-Survey of Sensor Networks - Applications of Sensor Networks: Introduction-Background-Range of Applications-Examples of Category 2 WSN Applications- Examples of Category 1 WSN Applications-Taxonomy of WSN Technology.	**9**
2	Basic Wireless Sensor Technology: Introduction-Sensor Node Technology-Sensor Taxonomy. WN Operating Environment- WN Trends -Wireless Transmission Technology and Systems: Radio Technology Primer-Propagation and Propagation Impairments- Available Wireless Technologies-Campus Applications- MAN/WAN Applications.	**9**
3	Medium Access Control Protocols for Wireless Sensor Networks: Introduction- BackgroundFundamentals of MAC Protocols-Performance Requirements-Common Protocols-MAC Protocols for WSNs-Sensor-MAC Case Study-IEEE 802.15.4 LR –WPANs Standard Case Study-PHY Layer-	**9**

	MAC Layer.	
4	Routing Protocols for Wireless Sensor Networks: Data Dissemination and Gathering-Routing Challenges and Design Issues in Wireless Sensor Networks-Routing Strategies in Wireless Sensor Networks- Transport Control Protocols for Wireless Sensor Networks: Traditional Transport Control Protocols- Transport Protocol Design Issues- Examples of Existing Transport Control Protocols-Performance of Transport Control Protocols-Middleware for Wireless Sensor Networks : WSN Middleware Principles-Middleware Architecture-Existing Middleware.	**9**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Describe the overview of wireless sensor networks and wireless sensor node architectures.	**K2**
CO2	Discuss the basic Wireless Sensor Technology and its applications.	**K2**
CO3	Explain the MAC protocols developed for WSN.	**K2**
CO4	Describe the infrastructure, topology, routing, Challenges and Design Issues for wireless sensor networks	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
SL No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Wireless Sensor Networks: Technology, Protocols, and Applications	Kazem Sohraby, Daniel Minoli and Taieb Znati	John Wiley & Sons	2007

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Protocols and Architectures for Wireless Sensor Networks	Holger Karl and Andreas Willig	John Wiley & Sons	2007
2	Handbook of Sensor Networks:Compact Wireless and Wire Sensing System	Mohammad Ilyas and Imad MahGoub	CRC Press	2005

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/106/105/106105160/
2	https://onlinecourses.swayam2.ac.in/arp19_ap52/preview
3	https://cse.iitkgp.ac.in/~smisra/course/wasn.html
4	https://youtu.be/ycaz99NogS4?si=TemMsONNFER22HeQ, https://youtu.be/PssAY3wgQqE?si=qRTYWduHXZRb4-6-

SEMESTER S5

CMOS VLSI DESIGN

Course Code	PEERT 522	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To understand the basic MOS inverter and its characteristics
2. To outline the performance parameters of CMOS circuits
3. To discuss the various combinational and sequential CMOS circuits
4. To explain the static and dynamic logic circuits

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	The MOS Inverter: Principle, Depletion and enhancement load inverters. The basic CMOS inverter, logic threshold, Noise margins, and Dynamic behaviour. Propagation Delay, Power Consumption, Latch-up in CMOS circuits, Tristate inverter, Bi CMOS inverter. Performance parameters: Static, dynamic and short circuit power dissipations; Propagation delay; Power delay product	9
2	Combinational MOS Logic Circuits: MOS logic circuits with NMOS loads Primitive CMOS logic gates – NOR & NAND gate, Complex Logic circuits design –Realizing Boolean expressions using NMOS gates and CMOS gates, AOI and OAI gates. Sequential MOS Logic Circuits: Behaviour of bi-stable elements, SR Latch, Clocked latch and flip flop circuits, CMOS D latch and edge triggered flip-flop.	9

3	Static Logic Circuits: Pseudo-NMOS – Full complementary CMOS, Ratioed logic, Pass Transistor Logic Pass Transistor Logic (PTL) families: DPTL, CPTL - DCVS, CMOS transmission gates, Designing with Transmission gates	**9**
4	Dynamic pass transistor circuits, Dynamic CMOS transmission gate logic High performance Dynamic CMOS circuits, N-P Dynamic logic - Domino logic - NORA logic - TSPC logic - Multiple output Domino logic - Dynamic NORA	**9**

Course Assessment Method

(CIE: 40 marks , ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
● 2 Questions from each module. ● Total of 8 Questions, each carrying 3 marks **(8x3 = 24marks)**	● Each question carries 9 marks. ● Two questions will be given from each module, out of which 1 question should be answered. ● Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Analyse CMOS Inverter characteristics	**K3**
CO2	Explain various combinational and sequential circuits	**K2**
CO3	Explain static logic circuits	**K2**
CO4	Explain dynamic logic circuits	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	CMOS Digital Integrated Circuits-Analysis and Design	Sung- Mo- Kang, Yusuf Leblebici	TATA McGraw-Hill	3e, 2003
2	CMOS VLSI Design, a Circuits and Systems Perspective	Neil H. E. Weste, David Money Harris	PEARSON	4e, 2015

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Integrated Circuits- A Design Perspective	J.M. Rabaey, A. Chandrakasan and B. Nikolic	PHI	**2e, 2016**
2	CMOS Logic Circuit Design	John P. Uyemura	Springer India Pvt. Ltd	**2005**

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1,2,3,4	https://archive.nptel.ac.in/courses/108/107/108107129/

SEMESTER S5

SENSORS AND ACTUATORS

Course Code	PCECT523	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. The course aims to provide students with comprehensive knowledge in the principles, design, and application of various sensors and actuators used in real-world applications..

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Sensors and actuators**: Block diagram of a closed loop control System, Sensors and Transducers, Sensors Classification, Sensor Characteristics - Transfer Function, Calibration, Span (Full Scale Input), Full-Scale Output, Accuracy, Precision, Hysteresis, Nonlinearity, Saturation, Repeatability, Dead Band, Sensitivity, Resolution.	9
2	Position and Displacement Sensors - Potentiometric Sensors, Capacitive Sensors, LVDT, Hall Effect Sensors Pressure Sensors -Mercury Pressure Sensor, Bellows, Membranes, and Thin plates, Piezoresistive Sensors, Capacitive Sensors. Force, Strain, and Tactile Sensors - Strain Gauges, Tactile Sensors - Switch Sensors, Piezoelectric Sensors,Piezoresistive Sensors, Capacitive Touch Sensors, Acoustic Touch Sensors, Optical Touch Sensors, Piezoelectric Force Sensors.	9
3	Flow Sensors - Ultrasonic FlowSensors, Electromagnetic FlowSensors. Temperature Sensors - Resistance Temperature Detectors, Thermistors, Thermocouple.	9

	Proximity Sensors - PIR sensors. Ultrasonic proximity sensors. Smart Sensors - Block Diagram, Difference between Normal Sensor & Smart Sensor, Advantages, Disadvantages and Applications.	
4	**Actuators**: - Definition- classification-Electric, Hydraulic, Pneumatic actuators. Hydraulic System - Physical Components and typical circuit. Hydraulic actuators - Linear actuators, Rotary actuators - Gear motor, vane motor. Pneumatic System - Components and typical circuit. Pneumatic Actuators - Bellows actuator, Flapper-nozzle, Diaphragm actuators for industrial control valves. Electric actuators- Solenoids, Stepper motors, DC motors, DC servo motors. Electro-Pneumatic actuator; rotary output actuators, Linear output actuators.	**9**

Course Assessment Method

(CIE: 40 marks , ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Understand Sensor Fundamentals	**K2**
CO2	Explain the basic principles and concepts of commonly used different types of sensors, including their purpose, how they work, and the various types of sensors available.	**K2**
CO3	Understand the working principles of smart sensors	**K2**
CO4	Understand the basic idea of Actuator Fundamentals and the working principle of different types of actuators.	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

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

Text Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Handbook of Modern Sensors	Jacob Fraden	Springer	Fourth Edition, 2010
2	Hydraulics and Pneumatics	Andrew Parr	Elsevier Science	Second edition, 1999
3	Process Control	K. Krishnaswamy	New Age International	Second edition,2009

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Sensors and Actuators in Mechatronics, Design and Applications	Andrzej M. Pawlak	Taylor & Francis Group	2006
2	Mechatronic systems, Sensors and Actuators Fundamentals and Modelling	Robert H. Bishop	Taylor & Francis Group	2007
3	Process Control Instrumentation Technology	Curtis D. Johnson	Pearson/Prentice Hall	2006
4	Sensors and Transducers	D. Patranabis	PHI Learning	2004

Video Links (NPTEL, SWAYAM…)	
Module No.	Link ID
1	https://onlinecourses.nptel.ac.in/noc21_ee32/preview
2	https://onlinecourses.nptel.ac.in/noc21_ee32/preview
3	https://onlinecourses.nptel.ac.in/noc21_ee32/preview
4	https://onlinecourses.nptel.ac.in/noc21_ee32/preview

SEMESTER S5

CLOUD COMPUTING

Course Code	PEERT524	CIE Marks	60
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	40
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Understand Cloud Computing Fundamentals.
2. Explore Cloud Technologies and Platforms.
3. Apply Cloud Solutions and Ensure Security.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Traditional computing- Limitations. Overview of Computing Paradigms- Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing. NIST reference Model-Basic terminology and concepts. Cloud characteristics, benefits and challenges, Roles and Boundaries. Cloud delivery (service) models-Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), Software-as-a-Service (SaaS), XaaS (Anything-as-a-service) - Cloud deployment models- Public cloud, Community cloud, Private cloud, Hybrid cloud.	8
2	Introduction to virtualization-Virtualizing physical computing resources, Virtual Machines (Machine virtualization), non-virtualized v/s virtualized machine environments. Types of VMs- process VM v/s system VM, Emulation, interpretation and binary translation. Hardware-level virtualization- Hypervisors/VMM. Types of Hypervisors. Full Virtualization, Para- Virtualization, Hardware-assisted virtualization, OS level virtualization. Basics of Network Virtualization, Storage Virtualization and Desktop Virtualization, Pros and cons of virtualization.	8

3	Broadband networks and internet architecture- Internet Service Providers (ISPs), Data center technology, Web technology, Multitenant technology, Service technology. Resource provisioning techniques-static and dynamic provisioning. Open-source software platforms for private cloud-OpenStack, Cloud Stack, Basics of Eucalyptus, Open Nebula, Nimbus. Cloud Programming- Parallel Computing and Programming Paradigms. Map Reduce – Hadoop Library from Apache, HDFS, Pig Latin High Level Languages, Apache Spark.	**8**
4	Basic terms and concepts in security- Threat agents, Cloud security threats/risks, Trust. Operating system security-Virtual machine security-Security of virtualization- Security Risks Posed by Shared Images, Security Risks Posed by Management OS. Infrastructure security- Network Level Security, Host Level Security, Application level security, Security of the Physical Systems. Identity & Access Management- Access Control. **Amazon Web Services (AWS)**:- AWS ecosystem- Computing services, Amazon machine images, Elastic Compute Cloud (EC2), Advanced compute services. Storage services-Simple Storage System (Amazon S3), Elastic Block Store (Amazon EBS). **Google Cloud Platform**:- IaaS Offerings: Compute Engine (GCE), Cloud Storage, PaaS Offerings: Google App Engine (GAE), Storage services, Application services, Compute services, Database Services, SaaS Offerings: Gmail, Docs, Google Drive. **Microsoft Azure:** Azure Platform Architecture, Hyper-V, Azure Virtual Machine, Compute services, Storage services.	**12**

Course Assessment Method
(CIE: 60 marks, ESE: 40 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	30	12.5	12.5	60

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 2 marks **(8x2 =16 marks)**	• Each question carries 6 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x6 = 24 marks)**	**40**

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Explain the various cloud computing models and services.	**K2**
CO2	Demonstrate the significance of implementing virtualization techniques.	**K2**
CO3	Explain different cloud enabling technologies and compare private cloud platforms	**K2**
CO4	Apply appropriate cloud programming methods to solve big data problems	**K3**
CO5	Describe the need for security mechanisms in cloud and compare the different popular cloud computing platforms	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Cloud Computing Concepts, Technology &Architecture	Thomas, E., Zaigham M., Ricardo P	Prentice Hall	2013
2	Mastering cloud computing: foundations and applications programming	Buyya, R., Vecchiola, C., & Selvi, S. T.	Morgan Kaufmann	2017
3	Cloud computing	Bhowmik, S	Cambridge University Press	2017

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Cloud computing: theory and practice	Marinescu, D. C	Morgan Kaufmann	2017
2	Cloud computing: Principles and paradigms	Buyya, R., Broberg, J., & Goscinski, A. M	John Wiley & Sons.	2011

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/105/106105167/
2	https://onlinecourses.nptel.ac.in/noc23_cs90/preview
3	https://onlinecourses.nptel.ac.in/noc22_cs18/preview
4	https://archive.nptel.ac.in/courses/106/105/106105167/

SEMESTER S5

PYTHON BASICS FOR MACHINE LEARNING

Course Code	PEERT526	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	2:1:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	UCEST105	Course Type	Theory

Course Objectives:

1. To provide foundational Python programming skills and data manipulation techniques.
2. Enabling learners to handle data, create visualizations, and apply basic machine learning algorithms using Python.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Programming Environment and Python Basics:** Getting Started with Python Programming - interactive shell, Editing, Saving, and Running a script. How python works? Using editors - IDLE, Jupyter. Basic coding skills - Working with data types, Numeric data types and Character sets, Strings, Keywords, Variables and Assignment statement, Operators, Expressions. Type conversions, Comments in the program. Input, Processing, and Output. Formatting text for output.	8
2	**Building Python Programs:** Data representation: List, tuple, Sets, Dictionary. Work with dates and times. Control statements - Selection structure (if-else, switch-case), Iteration with for/while loop, Testing the control statements. Functions - Hiding redundancy and complexity, Arguments and return values, Variable scopes and parameter passing, Named arguments, Main function, Working with recursion, Lambda functions.	9

3	**Object Oriented Programming:** Design with classes - Objects and Classes, Methods, Instance Variables, Constructor, Accessors and Mutators. Structuring classes with Inheritance and Polymorphism. Abstract Classes, Interfaces. Exceptions - Handle a single exception, handle multiple exceptions.	9
4	**Data Processing:** The *os* and *sys* modules. Introduction to file I/O - Reading and writing text files, Manipulating binary files. NumPy - Basics, Creating arrays, Arithmetic, Slicing, Matrix Operations, Random numbers. Plotting and visualization. Working with CSV files. Pandas - Reading, Manipulating, and Processing Data. Introduction to Micro service using Flask.	10

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Write, test and debug Python programs	**K3**
CO2	Illustrate uses of conditional, and iterative statements in Python programs	**K3**
CO3	Develop programs by utilizing the modules Lists, Tuples, Sets and Dictionaries in Python	**K3**
CO4	Implement Object Oriented programs with exception handling	**K3**
CO5	Write programs in Python to process data stored in files by utilizing the modules Numpy, Pandas	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping od Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Fundamentals of Python : First Programs	Kenneth A Lambert.	Cengage Publishing	2/e, 2016
2	Python for Data Analysis	Wes McKinney	Shroff / O'Reilly Publishers	2/e, 2017
3	Flask: Building Python web services	Jack Stouffer, Shalabh Aggarwal, Gareth Dwyer	PACKT Publishing Limited	2018

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Learn Python 3 The Hard Way	Zed A Shaw	Addison-Wesley	2017
2	Think Python: How to Think Like a Computer Scientist	Allen B. Downey	Schroff	2/e, 2016
3	Python Programming	Michael Urban and Joel Murach	Shroff/Murach	2016
4	Python Essential Reference	David M.Baezly	Addison-Wesley Professional	4/e, 2009
5	Python for Informatics: Exploring Information	Charles Severance	CreateSpace Independent Publishing Platform	2013

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.swayam2.ac.in/cec22_cs20/preview
2	https://onlinecourses.nptel.ac.in/noc22_cs32/preview
3	https://onlinecourses.nptel.ac.in/noc19_cs52/preview

SEMESTER S5

COMPUTATIONAL FUNDAMENTALS FOR MACHINE LEARNING

Course Code	**PEERT525**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	5/3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. The purpose of this course is to introduce mathematical foundations of basic Machine Learning concepts among learners, on which Machine Learning systems are built.
2. This course helps the learners to understand the mathematical principles in Machine Learning and aid in the creation of new Machine Learning solutions, understand & debug existing ones, and learn about the inherent assumptions & limitations of the current methodologies.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	LINEAR ALGEBRA: Systems of Linear Equations – Matrices, Solving Systems of Linear Equations. Vector Spaces –Vector Spaces, Linear Independence, Basis and Rank. Linear Mappings – Matrix Representation of Linear Mappings, Basis Change, Image and Kernel. OPTIMIZATION: Optimization Using Gradient Descent - Gradient Descent with Momentum, Stochastic Gradient Descent. Constrained Optimization and Lagrange Multipliers - Convex Optimization - Linear Programming - Quadratic Programming.	**12**
2	ANALYTIC GEOMETRY, MATRIX DECOMPOSITIONS: Norms, Inner Products, Lengths and Distances, Angles and Orthogonality, Orthonormal Basis, Orthogonal Complement, Orthogonal Projections – Projection into One Dimensional Subspaces, Projection onto General Subspaces, Gram-	**8**

	Schmidt Orthogonalization. Determinant and Trace, Eigenvalues and Eigenvectors, Cholesky Decomposition, Eigen decomposition and Diagonalization, Singular Value Decomposition, Matrix Approximation.	
3	VECTOR CALCULUS: Differentiation of Univariate Functions - Partial Differentiation and Gradients, Gradients of Vector Valued Functions, Gradients of Matrices, Useful Identities for Computing Gradients. Back propagation and Automatic Differentiation – Gradients in Deep Network, Automatic Differentiation. Higher Order DerivativesLinearization and Multivariate Taylor Series.	**8**
4	Probability and Distributions: Construction of a Probability Space - Discrete and Continuous Probabilities, Sum Rule, Product Rule, and Bayes' Theorem. Summary Statistics and Independence – Gaussian Distribution - Conjugacy and the Exponential Family - Change of Variables/Inverse Transform.	**8**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Internal exam	Evaluate	Analyse	Total
5	**15**	**10**	**10**	**40**

Assignment: 20 Marks

Students should evaluate and analyze a real-world problem, assess the proposed solutions, provide a conclusion on which solution is most appropriate for the problem.

Criteria for evaluation:

1. ***Problem Definition (K4 - 4 points)***
   a. *Clearly defines the real-world problem.*
   b. *Examine and identifies relevant contextual factors (constraints, resources, objectives).*
2. ***Problem Analysis (K4 - 4 points)***
   a. *Break-down and presents a well-reasoned solution approach.*
   b. *Compare and justify the proposed solutions with evidence and logical reasoning.*
3. ***Evaluate (K5 - 4 points)***
   a. *Thoroughly evaluate the proposed solutions.*

b. *Compares trade-offs, advantages, and disadvantages.*

c. *Considers feasibility, scalability, and practical implications.*

4. ***Implementation (K5 - 4 points)***

a. *Select the most feasible solution by implementing the proposed solutions.*

b. *Successfully translates the chosen solution into code.*

c. *Demonstrates proficiency in coding practices (readability, efficiency, error handling).*

5. ***Conclusion (K4- 2 points, K5 – 2 points)***

a. *Summarizes findings and insights. State which solution is most appropriate for the problem.* ***(K4)***

b. *Reflects critical thinking and informed decision-making.* ***(K5)***

Scoring:

1. ***Accomplished (4 points)****: Exceptional analysis, clear implementation, and depth of understanding.*
2. ***Competent (3 points)****: Solid performance with minor areas for improvement.*
3. ***Developing (2 points)****: Adequate effort but lacks depth or clarity.*
4. ***Minimal (1 point)****: Incomplete or significantly flawed.*

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Make use of the concepts, rules and results about linear equations, matrix algebra, vector spaces, eigenvalues & eigenvectors and orthogonality & diagonalization to solve computational problems.	Apply
CO2	Perform calculus operations on functions of several variables and matrices, including partial derivatives and gradients.	Apply
CO3	Utilize the concepts, rules and results about probability, random variables, additive & multiplicative rules, conditional probability, probability distributions and Bayes' theorem to find solutions of computational problems.	Apply
CO4	Train Machine Learning Models using unconstrained and constrained optimization methods.	Evaluate

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Mathematics for Machine Learning	Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong	Cambridge University Press	2020

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Linear Algebra and Its Applications	Gilbert Strang	Cengage India Private Limited	4e/2014
2	Linear Algebra Done Right	Axler, Sheldon	Springer	2015
3	Introduction to Applied Linear Algebra	Stephen Boyd and Lieven Vandenberghe	Cambridge University Press	2018
4	Convex Optimization	Stephen Boyd and Lieven Vandenberghe	Cambridge University Press	2004
5	Pattern Recognition and Machine Learning	Christopher M Bishop	Springer	2009
6	Learning with Kernels – Support Vector Machines, Regularization, Optimization, and Beyond	Bernhard Scholkopf and Smola, Alexander J Smola	MIT Press	2002
7	Information Theory, Inference, and Learning Algorithms	David J. C MacKay	Cambridge University Press	2003
8	Machine Learning: A Probabilistic Perspective	Kevin P Murphy	MIT Press	2012
9	The Nature of Statistical Learning Theory	Vladimir N Vapnik	Springer	2000

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/106/106106139/

SEMESTER: S5

DIGITAL SIGNAL PROCESSING LABORATORY

Course Code	**PCERL 507**	**CIE Marks**	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	**ESE Marks (Internal only)**	50
Credits	2	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	PCERT 501 Digital Signal Processing GYEST 204 Programming in C	**Course Type**	Lab

Course Objectives:

1. Simulate DSP algorithms using MATLAB/PYTHON/OCTAVE/SCILAB
2. Perform real time DSP computing on development boards

Expt. No.	**Experiments**
	PART-A **Experiments based on MATLAB/PYTHON/SCILAB/OCTAVE** **(7 experiments are mandatory**
1	Generation of Waveforms (Continuous and Discrete).
2	Time and Frequency Response of LTI systems (First and second order).
3	Linear Convolution, Circular Convolution and Linear Convolution using Circular Convolution.
4	To find the DFT and IDFT for the given input sequence.
5	Linear convolution using DFT.
6	To find FFT and IFFT for the given input sequence.
7	FIR and IIR filter design using Filter Design Toolbox.
8	FIR Filter (Low-pass, High-pass and Band-pass) design (Window method).
9	IIR Filter (Low-pass, High-pass) design (Butterworth).
	Part -B

	Experiments on Digital Signal Processor/ DSP kits (3 experiments are mandatory)
1.	Generation of sine wave and standard test signals.
2.	Convolution: Linear and Circular.
3.	Real time FFT of the signal using a real-time input signal.
4.	Real Time FIR Filter implementation (Low-pass, High-pass) using a real-time input Signal

Course Assessment Method
(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)	Internal Examination	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- ***Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.***
- ***Endorsement by External Examiner:*** *The external examiner shall endorse the record*

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Simulate digital signals.	**K2**
CO2	Understand LTI systems and its properties	**K2**
CO3	Simulate efficient DFT algorithms and digital filters	**K2**
CO4	Familiarize the DSP hardware and interface with computer.	**K2**
CO5	Understand the spectrum of real time signals.	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

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

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Signal Processing, A Practical approach	Sanjit K. Mitra	Tata McGraw Hill Publishing Company Limited	2005
2	*Digital signal processing using MATLAB*.	Ingle, Vinay K., and John G. Proakis	Brooks/Cole Publishing Co.,	1999
3	*Think DSP: digital signal processing in Python*.	Downey, Allen	O'Reilly Media, Inc.	2016

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Digital Signal Processing Principles, Algorithms, Applications	John G Proakis, G. Manolakis,	Prentice Hall India Private Limited, Fourth Edition	2007
2	Discrete time Signal Processing	Allen V. Oppenheim, Ronald W. Schafer	Prentice Hall India Private Limited, Fifth Edition	200
3	DSP applications using C and the TMS320C6x DSK.	Chassaing, Rulph	John Wiley & Sons	2003

Video Links (NPTEL, SWAYAM…)	
Module No.	Link ID
1	https://onlinecourses.nptel.ac.in/noc19_ee50/preview
2	https://onlinecourses.nptel.ac.in/noc21_ee20/preview
3	https://onlinecourses.nptel.ac.in/noc22_ee62/preview

Continuous Assessment (25 Marks)

1. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (7 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.

- Teamwork: Collaboration and participation in group experiments.

3. **Lab Reports and Record Keeping (6 Marks)**

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. **Viva Voce (5 Marks)**

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. **Procedure/Preliminary Work/Design/Algorithm (10 Marks)**

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. **Conduct of Experiment/Execution of Work/Programming (15 Marks)**

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. **Result with Valid Inference/Quality of Output (10 Marks)**

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted

SEMESTER S5

DATABASE MANAGEMENT SYSTEMS LAB

Course Code	**PCERL508**	**CIE Marks**	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	**ESE Marks**	50
Credits	2	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	PBERT504 Database Management Systems	**Course Type**	Lab

Course Objectives:

1. Enable students to design, create, and manage databases using practical tools.
2. Equip students with the skills to write and execute SQL queries for various database operations.
3. Introduce students to NoSQL databases and Big Data technologies like MongoDB for handling large datasets

Details of Experiment

Expt. No	Experiment
1	Design a database schema for an application with ER diagram from a problem description
2	Creation, modification, configuration, and deletion of databases using UI and SQL Commands
3	Creation of database schema - DDL (create tables, set constraints, enforce relationships, create indices, delete and modify tables)
4	Database initialization - Data insert, Data import to a database
5	Practice SQL commands for DML (insertion, updating, altering, deletion of data, and viewing/querying records based on condition in databases)
6	Implementation of built-in functions in RDBMS
7	Implementation of various aggregate functions in SQL
8	Implementation of Order By, Group By & Having clause
9	Implementation of set operators nested queries, and join queries
10	Practice of SQL TCL commands like Rollback, Commit, Save point
11	Practice of SQL DCL commands for granting and revoking user privileges

12	Practice of SQL commands for creation of views and assertions
13	Implementation of various control structures like IF-THEN, IF-THEN-ELSE, IF-THEN-ELSIF, CASE, WHILE using PL/SQL
14	Creation of Procedures, Triggers and Functions
15	Creation of Packages
16	Creation of Cursors
17	Familiarization of NoSQL Databases and CRUD operations
18	Design a database application using any front-end tool for any problem selected. The application constructed should have five or more tables

Course Assessment Method (CIE: 50 Marks, ESE 50 Marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work, experiments, Viva and Timely completion of Lab Reports / Record. (Continuous Assessment)	Internal Exam	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

Mandatory requirements for ESE:

- Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.
- Endorsement by External Examiner: The external examiner shall endorse the record.

Course Outcomes (COs)

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

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Design database schema for a given real world problem-domain using standard design and modeling approaches.	**K3**
CO2	Construct queries using SQL for database creation, interaction, modification, and updation.	**K3**
CO3	Design and implement triggers and cursors.	**K3**
CO4	Implement procedures, functions, and control structures using PL/SQL**.**	**K3**
CO5	Perform CRUD operations in NoSQL Databases.	**K6**

K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table

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

1: Slight (Low),2: Moderate (Medium),3: Substantial (High), : No Correlation

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Database Systems: Models, Languages, Design and Application Programming	Elmasri R. and S. Navathe	Pearson Education	6/e, 2013
2	Database System Concepts	Sliberschatz A, H.F.Korth and Sudarshan	McGraw Hill	6/e, 2011

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	NoSQL Data Models: Trends and Challenge	Wiley		2018
2	NoSQL for Dummies	John Wiley & Sons		2015

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://nptel.ac.in/courses/106105175
2	https://www.coursera.org/learn/sql-data-science
3	https://www.udemy.com/course/database-normalization-simplified
4	https://archive.nptel.ac.in/courses/106/104/106104135/

Continuous Assessment (25 Marks)

1. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (7 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (6 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.

- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (5 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. Procedure/Preliminary Work/Design/Algorithm (10 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. Conduct of Experiment/Execution of Work/Programming (15 Marks)

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted

SEMESTER 6

ELECTRONICS & COMPUTER ENGINEERING

SEMESTER S6

OPERATING SYSTEMS

Course Code	**PCERT601**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	**ESE Marks**	60
Credits	4	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	GYEST204, PCCST302	**Course Type**	PC

Course Objectives:

1. Gain a comprehensive understanding of the basic functionalities, structure and components of modern operating systems.
2. Gain proficiency in tasks such as process creation, synchronization, and deadlock handling.
3. Understand the trade-offs involved in choosing between different scheduling algorithms, memory management strategies, and file system structures.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction:** Operating system overview – Operations, Functions, Service – System calls, Types – Operating System structure - Simple structure, Layered approach, Microkernel, Modules– System boot process. **Processes** - Process states, Process control block, threads, scheduling, Operations on processes - process creation and termination – Inter-process communication - shared memory systems, Message passing systems.	**11**
2	**Process Scheduling** – Basic concepts- Scheduling criteria -scheduling algorithms- First come First Served, Shortest Job First, Priority scheduling, Round robin scheduling. **Deadlocks:** Necessary conditions, Resource allocation graphs, Deadlock prevention, Deadlock avoidance – Banker's algorithms, Deadlock detection, Recovery from deadlock.	**12**

3	**Process synchronization-** Race conditions – Critical section problem – Peterson's solution, Synchronization hardware, Mutex Locks, Semaphores, Classic Synchronization problems - Producer Consumer, Dining Philosophers and Readers-Writers.	**9**
4	**Memory Management:** Concept of address spaces, Swapping, Contiguous memory allocation, fixed and variable partitions, Segmentation, Paging. Virtual memory, Demand paging, Page replacement algorithms. **File System:** File concept - Attributes, Operations, types, structure – Access methods, Protection. File-system implementation, Directory implementation. Allocation methods. **Storage Management:** Magnetic disks, Solid-state disks, Disk Structure, Disk scheduling, Disk formatting.	**12**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Explain the relevance, structure and functions of Operating Systems in computingdevices along with the concepts of process management mechanisms employed in Operating Systems.(**Cognitive knowledge: Understand**)	**K2**
CO2	Illustrate the mechanisms for process scheduling and deadlock handling. (**Cognitive knowledge: Apply**)	**K3**
CO3	Explain the tools and mechanisms for process synchronization in Operating Systems (**Cognitive knowledge: Understand**)	**K2**
CO4	Elaborate on memory management and storage management techniques in Operating Systems. **(Cognitive knowledge: Apply)**	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Operating System Concepts	Abraham Silberschatz, Peter Baer Galvin, Greg Gagne,	Wiley India	9th Edition, 2015

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Modern Operating Systems	Andrew S Tanenbaum,	Prentice Hall	4th Edition, 2015
2	Operating systems	William Stallings,	Pearson, Global Edition	6th Edition, 2015.
3	Operating Systems	Garry Nutt, Nabendu Chaki, Sarmistha Neogy,	Pearson Education.	3rd Edition
4	Operating Systems	D.M.Dhamdhere,	Tata McGraw Hill	2nd Edition, 2011.
5	Operating Systems	Sibsankar Haldar, Alex A Aravind,	Pearson Education	2010

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/105/106105214/
2	https://nptel.ac.in/courses/106106144
3	https://onlinecourses.nptel.ac.in/noc20_cs04/preview
4	https://nptel.ac.in/courses/106105214

SEMESTER S6

DATA COMMUNICATION AND NETWORKING

Course Code	**PCERT602**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	PCERT403	**Course Type**	Theory

Course Objectives:

1. To analyze data transmission methods, error control mechanisms, and congestion management techniques in networking.
2. To understand the fundamental principles of data communication and networking protocols, including OSI and TCP/IP architectures.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	A data communication model-data communication - data communications networking - protocol architecture - the need for a protocol architecture - a simple protocol architecture - OSI – TCP/IP protocol architecture. Data transmission - Concepts and terminology - Analog and Digital data transmission-Transmission Impairments – channel capacity	8
2	Digital data, Digital signals & analog signals – analog data, digital signals and analog signals. Asynchronous and synchronous transmission -Types of Error -Error Detection -Error Correction. Data link Control -Flow control-Error Control-HDLC.	8
3	FDM – Synchronous TDM – statistical TDM – Asymmetric DSL – xDSL. Circuit Switching and packet switching: switching networks - circuit switching networks - circuit switching concepts - control signaling - soft switch architecture-Packet switching principles-X.25-Frame Relay. Routing in Switched Networks: routing in circuit switched network – routing in packet switched network – least cost algorithms.	10

4	Effect of congestion - Congestion control - Traffic management - Congestion control in packet switching networks - Frame Relay congestion control. Local Area Network: LAN protocol architecture – bridges – layer2 and layer3 switches. High speed LANs: the emergence of High-speed LAN's – Ethernet – token ring – fibre channel. Transport protocol: connection-oriented transport protocol mechanisms - TCP – TCP – congestion control - UDP.	10

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand data communication and networking using the layered concept, Open System Interconnect (OSI) and the TCP/IP Model. (Cognitive Knowledge: Understand)	**K2**
CO2	Illustrate various types of encoding techniques and error detection methods used in networks. (Cognitive Knowledge: Understand)	**K2**
CO3	Use the concept of multiplexing, switching and routing in networks. (Cognitive Knowledge: Apply)	**K3**
CO4	Discuss the working principles of LAN and the concepts behind congestion in networks. (Cognitive Knowledge: Understand)	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Data and Computer Communication	William Stallings	Pearson Education	9/e, 2013
2	Computer Networks	Andrew S. Tanenbaum	PHI (Prentice Hall India)	5/e, 2013

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Data Communication and Networking	Behrouz A Forouzan	Tata McGraw Hill	5/e,2013
2	Computer Networks – A Systems Approach	Larry L Peterson and Bruce S Dave	Morgan Kaufmann.	5/e,2011
3	Computer Networking and the Internet	Fred Halsall	Addison-Wesley.	5/e,2005

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/106105183
2	https://nptel.ac.in/courses/106105082
3	https://nptel.ac.in/courses/117105148
4	https://onlinecourses.nptel.ac.in/noc22_ee61/preview

SEMESTER S6
NETWORK AND LINEAR CONTROL SYSTEMS

Course Code	**PEERT631**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	2:1:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. This course aims to develop the skills for mathematical modelling and analysis of linear control systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Electrical Circuits** Circuit concept – Types of elements - source transformation-voltage - current relationship for passive elements. Network reduction techniques: series, parallel, series parallel, examples, time and frequency domain analysis of RLC circuits. **Introduction to control systems** Basic components of a control system, types of control systems, examples of control systems, effect of feedback systems, Laplace Transforms, transfer function, modelling of electrical networks, block diagram reduction, signal flow graphs.	11
2	**Modelling of mechanical systems** Translational and rotational systems, transfer function for typical mechanical systems, analogous systems–force voltage & force-current analogy, impulse response and its relation with transfer function	7
3	**Time domain analysis of feedback control systems** Transient and steady-state response, standard test signals, type and order of systems, concept of poles and zeros, time response of first and second order systems to unit impulse and step input, time domain specifications, Steady-state response, steady state error, static and dynamic error coefficients.	9

4	**Stability of linear control systems** Concept of stability, methods of determining stability, Routh's Hurwitz criterion, Root locus - construction of root locus, effect of addition of poles and zeros on root locus. Frequency response analysis: Frequency domain specifications, stability from Bode plots, relative stability, gain margin and phase margin, introduction to lead, lag and lead-lag compensating networks (excluding design).	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Analysis and modelling of mechanical systems using translational and rotational systems, along with the understanding of force voltage & force-current analogy.	**K3**
CO2	Implementing techniques to ensure the stability of linear control systems; using the Routh's Hurwitz criterion, Root locus method and frequency response analysis.	**K3**
CO3	Understand and model control systems using Laplace Transforms and transfer functions to analyze electrical networks and control systems structures.	**K3**
CO4	Apply poles and zeros concept, analyze first and second order systems, and compute static and dynamic error coefficients within time domain analysis of feedback control systems.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping od Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Network Analysis and Synthesis	Ravish R. Singh	McGraw Hill Education	2/e, 2019
2	Automatic Control Systems	Farid Golnaraghi, Benjamin C. Kuo	Wiley India	9/e, 2014
3	Control Systems	M. Gopal	McGraw Hill Education India	4/e, 2012

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Control System Engineering	Norman S. Nise	Wiley India	5/e, 2015
2	Modern Control Systems	Richard C Dorf and Robert H. Bishop	Pearson Education	13/e, 2016

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/108/104/108104139/
2	https://nptel.ac.in/courses/107106081
3	https://nptel.ac.in/courses/107106081
4	https://nptel.ac.in/courses/107106081

SEMESTER S6

MICRO-ELECTRO-MECHANICAL SYSTEMS

Course Code	PEERT632	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Nil	Course Type	PE

Course Objectives:

1. Acquire a thorough understanding of MEMS products, microfabrication evolution, and multidisciplinary applications including micro sensors and actuators.
2. Gain proficiency in MEMS material selection, fabrication techniques, and microsystem packaging design considerations.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	MEMS and Microsystems: Typical MEMS and microsystem products – Evolution of Microfabrication - Microsystem and microelectronics - Multidisciplinary nature of MEMS – Applications of Microsystems in Automotive Industry - Principles and examples of Micro sensors and micro actuators – micro accelerometer, Micro grippers, micro motors, micro valves, micro pumps.	9
2	Actuation and Sensing techniques: Actuation using Thermal forces, Actuation using Shape Memory Alloys, Actuation using Piezoelectric crystals, actuation using Electrostatic forces; Microsensors - Acoustic wave sensors, Biomedical sensors and biosensors, chemical sensors, pressure sensors, optical sensors - microfluidics.	8
3	Engineering science for Microsystem design - Atomic structure of Matter - Ions & ionization - Molecular Theory of matter & Intermolecular forces - Doping of semiconductors - Diffusion process - Electrochemistry - Quantum physics. Materials for MEMS and Microsystems - Substrate and wafer -	9

	Silicon as substrate Material - Silicon compounds - Silicon peizoresistors - Gallium Arsenide - Quartz - Peizoelectric crystals - Polymers.	
4	Overview of Microsystem fabrication – Photolithography – Ion implantation-Diffusion – Oxidation – Chemical vapour deposition – Etching. Overview of Micro manufacturing – Bulk micro manufacturing, Surface micro machining , LIGA process. Micro system Packaging: general considerations in packaging design – Levels of Micro system packaging.	**8**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination-2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the basic concepts of MEMS and microsystem products.	**K2**
CO2	Understand the working principles of micro sensors and actuators.	**K2**
CO3	Identify the typical materials used for fabrication of micro systems.	**K2**
CO4	Illustrate the various methods in microsystem fabrication and micro manufacturing.	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

	PO31	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2										3
CO2	3	2										3
CO3	3	2	1									3
CO4	3	2	1									3

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	MEMS and Microsystems Design, Manufacture and Nanoscale Engineering	Tai-Ran Hsu,	Wiley	2nd , 2020
2	Foundations of MEMS	Chang Liu	Pearson	2nd , 2012
3	Microsystem Design	Stephen D Senturia	Springer	3rd, 2013

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Silicon VLSI Technology	James D Plummer	Prentice Hall	4th, 2012
2	MEMS	Nitaigur Premchand Mahalik	Tata Mc Graw Hill	2013
3	Micro and Nano Fabrication: Tools and Processes	Hans H. Gatzen	Springer	2015

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	NPTEL course : “MEMS & Microsystems” by Prof. Santiram Kal, Video Lecture No: 5, MEMS materials https://archive.nptel.ac.in/courses/117/105/117105082/
2	NPTEL course: “MEMS & Microsystems” by Prof. Santiram Kal, Video Lecture No: 13, Surface & Quartz Micromachining. https://archive.nptel.ac.in/courses/117/105/117105082/

SEMESTER S6

FOUNDATIONS OF DATA SCIENCE

Course Code	PEERT 633	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To understand the data science fundamentals and process.
2. To learn to describe the data for the data science process.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Data Science**: Facets of data – structured, unstructured-semi structured data & patterns, Importance of data Science - History of Data Science -Need for Data Science, Steps in Data Science Process, Components of Data Science, Tools and skills needed - Differences between AI, ML, DL, Data Science & Data Analytics, Real world applications of data science-Simple case study based on real life applications such as - Market research case, tracking disease outbreaks, business predictions, (for example, Rating a product design).	7
2	**Data Preprocessing:** Need to preprocess the data- Major Tasks in Data Preprocessing, Data cleaning - Missing Values Noisy Data- Data Cleaning as a Process, Data Integration, Data Reduction, Data Transformation and Data Discretization	8
3	**Classification Models:** Classification - Basic Concepts, K-Nearest-Neighbour Classifiers, Decision Tree Induction (ID3 algorithm), Naïve Bayesian Classification, Support Vector Machines	8
4	**Mining Frequent Patterns, Associations, and Correlations:** Basic Concepts Frequent Itemset - Apriori Algorithm - Generating Association Rules from Frequent Itemsets **Clustering:** Partitioning methods- k-Means clustering, Hierarchical	9

	Methods- Agglomerative versus Divisive Hierarchical Clustering- Distance Measures in Algorithmic Methods, Density-Based Methods -DBSCAN	

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the basic principles and concepts of data science.	**K2**
CO2	Pre-process and explore datasets to extract meaningful insights.	**K3**
CO3	Illustrate the concepts of classification methods	**K3**
CO4	Perform association mining and analyze clusters using different methods	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping od Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Fundamentals of Data Science	Sanjeev J. Wagh, Manisha S. Bhende, and Anuradha D. Thakare	CRC press	1e, 2022
2	Data mining Concepts and Techniques	Jiawei Han, Michelin Kamber, Jian Pei	Morgan Kaufmann Publishers	3e, 2012

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Data Mining Techniques	Arun K. Pujari	Universities Press	2001
2	Data Science for Business	Foster Provost, Tom Fawcett	O'Reilly Media	1e, 2013

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/106/106106179/ https://www.youtube.com/watch?v=XohgKT13FKY
2	https://archive.nptel.ac.in/courses/106/105/106105174/
3	https://archive.nptel.ac.in/courses/106/105/106105174/ https://www.youtube.com/playlist?list=PLw5h0DiJ-9PCn4shW4X43FSjEqdBwc1Cn
4	https://archive.nptel.ac.in/courses/106/105/106105174/

SEMESTER S6

COMPILER DESIGN

Course Code	PEERT634	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PCERT502	Course Type	Theory

Course Objectives:

1. To understand the structure and functionality of compilers, including lexical and syntax analysis, parsing techniques, and code optimization strategies.
2. To learn about implementing various phases of a compiler, from lexical analysis to code generation.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Analysis of the source program - Analysis and synthesis phases, Phases of a compiler. Lexical Analysis - Role of Lexical Analyzer, Input Buffering, Specification of Tokens, Recognition of Tokens.	9
2	Role of the Syntax Analyser. Review of Context Free Grammars -Derivation and Parse Trees. Basic parsing approaches - Eliminating left recursion, left factoring. Top-Down Parsing - Recursive Descent parsing, Predictive Parsing,LL(1) Grammars.	9
3	Handle Pruning. Shift Reduce parsing. LR parsing - Constructing SLR, LALR and canonical LR parsing tables. Syntax directed translation - Syntax directed definitions, S-attributed definitions, L-attributed definitions, Storage organization, Storage-allocation strategies.	9
4	Intermediate code generation- Intermediate languages, Graphical representations, Three-Address code, Quadruples, Triples. Code Optimization - Principal sources of optimization, Local and global optimizations. Code generation - Issues in the design of a code generator, Target Language, A simple code generator.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Describe the phases in the compilation process (lexical analysis, syntax analysis, semantic analysis, intermediate code generation, code optimization, and code generation) and model a lexical analyzer.	**K3**
CO2	Describe the role of the syntax analyzer, review context-free grammars, and apply basic parsing approaches including top-down parsing techniques and LL (1) grammars.	**K3**
CO3	Illustrate handle pruning, shift-reduce parsing, LR parsing with SLR, LALR, and canonical LR tables, and apply syntax-directed translation concepts.	**K3**
CO4	demonstrate intermediate code generation techniques, including intermediate languages and three-address code, as well as discuss code optimization strategies and the issues involved in code generation and design.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Compilers – Principles Techniques and Tools	Aho A.V., Ravi Sethi and D. Ullman.	Addison Wesley	2006

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	System Programming and Operating Systems	D.M.Dhamdhere	Tata McGraw Hill & Company	1996
2	Compiler Construction – Principles and Practice	Kenneth C. Louden	Cengage Learning Indian Edition	2006
3	The Theory and Practice of Compiler Writing	Tremblay and Sorenson	Tata McGraw Hill& Company	1984

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/105/106105190/
2	https://archive.nptel.ac.in/courses/106/105/106105190/
3	https://archive.nptel.ac.in/courses/106/105/106105190/
4	https://archive.nptel.ac.in/courses/106/105/106105190/

SEMESTER 6

ALGORITHM ANALYSIS & DESIGN

Course Code	**PEERT636**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	PCERT302	**Course Type**	Theory

Course Objectives:

1. To introduce the concepts of Algorithm Analysis, Time Complexity, Space Complexity.
2. To discuss various Algorithm Design Strategies with proper illustrative examples.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Characteristics of Algorithms, Criteria for Analysing Algorithms, Time and Space Complexity - Best, Worst and Average Case Complexities, Asymptotic Notations - Big-Oh (O), Big- Omega (Ω), Big-Theta (Θ), Little-oh (o) and Little- Omega (ω) and their properties. Analysis of Recursive Algorithms: Recurrence Equations, Solving Recurrence Equations – Iteration Method, Recursion Tree Method, Substitution method and Master's Theorem (Proof not required).	**9**
2	Self-Balancing Tree - AVL Trees (Insertion and deletion operations with all rotations in detail, algorithms not expected); DFS and BFS traversals - Analysis, Strongly Connected Components of a Directed graph, Topological Sorting.	**9**
3	The Control Abstraction of Divide and Conquer- 2-way Merge sort, Strassen's Algorithm for Matrix Multiplication-Analysis. The Control Abstraction of Greedy Strategy- Fractional Knapsack Problem, Minimum Cost Spanning Tree Computation- Kruskal's Algorithms - Analysis, Single Source Shortest Path Algorithm - Dijkstra's Algorithm-Analysis.	**9**
4	The Control Abstraction- The Optimality Principle- Matrix Chain Multiplication-Analysis, All Pairs Shortest Path Algorithm - Floyd-Warshall Algorithm-Analysis. The Control Abstraction of Back Tracking – The N	**9**

	Queen's Problem. Branch and Bound Algorithm for Travelling Salesman Problem. Introduction to Complexity Theory - Tractable and Intractable Problems, Complexity Classes – P, NP, NP- Hard and NP-Complete Classes	

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination-2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Evaluate the efficiency of algorithms using asymptotic notations, solve recurrence relations for recursive algorithms, and apply these concepts to optimize algorithmic solutions.	**K3**
CO2	Implement AVL trees, perform DFS and BFS traversals, analyze strongly connected components of directed graphs, and apply topological sorting.	**K3**
CO3	Implement divide and conquer algorithms, apply greedy strategies, and evaluate shortest path solutions.	**K3**
CO4	Apply dynamic programming, backtracking, and branch and bound techniques, and understand complexity theory concepts.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Computer Algorithms	Ellis Horowitz, SartajSahni, Sanguthevar Rajasekaran	Universities Press	2007
2	Introduction to Algorithms	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein	MIT Press	2009

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	The Design and Analysis of Computer Algorithms	Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman	Pearson Education	1999
2	Introduction to the Design and Analysis of Algorithms	Anany Levitin,	Pearson	3/e, 2011
3	Fundamentals ofAlgorithmics	Gilles Brassard, Paul Bratley	Pearson Education	1995

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/106/106106131/
2	https://archive.nptel.ac.in/courses/106/106/106106131/
3	https://archive.nptel.ac.in/courses/106/106/106106131/
4	https://archive.nptel.ac.in/courses/106/106/106106131/

SEMESTER S6

DESIGN AND ANALYSIS OF ALGORITHMS

Course Code	**PEERT 635**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3-0-0-0	**ESE Marks**	60
Credits	5/3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To introduce the concepts of Algorithm Analysis, Time Complexity, Space Complexity.
2. To discuss various Algorithm Design Strategies with proper illustrative examples.
3. To introduce Complexity Theory.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Algorithm - Analysis Time and Space Complexity Elementary operations and Computation of Time Complexity Best, worst and Average Case Complexities- Complexity Calculation of simple algorithms. Recurrence Equations - Solution of Recurrence Equations – Iteration Method and Recursion Tree Methods.	6
2	Master’s Theorem (Proof not required) – examples, Asymptotic Notations and their properties- Application of Asymptotic Notations in Algorithm Analysis- Common Complexity Functions. AVL Trees – rotations, Red-Black Trees insertion and deletion (Techniques only; algorithms not expected). B-Trees – insertion and deletion operations. Sets- Union and find operations on disjoint sets.	8

3	Graphs – DFS and BFS traversals, complexity, Spanning trees – Minimum Cost Spanning Trees, single source shortest path algorithms, Topological sorting, strongly connected components. Divide and Conquer - The Control Abstraction, 2-way Merge sort, Strassen's Matrix Multiplication, Analysis. Dynamic Programming - The control Abstraction- The Optimality Principle- Optimal matrix multiplication, Bellman-Ford Algorithm. Analysis, Comparison of Divide and Conquer and Dynamic Programming strategies.	10
4	Greedy Strategy - The Control Abstraction- the Fractional Knapsack Problem, Minimal Cost Spanning Tree Computation- Prim's Algorithm – Kruskal's Algorithm Back Tracking -The Control Abstraction – The N Queen's Problem, 0/1 Knapsack Problem Branch and Bound: Travelling Salesman Problem. Introduction to Complexity Theory - Tractable and Intractable Problems- The P and NP Classes- Polynomial Time Reductions - The NP- Hard and NP-Complete Classes.	12

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Internal Ex	Evaluate	Analyse	Total
5	**15**	**10**	**10**	**40**

Criteria for Evaluation (Evaluate and Analyse): 20 marks

Assignment: 20 Marks

Students should design and implement a real-world application using object-oriented programming principles, evaluate and refine their class structures and relationships, provide a conclusion on the effectiveness of their design, and demonstrate the functionality of their application using Java.

<u>Criteria for evaluation:</u>

1. ***Problem Definition (K4 - 4 points)***

   . *Clearly defines the real-world problem.*

   a. *Examine and identifies relevant contextual factors (constraints, resources, objectives).*

2. ***Problem Analysis (K4 - 4 points)***
    . *Break-down and presents a well-reasoned solution approach.*
    . *Compare and justify the proposed solutions with evidence and logical reasoning.*
2. ***Evaluate (K5 - 4 points)***
    . *Thoroughly evaluate the proposed solutions.*
    . *Compares trade-offs, advantages, and disadvantages.*
    . *Considers feasibility, scalability, and practical implications.*
2. ***Implementation (K5 - 4 points)***
    . *Select the most feasible solution by implementing the proposed solutions.*
    . *Successfully translates the chosen solution into code.*
    . *Demonstrates proficiency in coding practices (readability, efficiency, error handling).*
2. ***Conclusion (K4- 2 points, K5 – 2 points)***
    . *Summarizes findings and insights. State which solution is most appropriate for the problem.* ***(K4)***
    . *Reflects critical thinking and informed decision-making.* ***(K5)***

Scoring:

1. ***Accomplished (4 points)****: Exceptional analysis, clear implementation, and depth of understanding.*
2. ***Competent (3 points)****: Solid performance with minor areas for improvement.*
3. ***Developing (2 points)****: Adequate effort but lacks depth or clarity.*
4. ***Minimal (1 point)****: Incomplete or significantly flawed.*

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• 2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 sub divisions. Each question carries 9 marks. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Analyze any given algorithm and express its time and space complexities in asymptotic notations.	**K4**
CO2	Derive recurrence equations and solve it using Iteration, Recurrence Tree, Substitution and Master's Method to compute time complexity of algorithms.	**K3**
CO3	Analyze and compare the functionality and applications of various graph traversal algorithms, and critically evaluate the structure and performance of advanced data structures	**K4**
CO4	Demonstrate Divide-and-conquer, Greedy Strategy, Dynamic programming, Branch-and Bound and Backtracking algorithm design techniques.	**K3**
CO5	Classify a problem as computationally tractable or intractable, and discuss strategies to address intractability.	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Computer Algorithms	Ellis Horowitz, SartajSahni, Sanguthevar Rajasekaran	Universities Press	2007
2	Introduction to Algorithms	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein	MIT Press	2009

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	The Design and Analysis of Computer Algorithms	Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman	Pearson Education	1999
2	Introduction to the Design and Analysis of Algorithms	Anany Levitin	Pearson	3/e, 2011
3	Fundamentals of Algorithmics	Gilles Brassard, Paul Bratley	Pearson Education	1995
4	Foundations of Algorithms using C++ Psuedocode	Richard E. Neapolitan, Kumarss Naimipour	Jones and Bartlett Publishers, Inc	2/e, 1997

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/106/106106131/
2	https://archive.nptel.ac.in/courses/106/106/106106131/
3	https://archive.nptel.ac.in/courses/106/106/106106131/
4	https://archive.nptel.ac.in/courses/106/106/106106131/

SEMESTER S6

EMBEDDED SYSTEMS AND IOT

Course Code	**PBERT 604**	**CIE Marks**	60
Teaching Hours/Week (L: T:P: R)	3:0:0:1	**ESE Marks**	40
Credits	4	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To give students a thorough understanding of designing embedded and internet of things systems for a range of applications
2. Expertise in the design and analysis of IOT and embedded systems

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Embedded Systems and IoT** **Introduction to Embedded Systems:-** Desirable features and general characteristics of Embedded Systems -Comparison: Microcontroller Vs Microprocessors - Model of Embedded Systems. **Introduction to IoT:-** Evolution and enabling technologies of IoT - Complex Interdependence of Technologies - IoT Networking Components and Addressing Strategies. **Basics of Networking:-** Network Types and Layered Network Models - Addressing and TCP/IP Transport Layer. **Project Task:** Create a basic embedded system using a microcontroller, establish simple networking, and demonstrate data transfer over the network.	9
2	**Embedded Systems & IoT - Sensors, Actuators, and Processing** **Sensors:-** Sensor Characteristics, Sensorial Deviations, and Sensing Types - Sensing Considerations.	9

	Actuators:- Actuator Types and Characteristics. **IoT Processing:-** IoT Processing Topologies and Types - Data Format and Importance of Processing in IoT - Device Design and Selection Considerations - Processing Offloading. **Project Task:** Develop an IoT device integrating sensors and actuators with processing capabilities.	
3	**IoT Connectivity and Communication Technologies** **IoT Connectivity Technologies:-** Overview of IEEE 802.15.4, Zigbee, ISA100.11A, Wireless HART, RFID, NFC, Z-Wave, Weightless, LoRa, NB-IoT, Wi-Fi, Bluetooth. **IoT Communication Technologies:-** Infrastructure Protocols - Discovery Protocols - Data Protocols - Identification Protocols - Device Management - Semantic Protocols. **Project Task:** Implement connectivity and communication protocols for an IoT device.	**9**
4	**Developing IoT Applications with Arduino/NodeMCU** **Arduino Platform:-** Hardware features and Arduino IDE - Interfacing LEDs, switches, and LCDs **NodeMCU Platform:-** Hardware features and programming with Arduino IDE - Interfacing sensors and actuators with NodeMCU. **Introduction to Raspberry Pi** - Raspberry Pi hardware details - installing OS in Raspberry Pi **IoT Physical Servers and Cloud Offerings:-** Overview of AWS IoT, Microsoft Azure IoT, and Blynk. **Project Task:** Build comprehensive IoT applications using various platforms.	**9**

Suggestion on Project Topics

Course Assessment Method

(CIE: 60 marks, ESE: 40 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Project	Internal Ex-1	Internal Ex-2	Total
5	30	12.5	12.5	60

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 2 marks **(8x2 =16 marks)**	• 2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 6 marks. **(4x6 = 24 marks)**	**40**

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Understand the basics of embedded systems, IoT and networking.	**K2**
CO2	Illustrate various sensors and actuators for embedded systems and IoT.	**K2**
CO3	Apply the understanding of IoT requirements and constrains to select the suitable IoT connectivity and communication technologies for specific IoT applications.	**K3**
CO4	Illustrate various IoT physical servers and cloud offerings.	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to IoT	Sudip Misra, Anandarup Mukherjee, Arijit Roy	Cambridge University Press	First edition, 2021
2	Arduino Cookbook: Recipes to Begin, Expand, and Enhance Your Projects	Michael Margolis	O'Reilly Media	3rd edition, 2020
3	Internet Of Things With Raspberry Pi And Arduino	Rajesh Singh, Anita Gehlot, Lovi Raj Gupta,Bhupendra Singh, and Mahendra Swain	CRC press	1st Edition, 2019
4	NodeMCU ESP8266 Communication Methods and Protocols _ Programming with Arduino IDE	Manoj R. Thakur	Amazon Media EU S.à r.l.	2018

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Internet of Things_ A Hands-On approach	Arshdeep Bahga, Vijay Madisetti		
2	https://docs.aws.amazon.com/whitepapers/latest/aws-overview/introduction.html			
3	https://azure.microsoft.com/en-us/explore			
4	https://docs.blynk.io/en/			

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/128108016
2	https://nptel.ac.in/courses/128108016
3	https://nptel.ac.in/courses/128108016
4	https://nptel.ac.in/courses/128108016

PBL Course Elements

L: Lecture (3 Hrs.)	R: Project (1 Hr.), 2 Faculty Members		
	Tutorial	**Practical**	**Presentation**
Lecture delivery	Project identification	Simulation/ Laboratory Work/ Workshops	Presentation (Progress and Final Presentations)
Group discussion	Project Analysis	Data Collection	Evaluation
Question answer Sessions/ Brainstorming Sessions	Analytical thinking and self-learning	Testing	Project Milestone Reviews, Feedback, Project reformation (If required)
Guest Speakers (Industry Experts)	Case Study/ Field Survey Report	Prototyping	Poster Presentation/ Video Presentation: Students present their results in a 2 to 5 minutes video

Assessment and Evaluation for Project Activity

Sl. No	Evaluation for	Allotted Marks
1	Project Planning and Proposal	5
2	Contribution in Progress Presentations and Question Answer Sessions	4
3	Involvement in the project work and Team Work	3
4	Execution and Implementation	10
5	Final Presentations	5
6	Project Quality, Innovation and Creativity	3
Total		**30**

1. **Project Planning and Proposal (5 Marks)**

    - Clarity and feasibility of the project plan
    - Research and background understanding
    - Defined objectives and methodology

2. **Contribution in Progress Presentation and Question Answer Sessions (4 Marks)**

    - Individual contribution to the presentation
    - Effectiveness in answering questions and handling feedback

3. **Involvement in the Project Work and Team Work (3 Marks)**

    - Active participation and individual contribution
    - Teamwork and collaboration

4. **Execution and Implementation (10 Marks)**

    - Adherence to the project timeline and milestones
    - Application of theoretical knowledge and problem-solving
    - Final Result

5. **Final Presentation (5 Marks)**

    - Quality and clarity of the overall presentation
    - Individual contribution to the presentation
    - Effectiveness in answering questions

6. **Project Quality, Innovation, and Creativity (3 Marks)**

    - Overall quality and technical excellence of the project
    - Innovation and originality in the project

Creativity in solutions and approaches

SEMESTER S6

BASICS OF ANAOLG AND DIGITAL COMMUNICATION

Course Code	OEERT 611	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To understand the main components and principles of analog and digital communication systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction, Elements of communication systems, Amplitude modulation (AM), Double-side band suppressed carrier (DSB-SC) modulation Single sideband modulation (SSB) – spectrum, power, efficiency of all the three variants. (Study of only tone modulation in DSB-SC, AM, and SSB.) Amplitude-modulator implementations –balanced modulator. AM demodulators -. Envelope detector.	9
2	Frequency modulation – modulation index, frequency deviation, average power, spectrum of tone modulated FM, bandwidth of FM, Narrow band FM and wide-band FM. FM generation: Varactor diode modulator, Armstrongs method. FM demodulation – slope detection.	9
3	Elements of digital communication system. Sources, channels and receivers. Sampling theorem. Sampling and reconstruction. Pulse code modulation. Sampling, quantization and encoding. Differential PCM, adaptive PCM, Delta modulator and adaptive delta modulator. Issues in delta modulation. Slope overload.	9

4	Digital modulation schemes. Baseband BPSK system and the signal constellation. BPSK transmitter and receiver. Base band QPSK system and Signal constellations. Plots of BER Vs SNR (Analysis not required). QPSK transmitter and receiver. Quadrature amplitude modulation.	9

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the main components in analog and digital communication systems.	**K2**
CO2	Understand the different analog modulation schemes.	**K2**
CO3	Illustrate the main principles of pulse code modulation.	**K2**
CO4	Understand different digital modulation schemes.	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Electronic Communication Systems	Kennedy, Davis	TATA McGraw-Hill	Fourth Edition
2	Electronic Communication Systems – Fundamentals through Advanced	Wayne Tomasi	Pearson	Fifth edition
3	Communication Systems	Simon Haykin	Wiley	Fourth edition

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital and Analog Communication Systems	Leon W. Couch	Prentice Hall	Eighth edition
2	Digital Communications: Fundamentals and Applications	Sklar	Pearson.	Third edition

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://youtu.be/S8Jod9AtpN4
2	https://youtu.be/jqJpbPseX2c
3	https://youtu.be/l_SqkcP6hZ4
4	https://youtu.be/ZW1glqkIgcw?si=zJ_ijYp7t6uh9WHx

SEMESTER S6

ROBOTICS AND AUTOMATION

Course Code	**OEERT 612**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Open Elective I

Course Objectives:

1. Aims to provide students with a comprehensive understanding of robotics and their wide-ranging applications.
2. Aims to provide students with a detailed understanding of sensor and actuator technologies in robotics.
3. Aims to equip students with a thorough understanding of robotic configurations, and the classification, selection, and design of end effectors and their operational criteria.
4. Aims to provide students with a comprehensive understanding of robotic coordinate systems, transformations, and control techniques.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction To Robotics:** Definitions- Robots, Robotics; Types of Robots- Manipulators, Mobile Robots-wheeled & Legged Robots, Aerial Robots; Anatomy of a robotic manipulator-wrist configurations, links, joints, open kinematic vs closed kinematic chain; degrees of freedom; Robot Applications- medical, mining, space, defence, security, domestic, entertainment, Industrial Applications-Material handling, welding, Spray painting, Machining.	9
2	**Sensors and Actuators:** Sensor classification- touch, force, proximity, vision sensors. Internal sensors-Position sensors, velocity sensors, acceleration sensors, Force	9

	sensors; External sensors-contact type, noncontact type; Vision - Elements of vision sensor, image acquisition, image processing; Selection of sensors. Actuators for robots- classification-Electric, Hydraulic, Pneumatic actuators; their advantages and disadvantages; Electric actuators- Stepper motors, DC motors, DC servo motors, AC motors, Hydraulic actuators- Components and typical circuit, advantages and disadvantages; Pneumatic Actuators- Components and typical circuit, advantages and disadvantages.	
3	**Robotic configurations and End effectors:** Robot configurations-PPP, RPP, RRP, RRR; features of SCARA, PUMA Robots; Robot considerations for an application- number of axes, work volume, capacity & speed, stroke &reach, Repeatability, Precision and Accuracy, Operating environment, point to point control or continuous path control. Classification of End effectors - mechanical grippers, special tools, Magnetic grippers, Vacuum grippers, adhesive grippers, Active and passive grippers, selection and design considerations of grippers in robot.	**9**
4	**Kinematics and Control of Robots:** Robot Coordinate Systems- Matrix representation of a point, vector, frame and a rigid body in space, Representation of transformations-translation, Fundamental and composite rotations, homogeneous transformations, combined transformations, D-H representation. Control Techniques- Transfer function and state space representation, Performance and stability of feedback control, PID control of a single link manipulator, selection of PID controller gains.	**9**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
10	10	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Familiarise with anatomy, specifications and applications of Robots.	**K2**
CO2	Choose the appropriate sensors and actuators for robots.	**K2**
CO3	Choose appropriate Robotic configuration and gripper for a particular application.	**K2**
CO4	Obtain kinematic model of robotic manipulators and design the controller for robotic manipulators	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Robotics	S. K. Saha,	Tata McGraw Hill Education Pvt. Ltd.,	2nd Edition, 2008
2	Fundamentals of robotics – Analysis and control	Robert. J. Schilling	Dorling Kindersley (India) Pvt Ltd	2006.
3	Introduction to Robotics: Mechanics and Control	John J. Craig,	Pearson Publishers	3rd Edition, 2008
4	Introduction to Robotics: Analysis, Systems, Applications	Saeed B. Niku	Wiely Publishers	3rd Edition, 2020
5	Robotics and Control	R K Mittal and I J Nagrath,	Tata McGraw Hill, New Delhi	1st Edition, 2003
6	Introduction to measurements and Instrumentation	Arun K Ghosh	PHI Learning	4th Edition, 2012
7	Control Systems Engineering	I.J Nagrath & M. Gopal	New Age International Publishers	7th Edition, 2021

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Robot Modeling and Control	Mark W. Spong, Seth Hutchinson, M. Vidyasagar	Wiley (India),	2nd Edition 2020.
2	Fundamentals of Robotics	D.K. Pratihar	Narosa Publishing House, New-Delhi	1st Edition, 2017
3	Robotics	K.S. Fu, R.C. Gonzalez, C.S.G. Lee	McGraw-Hill Book Company	1987
4	Robotics Technology and Flexible Automation, Second Edition,	S. R. Deb	McGraw Hill Education (India) Private Limited	2nd Edition 2010.
5	Control Systems	Les Fenical	Cenage Learning India Pvt. Ltd.	2nd Edition 2011.
6	Robotics: A Very Short Introduction	Alan Winfield	Oxford University Press	2012

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	Robotics, Prof. D. K Pratihar, IIT Kharagpur https://onlinecourses.nptel.ac.in/noc24_me88/preview Industrial Robotics: Theories for implementation, Prof. Arun Dayal Udai IIT (ISM Dhanbad) https://onlinecourses.nptel.ac.in/noc24_me117/preview
2	Robotics, Prof. D. K Pratihar, IIT Kharagpur https://onlinecourses.nptel.ac.in/noc24_me88/preview Industrial Robotics: Theories for implementation, Prof. Arun Dayal Udai IIT (ISM Dhanbad) https://onlinecourses.nptel.ac.in/noc24_me117/preview
3	Robotics, Prof. D. K Pratihar, IIT Kharagpur https://onlinecourses.nptel.ac.in/noc24_me88/preview Industrial Robotics: Theories for implementation, Prof. Arun Dayal Udai IIT (ISM Dhanbad) https://onlinecourses.nptel.ac.in/noc24_me117/preview
4	Robotics, Prof. D. K Pratihar, IIT Kharagpur https://onlinecourses.nptel.ac.in/noc24_me88/preview Industrial Robotics: Theories for implementation, Prof. Arun Dayal Udai IIT (ISM Dhanbad) https://onlinecourses.nptel.ac.in/noc24_me117/preview

SEMESTER SN6

OBJECT ORIENTED CONCEPTS

Course Code	OEERT613	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	GBEST204	Course Type	Theory

Course Objectives:

1. Understand and apply foundational object-oriented programming concepts in Java, including classes, objects, inheritance, polymorphism, encapsulation, and abstraction.
2. Design and implement Java applications that leverage OOP principles to achieve modularity, reusability, and scalability in software development

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basic Object-Oriented concepts, Introduction to Java - Java programming and Runtime Environment, Development Platforms- Java Virtual Machine (JVM), Java compiler, Bytecode, Java Buzzwords, Java program structure, Comments.Primitive Data types - Integers, Floating Point Types, Characters, Boolean. Literals, Operators - Arithmetic Operators, Bitwise Operators, Relational Operators, Boolean Logical Operators, Assignment Operator, Conditional (Ternary) Operator, Operator Precedence. Control Statements - Selection Statements, Iteration Statements and Jump Statements.	9
2	Object Oriented Programming in Java - Class Fundamentals, Declaring Objects, Introduction to Methods, Constructors, this Keyword, Method Overloading, Using Objects as Parameters, Returning Objects. Static Members, Final Variables, Inner Classes.Inheritance - Super Class, Sub Class, The Keyword super, protected Members, Calling Order of Constructors, Method Overriding, the Object class, Abstract Classes and Methods, using final with Inheritance.Packages and Interfaces - Defining Package, CLASSPATH, Access Protection, Importing Packages, Interfaces.	9

3	Exception Handling - Checked Exceptions, Unchecked Exceptions, try Block and catch Clause, Multiple catch Clauses, Nested try Statements, throw, throws and finally. Java Library - String Handling – String Constructors, String Length, Special String Operations -Character Extraction, String Comparison, Searching Strings, Modifying Strings.Multithreaded Programming - The Java Thread Model, The Main Thread, Creating Thread, Creating Multiple Threads, Synchronization, Suspending, Resuming and Stopping Threads.	**9**
4	Event handling - Event Handling Mechanisms, Delegation Event Model, Event Classes, Sources of Events, Event Listener Interfaces.Swings fundamentals-Swing Controls, Components and Containers, Swing Packages, Event Handling in Swings, Swing Layout Managers, Exploring Swings –JFrame, JLabel , Swing Buttons, JText Field.Java Database Connectivity (JDBC) - JDBC overview, Creating and Executing Queries – create table, delete, insert, select.	**9**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand and apply fundamental Java programming concepts, including the runtime environment, primitive data types, operators, and control statements, to develop efficient and well-structured Java applications.	**K2**
CO2	Apply key object-oriented programming principles in Java, leveraging packages and interfaces effectively to design and implement Java applications.	**K3**
CO3	Confidently handle Java exceptions, manipulate strings effectively, and implement multithreaded programming techniques.	**K3**
CO4	Develop Java applications that integrate event handling, Swing-based graphical user interfaces, and JDBC database connectivity to create robust and user-friendly software solutions.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Java: The Complete reference	Herbert Schildt	Tata McGraw Hill	8/e, 2011
2	Java How to Program, Early Objects	Paul Deitel, Harvey Deitel	Pearson	11/e, 2018

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Java Programming	Y. Daniel Liang	Pearson	7/e, 2013
2	Programming JAVA a Primer	Balagurusamy E	Tata McGraw Hill	5/e, 2014
3	Core Java: An Integrated Approach	Nageswararao R	Dreamtech Press	2008
4	Java in A Nutshell	Flanagan D	O'Reilly	5/e,2005

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/105/106105191/
2	https://archive.nptel.ac.in/courses/106/105/106105191/
3	https://archive.nptel.ac.in/courses/106/105/106105191/
4	https://archive.nptel.ac.in/courses/106/105/106105191/

SEMESTER S6

INTERNET OF THINGS

Course Code	OEERT614	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. This course aims to introduce IoT fundamentals.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to IoT technology:** Definitions of IoT, Characteristics of IoT devices – power, computational constraints, IoT Architectural view – Middleware based architecture, Service oriented architecture, M2M Communication and IoT, Typical application areas of IoT technology (case studies of at least four domains) - Energy management and Smart grid, IoT for Home, Cities, Environment monitoring, Agriculture, Supply chain and customer monitoring	9
2	**Components of IoT technology:** Identification/Addressing - Electronic Product Codes, RFID, ubiquitous code, IPv4, IPv6. Sensors and Actuators*. IoT Hardware**, IoT Software – overview of Operating systems, Firmware, Middle ware, Application software used in IoT. Connectivity for IoT devices – characteristics.	9

3	**Communication technologies for IoT :** Zigbee - key features, architecture, limitations, Bluetooth technology - bluetooth stack, piconet, scatternet, limitations, Bluetooth Low Energy (key features, architecture, limitations), Wifi (IEEE 802.11) technology – key features, limitations, Cellular technology – GSM, 3G, 4GLTE (overview), features, limitations, LoRa technology – features, LoRaWAN architecture, 6LoWPAN – features, protocol stack, Narrow Band (NB- IoT) – features, applications, Sigfox – features, applications	**9**
4	**IoT Data Management :** Storage technologies for IoT hardware – Volatile, Non-volatile, Embedded (MTP/OTP), external flash (NAND/NOR), DRAM, eflash, UFS, eMMC (overview of technologies). Cloud and IoT, Cloud computing – architecture, advantages of cloud computing, Software as a Service (SaaS), Platform as a Service (PaaS), Infrastructure as a Service (IaaS). Case study of commercial cloud computing platforms like - Microsoft Azure IoT Suite, Google Cloud's IoT Platform, IBM Watson IoT Platform. IoT analytics	**9**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain in a concise manner the architecture of IoT	**K2**
CO2	Identify various hardware and software components used in IoT	**K3**
CO3	Discuss the various communication technologies and interfaces in IoT	**K2**
CO4	Describe the usage of modern technologies like cloud computing for data management in IoT	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping od Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Internet of Things : Architecture and Design Principles"	Rajkamal	McGraw Hill (India) Private Limited.	2nd edition,2022
2	"Internet of Things (A Hands-on- Approach)"	Vijay Madisetti and Arshdeep Bahga	Orient Blackswan Private Limited - New Delhi	1st Edition,2015

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Internet of things: A survey on enabling technologies, protocols, and applications	Al-Fuqaha	IEEE Communications Surveys & Tutorials	2015
2	The Internet of Things	Samuel Greengard	The MIT Press Essential Knowledge series Paperback	March 20, 2015
3	The Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems	Ovidu Vermesan and Peter Friess	River Publishers	1st Edition, 2013
4	Internet of Things - From Research and Innovation to Market Deployment	Peter Friess, Ovidiu Vermesan	River Publishers	1st Edition,2014

Video Links (NPTEL, SWAYAM…)	
Module No.	Link ID
1	https://youtu.be/WUYAjxnwjU4?si=s58W-NKMrEQMaJ8m https://youtu.be/BXDxYh1EV2w?si=8oFtQB9vycC_c-t2
2	https://youtu.be/z3VEZPwl5gA?si=tNuzG_By-KBU3ks_ https://youtu.be/SXz0XR68dwE?si=1tVN1g9FQcGp87li https://youtu.be/TvzgzO6xKrY?si=gYzJstW51MTNsgKj
3	https://youtu.be/qko-f1VDhCM?si=0tWM_OHS395ESV_w https://youtu.be/d9QfVpCG00Y?si=qeHk8tPg_torr2yX https://youtu.be/1zQ8wbBozqI?si=7vOSHMt8OT3nQINO
4	https://youtube.com/playlist?list=PLE7VH8RC_N3bpVn- e8QzOAHziEgmjQ2qE&si=rr5Fpuew5q9_Y4qg

SEMESTER S6

INTRODUCTION TO ARTIFICIAL INTELLIGENCE

Course Code	**OEERT615**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To introduce basic principles that drive complex real world intelligence applications.
2. To introduce and discuss the basic concepts of AI Techniques and Learning.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Artificial Intelligence:** What is Artificial Intelligence(AI)? The Foundations of AI, History of AI, Applications of AI. Intelligent Agents, Types of agents and their environments, goodbehavior: The concept of rationality, nature of Environments, Structure of Agents. Examples of practical agents.	9
2	**Problem Solving:** Solving Problems by searching-Problem solving Agents, Example problems, Searching for solutions, Uninformed search strategies- Depth First Search (DFS) and Breadth First Search (BFS), Informed search strategies- Greedy Search, A* Search, AO* Search, Hill Climbing Algorithm, Heuristic functions.	9
3	**Adversarial search:** Games, Optimal decisions in games, The Minimax algorithm, Alpha-Beta pruning. Constraint Satisfaction Problems – Defining CSP, Constraint Propagation- inference in CSPs, Backtracking search for CSPs, Structure of CSP problems.	9
4	**Knowledge Representation and Reasoning:** First Order Predicate Logic – Syntax and Semantics of First Order Logic, Knowledge representation in	9

	First Order Logic. Inference in First Order Logic – Unification and Lifting, Forward chaining, Backward chaining, Resolution. **Basic concepts of Machine Learning:** Learning from Examples – Forms of Learning, Supervised Learning/Unsupervised Learning.	

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the fundamental concepts of intelligent systems and their architecture.	**K2**
CO2	Illustrate uninformed and informed search techniques for problem solving in intelligent systems.	**K2**
CO3	Solve Constraint Satisfaction Problems using search techniques.	**K3**
CO4	Represent AI domain knowledge using logic systems and use inference techniques for reasoning in intelligent systems.	**K3**
CO5	Illustrate different types of learning techniques used in intelligent systems	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Artificial Intelligence: A Modern Approach	Stuart Russell and Peter Norvig	Prentice Hall	3/e, 2010
2	Artificial Intelligence	E Rich, K Knight,	Tata McGraw Hill	3/e, 2009
3	Artificial Intelligence-Structures and Strategies for Complex Problem Solving	GeorgeF.Luger	Pearson Education	4/e, 2002

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Artificial Intelligence - A New Synthesis	Nilsson N.J	Harcourt Asia Pvt. Ltd.	1998
2	Artificial intelligence, A modern approach	Stuart Jonathan Russell, Peter Norvig	Pearson Education	3/e, 2010
3	Artificial Intelligence and Machine Learning	Chandra SS And Hareendran S	PHI Learning	2014

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	An Introduction to Artificial Intelligence - Course (nptel.ac.in) https://onlinecourses.nptel.ac.in/noc22_cs56/preview
2	Fundamentals of Artificial Intelligence - Course (nptel.ac.in) https://onlinecourses.nptel.ac.in/noc22_ge29/preview
3	Artificial Intelligence - Course (swayam2.ac.in) https://onlinecourses.swayam2.ac.in/cec21_cs08/preview

SEMESTER S6

EMBEDDED SYSTEMS AND IoT LAB

Course Code	**PCERL 607**	**CIE Marks**	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	**ESE Marks**	50
Credits	2	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	PBERT 604	**Course Type**	Lab

Course Objectives:

1. To provide students a lot of hands-on experience designing different embedded systems and exposing them to the tools needed to make them Internet of Things devices.

Details of Experiment

Expt. No	**Experiment**
Part A: Arduino based embedded system	
1	Implement an arduino based system to detect when something is moved, tilted, or shaken.
2	Implement temperature control system by controlling a fan, if the temperature exceeds a limit. (Use arduino as control board)
3	Use Arduino to read the key presses on matrix keypad and display the pressed key on an LCD display.
4	Use Arduino to monitor one or more voltages and take some action when the voltage rises or falls below a threshold. For example, you want to flash an LED to indicate a low battery level—perhaps to start flashing when the voltage drops below a warning threshold and increasing in urgency as the voltage drops further.
5	Use Arduino to measure voltages greater than 5 volts. For example, you want to display the voltage of a 9V battery and trigger an alarm LED when the voltage falls below a certain level.
Part B: NodeMCU based systems	
6	Installing the Arduino IDE for the ESP8266 and connecting the module to your Wi-Fi network.
7	Reading data from a digital sensor connected to a digital pin of ESP8266.

8	Configuring the ESP8266 module and controlling an LED connected to it, from anywhere in the world; using MQTT.
9	Controlling the lock from the cloud using Blynk and NodeMCU.
10	Sending an e-mail/SMS notification based on activity at sensor connected to NodeMCU; using IFTTT.
Part C: Raspberry Pi based systems	
11	Setting up Raspberry Pi by installing OS and obtaining static IP of Raspberry Pi.
12	Light an LED by reading status of a switch connected to GPIO of the board.
13	Install Arduino IDE on Raspberry Pi and control LED using LDR; in which both are connected to Digital IO pin of Arduino.
14	Realize a datalogger with ThingSpeak Server: capture the real-time data of any sensor by Raspberry Pi and upload to the cloud.
15	Implement a Home Appliance Control system using Raspberry Pi using Blynk App

**** Any four experiments are mandatory from each part.**

Course Assessment Method (CIE: 50 Marks, ESE 50 Marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work, experiments, Viva and Timely completion of Lab Reports / Record. (Continuous Assessment)	Internal Exam	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

Mandatory requirements for ESE:

- Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.
- Endorsement by External Examiner: The external examiner shall endorse the record.

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Implement interfacing of various sensors and actuators with Arduino.	**K3**
CO2	Implement interfacing of various sensors and actuators with Node MCU.	**K3**
CO3	Design and develop smart systems using Raspberry Pi.	**K3**

K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table

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

1: Slight (Low),2: Moderate (Medium),3: Substantial (High), : No Correlation

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Arduino Cookbook_ Recipes to Begin, Expand, and Enhance Your Projects	Michael Margolis	O'Reilly Media	3e, 2020
2	Internet of Things with ESP8266-Packt Publishing	Marco Schwartz	Packt Publishing	2016
3	Internet Of things With Raspberry Pi and Arduino	Rajesh Singh, Anita Gehlot, Lovi Raj Gupta, Bhupendra Singh, Mahendra Swain	CRC Press Taylor & Francis Group	2019

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to IoT	Misra, Mukherjee, Roy	Cambridge University Press	2021
2	NodeMCU ESP8266 Communication Methods and Protocols _ Programming with Arduino IDE	Manoj R. Thakur	Amazon Media EU S.à r.l	2018
3	Raspberry Pi and MQTT Essentials	Dhairya Parikh	Packt	2022
4	Electronics Projects with the ESP8266 and ESP32_ Building Web Pages, Applications, and WiFi Enabled Devices	Neil Cameron	Apress	2021

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://archive.nptel.ac.in/courses/128/108/128108016/

Continuous Assessment (25 Marks)

1. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. **Conduct of Experiments (7 Marks)**

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. **Lab Reports and Record Keeping (6 Marks)**

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. **Viva Voce (5 Marks)**

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. **Procedure/Preliminary Work/Design/Algorithm (10 Marks)**

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. **Conduct of Experiment/Execution of Work/Programming (15 Marks)**

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted

SEMESTER 7

ELECTRONICS & COMPUTER ENGINEERING

SEMESTER S7

IMAGE PROCESSING

Course Code	PEERT 741	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	Linear Algebra	**Course Type**	Theory

Course Objectives:

1. To introduce the fundamental concepts of Digital Image Processing and study the various transforms required for image processing.
2. To study spatial and frequency domain image enhancement and image restoration methods.
3. To understand image compression and segmentation techniques.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Digital Image Fundamentals: Image representation, Types of images, Elements of DIP system, Basic relationship between pixels, Distance Measures, Simple image formation model. Brightness, contrast, hue, saturation, Mach band effect. Colour image fundamentals-RGB, CMY, HIS models, 2D sampling and quantization.	9
2	2D Image transforms: DFT, Properties, Walsh transform, Hadamard transform, Haar transform, DCT, KL transform and Singular Value Decomposition. Image Compression: Image compression model, Lossy, lossless compression, Concept of transform coding, JPEG Image compression standard.	9
3	Image Enhancement: Spatial domain methods: Basic Gray Level Transformations, Histogram Processing, Enhancement Using Arithmetic/Logic Operations, Basics of Spatial Filtering, Smoothing spatial	9

	Filters, Sharpening spatial Filters. Frequency domain methods: low pass filtering, high pass filtering, homomorphic filtering.	
4	Image Restoration: Degradation model, Inverse filtering- removal of blur caused by uniform linear motion, Minimum Mean Square Error (Wiener) Filtering. Image segmentation: Region based approach, clustering , Segmentation based on thresholding, edge based segmentation, Hough Transform.	**9**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination-2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand different components of image processing system	**K2**
CO2	Analyse the various concepts and mathematical transforms necessary for image processing	**K3**
CO3	Illustrate the various schemes of image compression	**K3**
CO4	Understand the basic image segmentation techniques	**K3**
CO5	Analyze the filtering and restoration of images	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping od Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Image Processing	Gonzalez Rafel C	Pearson Education	4/e, 2019
2	Digital Image Processing	S Jayaraman, S Esakkirajan, T Veerakumar	Tata McGraw Hill Education	2009

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Image Processing	Kenneth R Castleman	Pearson Education	2/e,2003
2	Fundamentals of digital image processing	Anil K Jain	PHI	1988
3	Digital Image Processing	Pratt William K	John Wiley	4/e,2007

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/117/105/117105135
2	https://archive.nptel.ac.in/courses/106/105/106105216
3	https://nptel.ac.in/courses/117105079
4	https://nptel.ac.in/courses/106105032

SEMESTER S7

DEEP LEARNING

Course Code	PEECT742	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)		Course Type	Theory

Course Objectives:

1. Understand the theoretical basics of neural networks and deep learning.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Review of ANN: Perceptrons Convolutional Neural Networks: Convolution operation , CNN Architecture kernels, padding- Convolutional layers-, Pooling Layers, fully connected layers. Feature and weight visualization, t-SNE	7
2	Loss functions-Mean Squared Error, Cross Entropy Activation functions, Sigmoid Relu , Softmax Training CNNs:-Initialization Back-propagation Optimization algorithms:-SGD, Momentum, Adagrad, RMS Prop, Adam, Hyper parameter optimization-Learning rate Regularization methods: L1, L2 regularizaton dropout, Data Augmentation, Early stopping batch normalization Introduction to Transfer learning, feature extraction , fine tuning.	10
3	Sequence models, Recurrent Neural Networks (RNN): cell structure and architecture, Training RNN, back propagation through time. Vanishing and exploding gradients. Long Short-Term Memory (LSTM), architecture and training.	10

	Gated Recurrent Units (GRU), architectture and training.	
4	Introduction to Generative models: parameter estimation, Maximum Likelyhood Estimation. GANs : adversarial training. Discriminator , Generator, up sampling, Transformer models, architecture Word embedding, position encoding , attention , training transformer models Large language models BERT,GPT (Detailed mathematical treatment not required for this module)	**9**

Note:- Assignments/ Micro project should be given for modules 2 ,3 and 4 using standard machine learning frameworks such as tensorflow/keras/ pytorch. They may also be introduced to GPUs and standard data sets on hugging face/kaggle

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Explain the basic concepts of neural networks	**K2**
CO2	Solve real world problems usig CNN	**K2**
CO3	Solve real world problems using RNN	**K2**
CO4	Describe the concepts of GAN	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Learning Deep Learning	Magnus Ekman	Addison -Wesley	2022
2	Hands-on Machine learning with Sc-kit Learn Keras and Tensorflow	Aurelien Geron	Oreilly	Second edition 2019
3	Dive deep into machine learning	Astan Zhang and Zachary and Alexander semola	Cambridge university press https://d2l.ai/	2019
4	Neural Networks for deep learning	Michael Nielsen	http://neuralnetworksanddeeplearning.com/	2019

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Deep Learning.	Ian Goodfellow. Yoshua Bengio and Aaron Courville.	MIT Press	2016.
2	Neural Networks and Deep Learning: A Textbook..	Charu C. Aggarwal.	Springer	. 2019
3	Generative Deep Learning	David Foster	OReilly	2022
4	Build a Large Language Model	Sebastian Raschka	Manning	2023

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://www.cse.iitm.ac.in/~miteshk/CS6910.html
2	https://cs231n.github.io/
3	https://wiki.pathmind.com/lstm http://colah.github.io/posts/2015-08-Understanding-LSTMs/
4	https://jalammar.github.io/illustrated-transformer/ Jay Almar

SEMESTER S7

ROBOTICS AND AUTOMATION

Course Code	**PEERT743**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	Engineering mathematics	**Course Type**	Theory

Course Objectives:

1. To understand the basics of robotics.
2. To gain insights into various sensors used with robots.
3. To understand the spatial descriptions and kinematics of robots.
4. To design controllers for robots

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Definition and Origin of Robotics. Robot Anatomy. Robot Specifications. Robot Characteristics –Accuracy, Precision, and Repeatability. Classification of Robots. Advantages and Disadvantages of Robots. Robot Structure - Types of Joints and End Effectors, Mechanisms and Manipulators.Common Kinematic Arrangements. Degree of Freedom. Robot Coordinates. Areas of Applicationfor Robots	9
2	Actuators: Types of Robotic Drive Systems and Actuators: Hydraulic, Pneumatic and Electric drives. Transmission: Gears, Timing Belts and Bearings. Parameters for selection of actuators. Specification. Areas of Application for: Stepper Motor & Servo Motor. Sensors: Types and Applications of Sensors in Robotics: Position, Displacement and VelocitySensors. Tactile Sensors for Contact and Proximity Assessment	9
3	Introduction to Kinematics: Positionand Orientation of Objects. Rotation. Euler Angles. Rigid Motion Representation using Homogenous Transformation Matrix. Kinematic Modelling:Translation and Rotation Representation,	9

	Coordinate Transformation, Forward and Inverse Kinematics. Forward Kinematics-Link Coordinates, Denavit-Hartenberg Representation,Application of DH Convention to Different Serial Kinematic Arrangements	
4	Basics of Control: Open Loop- Closed Loop, Transfer Functions, Control Laws: P, PD, PID, Linearand Non-linear Controls; Control Hardware and Interfacing; Embedded Systems: Microcontroller Architecture and Integration with Sensors, Actuators, Components.	9

Course Assessment Method

(CIE: 40 marks,ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination-2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Attain a thorough understanding of different types of Robots and their applications	**K2**
CO2	Select appropriate sensors and actuators based on the robotic application	**K2**
CO3	Perform kinematic and dynamic analyses for robots	**K2**
CO4	Carry out the design and control of a simple robot.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping od Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Industrial Robotics Technology, Programming and Applications	M.PGroover	McGraw-HillUSA	2e(SIE),2012
2	Introduction to Robotics	JohnCraig	Macmillan	4e,2022
3	Fundamentals of Robotics Analysis& Control	Robert J Shilling	PHI	2003
4	Introduction to Robotics	S.K. Saha	Tata McGraw Hill	2e,2014

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Robotics, Analysis, Control, Application	NikuS.B.,	John Wiley	Second Edition, 2000
2	Robot Dynamics and Control	Mark W. Spong, Seth Hutchinson, and M. Vidyasagar	Wiley	2008
3	Robotics, Fundamental concepts and analysis	AshitavaGhosal	OXFORD University Press	2006
4	Robot Analysis and Control	Asada, H., and J. J. Slotine.	New York, NY:Wiley,	1986
5	Robotic Engineering An Integrated Approach	Klafter, R.D., Chmielewski, T.A, Negin, M,	PHI	2007

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/107106090
2	https://nptel.ac.in/courses/112105249
3	https://nptel.ac.in/courses/112101098
4	https://nptel.ac.in/courses/112107289

SEMESTER S7

NANOELECTRONICS

Course Code	**PEERT 744**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To understand the challenges of scaling of devices to Nano-meter scales
2. To apply quantum mechanics in materials and quantum devices

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Nano electronics-Review of MOSFETs-** Band diagram-operation-threshold voltage- current-MOSFET parameters. **Challenges going to sub-100 nm MOSFETs-**Technological and physical limits of Nanoelectronic systems, characteristic lengths **Scaling and short channel effects-L**ength, Oxide layer thickness, tunneling, power density, non-uniform dopant concentration, threshold voltage scaling, hot electron effects, sub-threshold current, velocity saturation, DIBL, and channel length modulation.	9
2	**Novel MOS Devices and Performance Optimization** **Silicon-on-insulator devices--**FD SOI, PD SOI **Multiple gate MOSFETs--**Double gate MOSFETs, FinFETs, Nanowires	9

	Multi Gate MOSFET performance optimization: Fins, Fin Width, Fin Height and Fin Pitch, Fin Surface Crystal Orientation, Fins on Bulk Silicon, Nano-wires. Gate Stack, Gate Patterning, Threshold Voltage and Gate Work function requirements.	
3	**Quantum Transport** **Atomistic view of electrical Resistance**-Energy level diagram- What makes electrons flow- The quantum of conductance - Potential profile- Coulomb blockade - Towards Ohm's law **Schrodinger equation**- Method of finite differences – Examples (particle in a box only) **Band structure**- 1-D examples- General result with basis- 2-D example **Sub bands**- Quantum wells, wires, dots, graphene, and "carbon nanotubes" -- Density of states-Minimum resistance of a wire **Ballistic to Diffusive Transport**-Landauer formula, Landauer-Buttiker formula. Ballistic and Diffusive transport – transmission.	**9**
4	**Applications of Quantum mechanics and Quantum devices** **Tunneling and applications of quantum mechanics-** Solution of Schrodinger equation: Free space, Potential well, tunneling through a potential barrier. Potential energy profiles for material interfaces **Hetero junctions** -Modulation-doped hetero junctions- SiGe strained heterostructures- MODFET- Resonant Tunnelling-Resonant Tunneling transistor. **Single electron devices** –Coulomb blockade in a Nano capacitor, tunnel junctions, Double tunnel junction--Coulomb staircase, Single electron transistor. **Spintronics**-Transport of spin, GMR-TMR,applications, Spin Transistor	**9**

Course Assessment Method

(CIE: 40 marks,ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Describe the challenges of scaling of electron devices to Nano meter scales	**K2**
CO2	Design novel transistor devices to reduce the short channel effects and improve performance	**K3**
CO3	Outline the Nano scale quantum transport in Nano electronic devices from atom to transistor	**K2**
CO4	Apply quantum mechanics in materials and quantum devices	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Fundamentals of Modern VLSI Devices	Yuan Taur, Tak H Ning	Cambridge University Press,	Second edition 2009
2	Nanoelectronics and Nanosystems	Karl Goser· Peter GlÖsekötter· Jan Dienstuhl	Springer-Verlag Berlin Heide1berg	First Edition, 2004
3	Nanotechnology for microelectronics and optoelectronics,	J M Martinez Duart, R J Martin Palma, F Agullo Rueda	Elsevier,	First Edition, 2006
4	FinFETs and Other multigate Transistors	J-P Colinge	Springer	First Edition, 2008
5	Quantum Transport Atom to Transistor	Supriyo Datta	Cambridge University Press	First Edition, 2005
6	Fundamentals of nano electronics,	George W.Hanson,	Pearson Education.	First Edition 2009

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Fundamentals of Carrier Transport	Mark Lundstrom	Cambridge University Press	Second Edition, 2000
2	High Dielectric Constant materials VLSI MOSFET Applications,	H R Huff, D C Gilmer,	Springer	First Edition, 2004
3	Nanoelectronics and nanosystems From Transistors to Molecular and Quantum Devices	Karl Goser· Peter GlÖsekötter· Jan Dienstuhl	Springer	First Edition, 2004
4	NANOSCALE TRANSISTORS Device Physics, Modeling and Simulation	Mark S. Lundstrom, Jing Guo	Springer	First Edition, 2006
5	Fundamentals of Ultra-Thin-Body MOSFETs and FinFETs	Jerry G. Fossum, Vishal P. Trivedi	Cambridge University Press	First Edition, 2013
6	Introduction to Nanotechnology	Charles P Poole jr. Frank J Owens	John Wiley and Sons	First Edition, 2003
7	Introduction to Quantum Mechanics	David J Griffiths, Darrel F schroetter	Cambridge University Press	Third Edition, 2018

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/117108047, https://nanohub.org/resources/5328
2	https://nptel.ac.in/courses/117108047
3	https://nptel.ac.in/courses/117107149, https://nanohub.org/resources/8086, https://nanohub.org/courses/FON1, https://nanohub.org/resources/5306
4	https://nptel.ac.in/courses/117107149, https://nanohub.org/resources/8086

SEMESTER S7

BLOCKCHAIN TECHNOLOGIES

Course Code	**PEERT 746**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	Data structures, Operating systems.	**Course Type**	Theory

Course Objectives:

1. Illustrate the cryptographic building blocks of blockchain technology.
2. To understand the function of blockchains, understanding why/when it is better than a simple distributed database.
3. Summarize the classification of consensus algorithms.
4. Explain the use of smart contracts and its use cases.
5. Develop simple applications using Solidity language on Ethereum platform.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Fundamentals of Cryptography** Introduction to Cryptography, Symmetric cryptography – AES. Asymmetric cryptography – RSA. Elliptic curve cryptography, Digital signatures – RSA digital signature algorithms. Secure Hash Algorithms – SHA-256. Applications of cryptographic hash functions – Merkle trees, Distributed hash tables **Fundamentals of Blockchain Technology** Blockchain – Definition, architecture, elements of blockchain, benefits and limitations, types of blockchain.	9
2	**Consensus Algorithms** Consensus – definition, types, consensus in blockchain.	9

	Consensus Algorithms, Crash fault-tolerance (CFT) algorithms – Paxos, Raft. Byzantine faulttolerance (BFT) algorithms – Practical Byzantine Fault Tolerance (PBFT), Proof of work (PoW), Proof of stake (PoS), Types of PoS **Bitcoin** Bitcoin – Definition, Cryptographic keys – Private keys, public keys, addresses. Transactions – Lifecycle, coinbase transactions, transaction validation. Blockchain – The genesis block. Mining – Tasks of miners, mining algorithm, hash rate. Wallets – Types of wallets	
3	**Smart Contracts and Use cases** Smart Contracts – Definition, Smart contract templates, Oracles, Types of oracles, Deploying smart contracts. Use cases of Blockchain technology – Government, Health care, Finance, Supply chain management. Blockchain and allied technologies – Blockchain and Cloud Computing, Blockchain and Artificial Intelligence.	9
4	**Ethereum and Solidity** Ethereum – The Ethereum network. Components of the Ethereum ecosystem – Keys and addresses, Accounts, Transactions and messages. The Ethereum Virtual Machine, Blocks and blockchain. The Solidity language – The layout of a Solidity source code, Structure of a smart contract, variables, data types, control structures, events, inheritance, libraries, functions, error handling. Smart contracts Case study: Voting, Auction.	9

Course Assessment Method

(CIE: 40 marks,ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Understand the fundamentals of cryptography and block chain	**K2**
CO2	Analyse how the various consensus algorithms ensure security and reliability in blockchain networks.	**K4**
CO3	Learn about the concept of smart contracts and their applications.	**K2**
CO4	Identify and discuss potential applications of blockchain technology in various sectors	**K4**
CO5	Study real-world examples of successful blockchain implementations and their impact.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Mastering Blockchain: A deep dive into distributed ledgers, consensus protocols, smart contracts, DApps, cryptocurrencies,Ethereum, and more,	Imran Bashir	Packt Publishing	Third edition 2020

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Block Chain in Action	Bina Ramamurthy	Mnning Publication	First edition& 2020
2	Solidity Programming Essentials: A beginner's guide to build smart contracts for Ethereum and blockchain	Ritesh Modi	Packt Publication	First edition&2018.
4	Blockchain Technology: Concepts and Applications	Kumar Saurabh, Ashutosh Saxena	Wiley Publication	First Edition&2020 .

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	Blockchain Demo (andersbrownworth.com)
2	Blockchain.com Explorer | BCH | ETH | BCH
3	Remix - Ethereum IDE
4	Ethereum Transactions Information | Etherscan

SEMESTER S7

NETWORK SECURITY

Course Code	PEERT 745	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	5/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To understand the fundamental concepts and importance of network security.
2. To learn and apply various cryptographic techniques for securing data.
3. To explore and analyze different network security protocols and their applications.
4. To identify and mitigate various network threats and vulnerabilities.
5. To examine advanced topics in network security, including intrusion detection systems, wireless security, and emerging security challenges.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fundamentals of network security - Introduction to Network Security, Understanding Security: Confidentiality, Integrity, Availability (CIA Triad), Threats, Vulnerabilities, and Attacks: Types and Examples, Security Policies and Mechanisms, Network Security Technologies and Devices - Firewalls: Types, Configurations, and Best Practices, Intrusion Detection and Prevention Systems (IDS/IPS), Virtual Private Networks (VPNs): Concepts and Uses, Access Control and Authentication - Access Control Models: DAC, MAC, RBAC, Authentication Methods: Passwords, Biometrics, Two-Factor Authentication, Authorization and Accounting Concept	9
2	Cryptography and Secure Communications - Introduction to Cryptography, Symmetric Key Cryptography: Algorithms (AES, DES), Modes of Operation,	9

	Encryption and Decryption Processes, Asymmetric Cryptography and Key Management- Public Key Cryptography: RSA, Diffie-Hellman, Digital Signatures and Certificates, Public Key Infrastructure (PKI) and Key Management, Hash Functions and Message Authentication- Hash Functions: SHA, MD5 – Concepts and Applications, Message Authentication Codes (MAC) and HMAC, Secure Email: PGP and S/MIME	
3	Network Security Protocols and Applications Secure Network Protocols - Secure Socket Layer (SSL) and Transport Layer Security (TLS), Secure Shell (SSH): Concepts and Uses, IP Security (IPsec): Architecture and Protocols, Web and Email Security, HTTP Security: HTTPS, Secure Cookies, and Content Security Policy, Email Security Threats and Solutions, Web Application Security: OWASP Top 10, Wireless and Mobile Security, Wireless Security Protocols: WEP, WPA, WPA2, WPA3, Mobile Device Security Challenges and Solutions, Bluetooth and Near Field Communication (NFC) Security	9
4	Advanced Topics in Network Security - Intrusion Detection and Prevention, Types of Intrusions and Attack Patterns, Host-based and Network-based IDS/IPS, Anomaly Detection and Signature-Based Detection, Types of Malware: Viruses, Worms, Trojans, Ransomware, Malware Detection and Removal Techniques, Threat Intelligence and Cybersecurity Frameworks Malware and Threat Analysis - Cloud Security: Challenges and Solutions, Emerging Trends and Future Directions - Internet of Things (IoT) Security Concerns, Artificial Intelligence and Machine Learning in Security, Blockchain Technology for Secure Transactions	9

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Internal Ex	Evaluate	Analyse	Total
5	15	10	10	40

Criteria for Evaluation (Evaluate and Analyse): 20 marks

Evaluation Methods:

1. Experiments may be done using following Software and Tools: (10 marks)

:

- Wireshark: For network traffic analysis.
- Nmap: For network scanning and vulnerability assessment.
- OpenSSL: For implementing and testing cryptographic functions.
- Snort: For intrusion detection and prevention.
- VirtualBox/VMware: For creating virtualized network environments.
- Kali Linux: A Linux distribution specialized for digital forensics and penetration testing.

1. Setting Up a Secure Network Environment Using Virtual Machines
2. Configuring a Basic Firewall and Monitoring Network Traffic
3. Implementing User Authentication and Access Control in a Network
4. Implementing Symmetric Encryption Using OpenSSL
5. Creating and Using Digital Certificates with OpenSSL
6. Generating and Verifying Hashes and Digital Signatures
7. Establishing Secure Connections Using SSH and TLS
8. Configuring HTTPS for a Web Server and Implementing Basic Web Security Measures
9. Securing a Wireless Network and Assessing Vulnerabilities
10. Setting Up and Configuring Snort IDS for Network Monitoring
11. Conducting Basic Malware Analysis in a Controlled Environment
12. Case Study Presentation on an Emerging Network Security Topic

Criteria for Evaluation: Course Project (10 marks)

1. Project Proposal and Planning (2 marks)
    - Submits a well-defined project proposal outlining objectives, methodology, and expected outcomes.
    - Demonstrates thorough planning and a clear timeline for the project.
2. Design and Implementation (3 marks)
    - Implements the project design accurately using appropriate tools and techniques.
    - The design is functional and meets the project objectives.
2. Innovation and Creativity (2 marks)
    - Introduces innovative ideas or unique approaches in the design and implementation.
    - Demonstrates creativity in solving problems or optimizing designs.
2. Analysis and Testing (2 marks)
    - Effectively analyzes the project design to identify and address any issues.
    - Conducts thorough testing to verify the functionality and performance of the design.
2. Final Report and Presentation (1 mark)
    - Submits a comprehensive final report detailing the project, including objectives, design, methodology, analysis, and results.
    - Clearly presents the project and its outcomes, and effectively communicates the key points.

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• 2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 sub divisions. Each question carries 9 marks. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Apply cryptographic techniques and protocols to secure network communications and ensure data confidentiality, integrity, and authenticity.	**K3**
CO2	Configure and manage network security devices and software, such as firewalls, IDS/IPS, and VPNs, to protect network infrastructures.	**K3**
CO3	Identify and respond to security incidents and network breaches by conducting threat analysis and implementing appropriate countermeasures.	**K2**
CO4	Evaluate emerging network security challenges and technologies, proposing solutions to complex security problems in modern network environments.	**K4**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping od Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Network Security Essentials: Applications and Standards	William Stallings	Pearson	7th Edition, 2022
2	Cryptography and Network Security: Principles and Practice	William Stallings	Pearson	8th Edition, 2023
3	Computer Security: Principles and Practice"	William Stallings and Lawrie Brown	Pearson	5th Edition, 2021

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	The Network Security Test Lab: A Step-by-Step Guide	Michael Gregg	Wiley	2nd Edition, 2022
2	Applied Network Security Monitoring: Collection, Detection, and Analysis	Chris Sanders and Jason Smith	Syngress	1st Edition, 2018
3	Hacking Exposed 7: Network Security Secrets and Solutions	Stuart McClure, Joel Scambray, and George Kurtz	McGraw-Hill Education	7th Edition, 2020

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/106105031
2	https://onlinecourses.nptel.ac.in/noc22_cs90/preview

SEMESTER S7

WEB PROGRAMMING

Course Code	**PEERT 751**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. Learn how servers and web browsers communicate.
2. Learn how to use HTML elements to construct well-structured web pages.
3. Explore advanced CSS methods such as animations, transitions, and responsive design.
4. Learn how to write PHP scripts to handle form submissions and perform server-side processing.
5. Learn how to integrate HTML, CSS, PHP, and MySQL to create dynamic and interactive web applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**WWW:** Web Basics, URI's & URL, Search Engine Optimization (SEO), Analytics, Domain Names & Hosting, Ftp & Third party tools **HTML5:** Introduction to HTML5, Basic Structure for HTML, Basic HTML tags-Headings, Hyper Links, Images, Special Characters and Horizontal Rules, Lists, Tables, Forms, Internal Linking, Meta Elements, HTML5 Form Input Types, Input and Data List Elements, Autocomplete Attribute, Page Structure Elements, Multimedia-HTML5 Audio & video elements	8
2	Introduction to Stylesheets : Introduction to CSS-Basic syntax and structure-Inline, Internal and External Styles, Embedded Style Sheets, Conflict Resolution, Linking External Style Sheets-Exploring CSS Selectors-Properties, values, Positioning Elements: Absolute Positioning, Relative	7

	Positioning, Backgrounds,List Styles,Element Dimensions, Table Layouts-Box Model and Text Flow-div and span, Basics of Responsive CSS, Media port & Media Queries.	
3	JavaScript:Introduction, Examples of JavaScript in browser, Basic JavaScript Instructions: Statements, Comments, Variable, Data Types, Arrays, Expressions, Operators, Functions and Objects, Variable Scope, Object, Arrays are objects, Browser Object Model, DOM, Global Objects: String, Number, Math, Date. Decision Making and Loops: if statement, if…else statement, switch statement, Loops: Key Concepts, for loops, while loops, do while loops; DOM: Document Object Model (DOM),Working with DOM tree, Accessing Elements, Nodelists, Selecting Elements: Using Class Attribute, Tag Name, CSS Selector, repeating actions for an entire nodelist, Looping through a Nodelist, Traversing the DOM, Adding or Removing HTMLcontent, Update Text and Markup, Adding/Removing Elements, Event Handling: Different event types and ways to bind an event to an element: using DOM Event Handlers, using Event listeners, using Parameters with Event Listeners; the Event Object, Event Delegation, User Interface Events, Event Bubbling ECMAScript: Versions, Features, Introduction, Var Declarations and Hoisting, let declaration, Constant declaration, Function with default parameter values, Default parameter expressions, Unnamed parameters, the spread operator, arrow functions, object destructuring, array destructuring, sets and maps, Array.find(), Array.findIndex(), template strings, Javascript classes, callbacks, promises, async/await	10
4	**PHP**: Introduction, Building blocks of PHP, Variables, Data Types Simple PHP program, Converting between Data Types, Operators and Expressions, Flow Control functions, Control statements, Working with Functions, Initialising and Manipulating Arrays, Objects, String Comparisons,String processing with Regular Expression **Advanced PHP**: Form processing and Business Logic, Cookies, Sessions, MySQL Integration: Connecting to MySQL with PHP, Performing CREATE, DELETE, INSERT, SELECT and UPDATE operations on MySQL table, Working with MySQL data, Reading from Database Dynamic Content.	10

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Comprehend the principles of the WWW and create web pages using HyperText Markup Language (HTML)	**K3**
CO2	Implement Cascading Style Sheet to apply style in HTML pages	**K3**
CO3	Add functionality to web pages by using Java Script	**K3**
CO4	Construct websites using advanced sever side programming tool PHP	**K3**
CO5	Use PHP to create dynamic web pages and perform MySQL database operations	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Internet and World Wide Web How To Program	Paul J. Deitel, Harvey M. Deitel, Abbey Deitel	Pearson Education	5th Edition, 2012
2	HTML and CSS: Design and	Jon Duckett	Wiley	2011

	Build Websites			
3	JavaScript and JQuery : Interactive Front–End Web Development	Jon Duckett	Wiley	2014
4	Understanding ECMAScript 6: The Definitive Guide for JavaScript Developers	Nicholas C. Zakas	William Pollock	2016
5	PHP, MySQL & JavaScript All in One	Julie C. Meloni	Pearson - Sams Publishing	5th edition, 2017

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Programming the World Wide Web	Robert W Sebesta	Pearson	8th Edition, 2015
2	PHP 6 and MySQL 5 for Dynamic Web Sites: Visual QuickPro Guide	Larry Ullman	Pearson	5th Edition, 2017
3	The Joy of PHP: A Beginner's Guide to Programming Interactive Web Applications with PHP and mySQL	Alan Forbes	Plum Island	6th Edition, 2020
4	Head First PHP & MySQL	Lynn Beighley & Michael Morrison	O'Reilly	1st Edition, 2009
5	PHP: A Beginner's Guide	Vikram Vaswani	McGraw-Hill Education	1st Edition, 2008
6	Learning PHP, MySQL, JavaScript, CSS & HTML5	Robin Nixon	O'Reilly	2nd Edition, 2012

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/106106156/
2	https://www.php.net/
3	https://www.mysql.com/
4	https://www.w3schools.com/php/
5	https://www.w3schools.com/sql/

SEMESTER S7

LOW POWER VLSI

Course Code	PEERT 752	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Students will be able to understand the fundamental principles of power dissipation in digital integrated circuits and the impact of power consumption on modern VLSI design
2. Students will be able to explore various low power design techniques and methodologies for minimizing power consumption in digital circuits, such as voltage scaling, power gating, and clock gating.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Physics of Power dissipation in MOSFET devices** Need for low power circuit design, MIS Structure **Deep submicron transistor design issues: Short channel effects** Channel Length Modulation, Surface scattering, Punch through, Velocity saturation, Impact ionization, Hot electron effects, Body Effect, Narrow width effect, V_{th} roll-off, Drain Induced Barrier Lowering, Gate Induced drain leakage, Tunnelling Through Gate Oxide, Subthreshold Leakage Current, **Emerging Technologies for Low Power:** Hi-K Gate Dielectric, Lightly Doped Drain–Source, Silicon on Insulator.	9
2	**Sources of power dissipation in digital ICs** – **Dynamic Power Dissipation:** Short Circuit Power: Short Circuit Current of Inverter, Short circuit current	9

	dependency on input rise and fall time, Variation of short circuit current with load capacitance. Switching power dissipation: Switching Power of CMOS Inverter, Switching activity and its effects. Glitching Power: Glitches and its effect on power dissipation **Static Power Dissipation:** Sources of Leakage Power, Effects of V_{dd} and Vton speed, Constraints on Vt Reduction.	
3	**Low-Power Design Approaches-** **Supply Voltage Scaling for Low Power:** Effect of Supply Voltage on Delay and Power, Effect of Supply Voltage on Static and Dynamic Power, Multi VDD, Dynamic VDD, Dynamic Voltage and Frequency Scaling (DVFS) Approaches. Architectural Level Approaches: Pipelining and Parallel Processing **Leakage power reduction Techniques:** Effect of Threshold Voltage on Leakage Power, Transistor stacking, MTCMOS, VTCMOS, Power gating& Clock gating Techniques.	9
4	**Circuit Design Styles for Low Power-** **Non-clocked circuit design style:** Fully Complementary logic. NMOS and Pseudo–NMOS logic, Differential Cascode Voltage Switch logic(DCVS) **Clocked design style:** Basic concept, Dynamic Logic, Domino logic, Differential Current Switch Logic. **Adiabatic switching** – Adiabatic charging, Adiabatic amplification, Adiabatic logic gates, Pulsed power supplies.	9

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub-divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course, students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Understand the Impact of Technology Scaling on Power Dissipation and Short Channel Effects	**K2**
CO2	Identify Different Sources of Power Dissipation in Digital ICs	**K2**
CO3	Apply Power Management Approaches in Digital ICs	**K3**
CO4	Utilize Clocked and Non-Clocked Design Styles and Adiabatic Switching for Power Management	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Design of Analog CMOS Integrated Circuits	Behzad Razavi	McGraw-Hill	2/e, 2002
2	CMOS: Circuits Design, Layout and Simulation,	Baker, Li, Boyce	Prentice Hall India,	2000
3	Microelectronic Circuits	Sedra & Smith	Oxford University Press	6/e,2017

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	CMOS Analog Circuit Design,	Phillip E. Allen, Douglas R. Holbery	Oxford University Press	3/e
2	Fundamentals of Microelectronics	Behzad Razavi	Wiley student Edition	2014
3	Analysis and Design of Analog Integrated Circuits	Meyer Gray , Hurst, Lewis	Wiley	5/e, 2009

Video Links (NPTEL, SWAYAM…)	
Module No.	Link ID
1	www.youtube.com/@b_razavi, www.youtube.com/@analogicdesign-iitm5234
2	www.youtube.com/@b_razavi, www.youtube.com/@analogicdesign-iitm5234
3	www.youtube.com/@b_razavi, www.youtube.com/@analogicdesign-iitm5234
4	Switching Circuits and Logic Design by Prof. Indranil SenguptaLectures 47-51

SEMESTER S7

REAL TIME OPERATING SYSTEM

Course Code	**PEECT 753**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. Introduce Real Time Operating Systems, its basic structure, building blocks and various operations
2. Summarize the different scheduling algorithms used in RTOS.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Real-Time Systems** **Overview of Real-Time Systems:** Definition and types of real-time systems, Hard vs. soft real-time systems. **Basic Concepts:** Real-time tasks and their characteristics, Task scheduling, Timing constraints and requirements. **RTOS Architectures:** Monolithic kernels vs. microkernels. **RTOS examples:** commercial vs Open RTOS and their comparison, examples. **Inter-Process Communication (IPC):** Shared memory, Message passing. **RTOS Environment Setup:** Installation and setup of an RTOS on a microcontroller (e.g., ARM Cortex-M), **Task Creation and Management:** Writing simple tasks, Task states and transitions, **Scheduling and Context Switching:** Implementing basic scheduling algorithms, Demonstrating context switching with example tasks	**9**
2	**Real-Time Scheduling and Synchronization**	

	Real-Time Scheduling Algorithms: Fixed-priority scheduling (Rate-Monotonic, Deadline-Monotonic), Dynamic priority scheduling (Earliest Deadline First), Priority based preemption, Round Robin, **Task Synchronization:** Mutual exclusion, Priority inversion and inheritance **Inter-Task Communication:** Semaphores, Mutexes, Event flags **Implementing Scheduling Algorithms:** Practical implementation of scheduling, **Synchronization Mechanisms:** Practical implementation of semaphores and mutexes in task synchronization, Demonstrating priority inversion and its mitigation: **Real-Time Task Communication:** Implementing inter-task communication using queues and mailboxes	**9**
3	**Real-Time System Design and Analysis** **System Design Principles:** Modular design, Time-triggered vs. event-triggered systems, **Worst-Case Execution Time (WCET) Analysis:** Techniques for WCET estimation, Timing analysis, **Reliability and Fault Tolerance:** Redundancy, Error detection and recovery. **Designing a Real-Time System:** Case study: Designing a real-time control system, **WCET Analysis Tools:** Using tools for WCET analysis and timing verification, **Implementing Fault Tolerance:** Practical implementation of redundancy and error recovery mechanisms	**9**
4	**Real-Time Operating System Services and Applications** **Real-Time Operating System Services:** Memory management, I/O management. **Real-Time Middleware:** Middleware services for real-time systems, **Case Studies and Applications:** Automotive systems, Aerospace and defense, Medical devices **Memory Management in RTOS:** Implementing dynamic memory allocation, **Real-Time Middleware Implementation:** Developing middleware components for a real-time application **Case Study Implementation:** Implementing a real-time system for a specific application (e.g., real-time data acquisition)	**9**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Understand the fundamental concepts and characteristics of real-time systems.	**K1, K2**
CO2	Analyze and implement real-time scheduling algorithms and techniques.	**K4**
CO3	Conduct worst-case execution time (WCET) analysis for real-time tasks.	**K3, K4**
CO4	Utilize RTOS services and middleware for developing real-time applications	**K3,K4**
CO5	Develop practical real-time applications in various domains such as automotive, aerospace, and medical devices.	**K3, K5, K6**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Real-Time Operating Systems Book 1: The Theory	Jim Cooling	CreateSpace Independent Publishing Platform	1st 2018
2	Real-Time Systems: Theory and Practice	Rajib Mall	Pearson Education	2007
3	Real-Time Systems: Design Principles for Distributed Embedded Applications	Hermann Kopetz	Springer	2nd 2011
4	Embedded Systems: Real-Time Operating Systems for Arm Cortex-M Microcontrollers	Jonathan W. Valvano	CreateSpace Independent Publishing Platform	3rd, 2017

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Real-Time Systems	C. M. Krishna, Kang G. Shin,	McGraw-Hill	2010
2	Real-Time Systems	Jane W. S. Liu	Pearson Education	2009
3	Real-Time Systems Design and Analysis	Philip A. Laplante, Seppo J. Ovaska,	Wiley	2012
4	Embedded Systems with ARM Cortex-M Microcontrollers in Assembly Language and C	Yifeng Zhu	E-Man Press LLC	3rd , 2017

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://elearn.nptel.ac.in/shop/iit-workshops/completed/lab-workshop-on-embedded-rtos/?v=c86ee0d9d7ed https://onlinecourses.nptel.ac.in/noc21_cs98/preview
2	https://elearn.nptel.ac.in/shop/iit-workshops/completed/lab-workshop-on-embedded-rtos/?v=c86ee0d9d7ed
3	https://elearn.nptel.ac.in/shop/nptel/real-time-operating-system/?v=c86ee0d9d7ed https://onlinecourses.nptel.ac.in/noc21_cs98/preview
4	https://elearn.nptel.ac.in/shop/iit-workshops/completed/lab-workshop-on-embedded-rtos/?v=c86ee0d9d7ed

SEMESTER S7

CLIENT SERVER ARCHITECTURE

Course Code	**PEERT 754**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

Understand fundamental concepts of Web Services including

1. Client Server systems
2. system models of distributed systems
3. networks that distributed systems run on
4. communication protocols between processes in distributed systems
5. Middleware
6. Enterprise Application integration
7. Web Services Security

SYLLABUS

Module No.	**Syllabus Description**	**Contact Hours**
1	**Introduction**: Introduction to Client/Server computing - Driving forces behind Client/ Server, Client/ Server development tools, Development of client/server systems, Client/Server security, Organizational Expectations, Improving performance of client/server applications, Single system image, Downsizing and Rightsizing, Advantages of client server computing, Applications of Client/Server.	**7**
2	**Client/ Server Application and Network**: Classification of Client/Server Systems- Two-Tier Computing, Middleware, Three-Tier Computing- Model View Controller (MVC), Principles behind Client/Server Systems. Client/Server Topologies. Existing Client/Server Architecture. Architecture for Business Information System..	**8**

	Client- Services, Request for services, RPC, Windows services, Print services, Remote boot services, other remote services, Utility Services **Server-** Detailed server functionality, Network operating system, Available platforms, Server operating system.	
3	**Client/ Server Systems Development**: Services and Support- System administration, Availability, Reliability, Scalability, Observability, Agility, Serviceability. Software Distribution, Performance, Network management. Remote Systems Management- RDP, Telnet, SSH, Security. LAN and Network Management issues, Training, Connectivity, Communication interface technology, Interprocess communication, Wide area network technologies, Network Acquisition, PC-level processing unit, X-terminals, Server hardware.	**8**
4	**Client/Server Technology and Web Services:** Web Services History. Web Server Technology- Web Server, Web Server Communication, Role of Java for Client/Server on Web. Web Services- MicroServices, APIs, API Gateway, Authentication of users/clients, Tokens/Keys for Authentication, Service Mesh, Message Queues, SaaS, Web Sockets.Client/Server/Browser – Server Technology, Client/Server Technology and Web Applications, Balanced Computing and the Server's Changing Role.	**8**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Explain the basics of client/server systems and the driving force behind the development of client/server systems	**K2**
CO2	Outline the architecture and classifications of client/server systems	**K2**
CO3	Choose the appropriate client/server network services for a typical application	**K2**
CO4	Describe management services and issues in network	**K2**
CO5	Compare and summarize the web extensions and choose appropriate web services standards for an application	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Client/ Server Computing	Patrick Smith & Steave Guengerich	Sam Publishers	2^{nd} Edition, 1994
2	Client/ Server Computing	Dawna Travis Dewire	Mc Graw Hill	1993
3	An Indroduction to Client/ Server Computing	Subash Chandra Yadhav, Sanjay Kumar Sigh	New Age International Publishers	1^{st} Edition, 2009

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Guide to Client- Server Application & Architecture	Jerffrey D Schank	Novell Press	1994
2	Client/ Server Survival Guide	Robert Orfali , Dan Harkey , Jeri Edwards	Wiley Indian Edition	3^{rd} Edition, 1996
3	Client/ Server Applications	W H Inman		
4	Client/ Server Computing	Dawna Travis Dewire	Mc Graw Hill	1993
5	Developing Client/ Server Application	W H Inman		

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/105/106105084/
2	https://www.geeksforgeeks.org/client-server-architecture-system-design/
3	https://intellipaat.com/blog/what-is-client-server-architecture/
4	https://www.tutorialspoint.com/client-server-computing
5	https://www.simplilearn.com/what-is-client-server-architecture-article

SEMESTER S7

SPEECH AND AUDIO PROCESSING

Course Code	PEECT 756	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	4/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To impart the basic concepts of speech signal processing
2. To familiarize the auditory mechanism and speech perception

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Speech Production: - Acoustic theory of speech production- -Source/Filter model - Pitch, Formant, Spectrogram-- Discrete model for speech production, Articulatory Phonetics -Acoustic Phonetics- Basic speech units and their classification.	9
2	Short-Time Speech Analysis, Windowing, STFT, spectra of windows- Wide and narrow band spectrogram -Time domain parameters (Short time energy, short time zero crossing Rate, ACF). Frequency domain parameters-Filter bank analysis. STFT Analysis. Prosody of speech. MFCC-computation, LPC Model, Pitch and Formant Estimation.	9
3	Speech Enhancement: Spectral subtraction and Filtering, Harmonic filtering, parametric resynthesis. Speaker Recognition: Speaker verification and speaker identification- log-likelihood. Machine learning models in Speaker Recognition. Language identification: implicit and explicit models.	9
4	Signal Processing models of audio perception: Basic anatomy of hearing System: Basilar membrane behaviour. Sound perception: Auditory Filter Banks, Critical Band Structure, Absolute Threshold of Hearing, Masking- Simultaneous Masking, Temporal Masking. Models of speech perception	9

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	To describe the fundamental concepts, principles, and theories of speech production	**K1**
CO2	To analyse the speech signal in the time and frequency domain	**K2**
CO3	To apply speech processing concepts in real-world applications	**K3**
CO4	To describe the fundamental concepts, principles, and theories of hearing mechanism	**K1**
CO5	To develop applications by combining concepts of speech production and hearing mechanism	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping od Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Speech Communications: Human and Machine, 2nd Edition	Douglas O'Shaughnessy	Wiley-IEEE Press	2^{nd} edition
2	Discrete-Time Speech Signal Processing: Principles and Practice	Thomas F. Quatieri	Prentice-Hall Signal Processing Series	2001

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Processing of Speech Signals	Rabinar	Pearson	2003

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	Speech and Audio Processing 1: Introduction to Speech Processing - Professor E. Ambikairajah https://www.youtube.com/watch?v=Xjzm7S__kBU
2	Speech Analysis - Professor E. Ambikairajah https://www.youtube.com/watch?v=Y_mSQ7tTlvQ&t=38s
3	Speech and Audio Processing 1: Introduction to Speech Processing - Professor E. Ambikairajah https://www.youtube.com/watch?v=Xjzm7S__kBU
4	Video Links available on hearing anatomy

SEMESTER S7

NEURAL NETWORKS AND DEEP LEARNING

Course Code	PEERT 755	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	5/3	Exam Hours	2Hr.30 Min.
Prerequisites (if any)	None		Elective

Course Objectives:

1. To introduce the fundamental concepts of neural networks, including their structure, function, and basic training algorithms.
2. To provide an understanding of deep learning concepts, architectures, and key techniques for training deep neural networks.
3. To explore advanced neural network architectures and techniques, including optimization methods and regularization techniques.
4. To explore real-world applications of deep learning and discuss the latest trends and future directions in the field.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Neural Networks:** Overview of Artificial Neural Networks (ANNs), Biological Neurons vs. Artificial Neurons, Applications of Neural Networks, Neuron Model: Activation Functions (Sigmoid, ReLU, Tanh), Single-layer Perceptron: Theory and Implementation, Multi-layer Perceptrons (MLPs), Backpropagation Algorithm: Concepts and Mathematical Foundations	9
2	**Deep Learning Fundamentals:** Introduction to Deep Learning, Differences Between Shallow and Deep Networks, Convolutional Neural Networks (CNNs): Architecture and Applications, Pooling Layers and Feature Maps,	9

	Training Deep Networks: Vanishing and Exploding Gradients, Recurrent Neural Networks (RNNs): Architecture and Applications, Long Short-Term Memory (LSTM) Networks	
3	**Advanced Neural Network Architectures:** Autoencoders: Concept, Architecture, and Applications, Variational Autoencoders (VAEs), Generative Adversarial Networks (GANs): Theory and Architecture, Applications of GANs in Image Generation and Data Augmentation, Optimization Techniques: Gradient Descent, Adam, RMSprop, Regularization Methods: Dropout, Batch Normalization	**9**
4	**Applications and Emerging Trends in Deep Learning:** Deep Learning in Computer Vision: Object Detection, Segmentation, Deep Learning in Natural Language Processing: Word Embeddings, Transformers, Deep Reinforcement Learning: Concepts and Applications, Emerging Trends: Federated Learning, Explainable AI,	**9**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	***Internal Ex***	***Evaluate***	***Analyse***	***Total***
5	**15**	**10**	**10**	**40**

Criteria for Evaluation (Evaluate and Analyse): 20 marks

Evaluation Methods:

1. Experiments Using Software Tools: (10 marks)

Introduction to Neural Network Libraries (e.g., TensorFlow, Keras)

Building a Simple Perceptron Model

Implementing Backpropagation in a Neural Network

Implementing Deep Neural Networks with Keras

Building and Training a CNN for Image Classification

Implementing an RNN for Sequence Prediction

Implementing an Autoencoder for Data Compression

Implementing a Simple GAN for Image Generation

Applying Regularization Techniques to Improve Model Performance

Implementing a Transformer Model for Text Classification

2. Criteria for Evaluation: Course Project (10 marks)

1. Project Proposal and Planning (2 marks)
   - Submits a well-defined project proposal outlining objectives, methodology, and expected outcomes.
   - Demonstrates thorough planning and a clear timeline for the project.
2. Design and Implementation (3 marks)
   - Implements the project design accurately using appropriate tools and techniques.
   - The design is functional and meets the project objectives.
2. Innovation and Creativity (2 marks)
   - Introduces innovative ideas or unique approaches in the design and implementation.
   - Demonstrates creativity in solving problems or optimizing designs.
2. Analysis and Testing (2 marks)
   - Effectively analyzes the project design to identify and address any issues.
   - Conducts thorough testing to verify the functionality and performance of the design.
2. Final Report and Presentation (1 mark)
   - Submits a comprehensive final report detailing the project, including objectives, design, methodology, analysis, and results.
   - Clearly presents the project and its outcomes, and effectively communicates the key points.

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 sub divisions. Each question carries 9 marks. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Analyze and implement the basic structure and functioning of neural networks and apply the backpropagation algorithm for training.	**K3**
CO2	Demonstrate the ability to design, train, and evaluate deep neural network architectures, including Convolutional Neural Networks and Recurrent Neural Networks.	**K2**
CO3	Evaluate and apply advanced neural network architectures, including Autoencoders and Generative Adversarial Networks, to solve real-world problems, and optimize models using advanced techniques such as regularization and optimization algorithms.	**K4**
CO4	Synthesize knowledge of deep learning applications in fields like computer vision, natural language processing, and reinforcement learning.	**K4**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Deep Learning	Ian Goodfellow, Yoshua Bengio, and Aaron Courville	MIT Press	1stEdition, 2016
2	Deep Learning: A Practitioner's Approach	Adam Gibson and Josh Patterson	O'Reilly Media	1stEdition, 2020

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Neural Networks: A Comprehensive Foundation	Simon Haykin	Prentice Hall	2ndEdition , 1998
2	Deep Learning for Computer Vision	Rajalingappaa Shanmugamani	Packt Publishing	2ndEdition 2022
3	Neural Networks and Deep Learning: A Textbook	Charu C. Aggarwal	Springer	2nd Edition, 2024

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/117105084
2	https://nptel.ac.in/courses/106106184
3	https://nptel.ac.in/courses/106106184
4	https://nptel.ac.in/courses/106106184

SEMESTER S7

SENSORS AND INSTRUMENTATION

Course Code	**OEERT721**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. Students will be able to identify and differentiate between various types of sensors and their applications.
2. Students will learn about different measurement instruments.

SYLLABUS

Module No.	**Syllabus Description**	**Contact Hours**
1	Introduction to sensor based measurement systems: General concepts and terminology, sensor classification, Primary Sensors, material for sensors, micro sensor technology. Self-generating Sensors-Thermoelectric sensors, piezoelectric sensors, pyroelectric sensors, photovoltaic sensors, electrochemical sensors.	**8**
2	Principles of Measurement: Static Characteristics, Error in Measurement, Types of Static Error. Multirange Ammeters, Multirange voltmeter. Digital Voltmeter: Ramp Technique, Dual slope integrating Type DVM, Direct Compensation type and Successive Approximations type DVM	**8**
3	Digital Multimeter: Digital Frequency Meter and Digital Measurement of Time, Function Generator. Bridges: Measurement of resistance: Wheatstone's Bridge, AC Bridges - Capacitance and Inductance Comparison bridge, Wien's bridge.	**8**

4	Transducers: Introduction, Electrical Transducer, Resistive Transducer, Resistive position Transducer, Resistance Wire Strain Gauges, Resistance Thermometer, Thermistor, LVDT. Instrumentation Amplifier using Transducer Bridge, Temperature indicators using Thermometer.	**8**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the Sensor Concepts and Classification	**K2**
CO2	Gain knowledge of self-generating sensors	**K2**
CO3	Understand the principles of measurement	**K3**
CO4	Understand the various types of transducers	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Electronic Instrumentation & Measurements.	David A. Bell	Oxford University Press PHI	2^{nd}Edition, 2006.
2	Modern Electronic Instrumentation and Measuring Techniques.	D. Helfrick and W.D. Cooper	Pearson	1stEdition, 2015,
3	Sensors and Signal Conditioning.	Ramon Pallas Areny, JohnG. Webster,	John Wiley and Sons	2^{nd}Edition, 2000.
4	Electronic Instrumentation	H.S.Kalsi	Mc Graw Hill	3^{rd} Edition, 2012

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Measurement Systems: Application and Design	Ernest O. Doebelin	McGraw-Hill	7th edition 2019
2	Transducers and Instrumentation	D. V. S. Murty	PHI	2nd edition and 2008
3	Electronic Measurement and Instrumentation	K. Lal Kishore	Pearson	1st edition 2009
4	Electrical and Electronic Measurements and Instrumentation	A.K. Sawhney	Dhanpat and Rai	19th revised edition 2011

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc23_ee105/preview
2	https://onlinecourses.nptel.ac.in/noc21_ee107/preview

SEMESTER S7

BIOMEDICAL INSTRUMENTATION

Course Code	OEERT 722	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	NIL	Course Type	Theory

Course Objectives:

1. To understand various bio potentials and its recording
2. To illustrate the working of various diagnostic equipment
3. To illustrate the working of various therapeutic equipment
4. To describe the imaging techniques used in clinical applications

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to human physiological system** Physiological systems of the body (brief discussion on Heart and cardio vascular system, Anatomy of nervous system, Physiology of respiratory systems) Problems encountered in biomedical measurements. Sources of bioelectric potentials – resting and action potentials -propagation of action potentials – bioelectric potentials example (ECG, EEG, EMG, ERG, EOG, EGG etc.)	9
2	**Bio potential electrodes, ECG and BP Measurement** Bio potential electrodes –basic theory – microelectrodes – skin surface electrodes – needle electrodes Instrumentation for clinical laboratory: Bio Potential amplifiers instrumentation amplifiers, isolation amplifiers, chopper amplifier Electro conduction system of the heart, Electro cardiograph –electrodes and	9

	leads – Einthoven triangle, ECG readout devices ECG machine – block diagram Measurement of blood pressure – direct and indirect measurement–oscillometric measurement –ultrasonic method.	
3	**Measurement EEG, EMG Respiratory Parametersand Therapeutic devices** Electro encephalogram –EEG measurement Electromyogram (EMG) – Nerve conduction velocity measurements- Respiratory parameters – Spiro meter, pneumograph. Therapeutic devices- Pacemakers – defibrillators-heart lung machine, haemodialysis -Surgical diathermy.	**9**
4	**Advances in Radiological Imaging and Electrical safety** X-rays- principles of generation, uses of X-rays- Basic principle of computed tomography, magnetic resonance imaging system and nuclear medicine system. Ultrasonic imaging system Electrical safety– physiological effects of electric current –shock hazards from electrical equipment –method of accident prevention, introduction to telemedicine	**9**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	To understand the physiology of major systems of human body	**K2**
CO2	To understand various bio potentials and its recording	**K1**
CO3	To illustrate the working of various diagnostic equipment	**K2**
CO4	To illustrate the working of various therapeutic equipment	**K2**
CO5	To describe the imaging techniques used in clinical applications	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping od Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Biomedical Instrumentation Measurements	L. Cromwell, F. J. Weibell and L. A. Pfeiffer	Pearson education	2nd Edton1990
2	Handbook of Biomedical Instrumentation	R. S. Khandpur	Tata McGraw Hill	
3	Introduction to Biomedical Equipment Technology	J. J. Carr and J. M. Brown	Pearson Education	

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Medical Instrumentation, Application and Design	J. G. Webster	John Wiley and Sons	
2	John Enderele , Susan Blanchard, Joseph Bronzino	Introduction to Biomedical Engg	Academic Press	
3	Welkovitz	Biomedical Instruments, Theory and Design	Elselvier	
4	Jerry L Prince, Jonathan M Links	Medical Imaging Signals & Systems	Pearson Education	

SEMESTER S7

EMBEDDED SYSTEM DESIGN AND APPLICATIONS

Course Code	OEERT 723	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Microprocessors and Microcontrollers	Course Type	Theory

Course Objectives:

1. This course aims to introduce the design of embedded electronic systems and its applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Embedded System Components: Embedded Systems vs. General Computing Systems, Classification of Embedded Systems, Major Application Areas of Embedded Systems, Purpose of Embedded Systems, Core of the Embedded System, Memory, Sensors and Actuators, Communication Interface, Embedded Firmware, Other System Components.	9
2	Embedded System Design Concepts: Characteristics of an Embedded System, Quality Attributes of Embedded Systems, Application-Specific Embedded System, Domain Specific Examples of Embedded System, Fundamental Issues in Hardware Software Co-Design, Computational Models in Embedded Design, Embedded Firmware Design Approaches, Embedded Firmware Development Languages.	9
3	Design and Development of Embedded Product: Embedded Hardware Design and Development, Embedded Firmware Design and Development: Embedded firmware Design Approaches, Embedded firmware Development Languages, Programming in Embedded 'C'. Real Time Operating System (RTOS) based Embedded System Design: Operating System Basics, Types	9

	of Operating Systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Threads, Processes and Scheduling: Putting them altogether, Task Communication, Task Synchronisation, Device Drivers, How to choose an RTOS.	
4	Design and Development of Embedded Systems: Integration of Hardware & Firmware, Board Power up. The Embedded System Development Environment: Integrated Development Environment (IDE), Types of files generated on cross-compilation, Disassembler/Decompiler, Simulators, Emulators & Debugging, Target Hardware Debugging, Boundary Scan. Product Enclosure Design & Development: Product Enclosure Design Tools, Product Enclosure Development Techniques.	**9**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understanding of Embedded Systems Concepts, its classification and applications	**K2**
CO2	Understand application-specific embedded systems by familiarizing their characteristics, quality attributes, and hardware-software co-design principles.	**K2**
CO3	To understand the design concepts of embedded products, with proficiency in embedded hardware and firmware, real-time operating systems, and task management.	**K2**
CO4	Understand the skills to integrate hardware and firmware, utilize development environments and debugging tools, and design and develop product enclosures for embedded systems.	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping od Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Embedded Systems,	Shibu K.V.	Tata McGraw Hill Education Private Limited, New Delhi	2nd Edition, 2017
2	Embedded Systems: Design, Programming and Applications	A K Ganguly	Alpha Science International Ltd	2014

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Embedded Systems, A Contemporary Design Tool	J. K. Peckol	Wiley Student edition	2009
2	Embedded System Design	Peter Marwedel	Springer	4th edition, 2022
3	Programming Embedded Systems in C and C++	Michael Barr	O'Reilly	1999
4	Embedded System Applications	C. Baron, J. Geffroy and G. Motet	Springer-Verlag New York Inc.	2010

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc23_cs54/preview
2	https://onlinecourses.nptel.ac.in/noc20_ee98/preview
3	http://www.digimat.in/nptel/courses/video/106105159/L01.html

SEMESTER 7

DIGITAL IMAGE PROCESSING

Course Code	OEERT 724	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Linear Algebra	Course Type	Theory

Course Objectives:

1. To introduce the fundamental concepts of Digital Image Processing and study the various transforms required for image processing.
2. To study spatial and frequency domain image enhancement and image restoration methods.
3. To understand image compression and segmentation techniques.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Digital Image Fundamentals: Image representation, Types of images, Elements of DIP system, Basic relationship between pixels, Distance Measures, Simple image formation model. Brightness, contrast, hue, saturation, Mach band effect. Colour image fundamentals-RGB, CMY, HIS models, 2D sampling and quantization.	9
2	2D Image transforms: DFT, Properties, Walsh transform, Hadamard transform, Haar transform, DCT, KL transform and Singular Value Decomposition. Image Compression: Image compression model, Lossy, lossless compression, Concept of transform coding, JPEG Image compression standard.	9
3	Image Enhancement: Spatial domain methods: Basic Gray Level Transformations, Histogram Processing, Enhancement Using Arithmetic/Logic Operations, Basics of Spatial Filtering, Smoothing	9

	spatial Filters, Sharpening spatial Filters. Frequency domain methods: low pass filtering, high pass filtering, homomorphic filtering.	
4	Image Restoration: Degradation model, Inverse filtering- removal of blur caused by uniform linear motion, Minimum Mean Square Error (Wiener) Filtering. Image segmentation: Region based approach, clustering, Segmentation based on thresholding, edge based segmentation, Hough Transform.	**9**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand different components of image processing system	**K2**
CO2	Analyse the various concepts and mathematical transforms necessary for image processing	**K3**
CO3	Illustrate the various schemes of image compression	**K3**
CO4	Understand the basic image segmentation techniques	**K3**
CO5	Analyze the filtering and restoration of images	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping od Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Image Processing	Gonzalez Rafel C	Pearson Education	4/e, 2019
2	Digital Image Processing	S Jayaraman, S Esakkirajan, T Veerakumar	Tata McGraw Hill Education	2009

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Image Processing	Kenneth R Castleman	Pearson Education	2/e,2003
2	Fundamentals of digital image processing	Anil K Jain	PHI	1988
3	Digital Image Processing	Pratt William K	John Wiley	4/e,2007

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/117/105/117105135
2	https://archive.nptel.ac.in/courses/106/105/106105216
3	https://nptel.ac.in/courses/117105079
4	https://nptel.ac.in/courses/106105032

SEMESTER S7

CONCEPTS IN MACHINE LEARNING

Course Code	**OEERT 725**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To understand the concepts and algorithms in machine learning and the most popular supervised and unsupervised learning algorithms
2. To help the students provide machine learning-based solutions to real world problems

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to ML** Machine Learning vs. Traditional Programming, Machine learning paradigms - supervised, semi-supervised, unsupervised, reinforcement learning. **Basics of parameter estimation** - maximum likelihood estimation (MLE) and maximum aposteriori estimation (MAP), Bayesian formulation. **Supervised Learning** Feature Representation and Problem Formulation, Role of loss functions and optimization **Regression** - Linear regression with one variable, Linear regression with multiple variables - solution using gradient descent algorithm and matrix method.	

2	**Classification** - Naïve Bayes, KNN **Generalisation and Overfitting** - Idea of overfitting, LASSO and RIDGE regularization, Idea of Training, Testing, Validation **Evaluation measures** – Classification - Precision, Recall, Accuracy, F-Measure, Receiver Operating Characteristic Curve(ROC), Area Under Curve (AUC). Regression - Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), R Squared/Coefficient of Determination.	
3	**Neural Networks (NN) -** Perceptron, Neural Network - Multilayer feed-forward network, Activation functions (Sigmoid, ReLU, Tanh), Back propagation algorithm. **Decision Trees** – Information Gain, Gain Ratio, ID3 algorithm	
4	**Unsupervised Learning** **Clustering** - Similarity measures, Hierarchical Clustering - Agglomerative Clustering, partitional clustering, K-means clustering **Dimensionality reduction** - Principal Component Analysis, Multidimensional scaling **Ensemble methods**- bagging, boosting **Resampling methods** - Bootstrapping, Cross Validation. Practical aspects - Bias-Variance trade-off.	

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Illustrate Machine Learning concepts and basic parameter estimation methods.	**K2**
CO2	Demonstrate supervised learning concepts (regression, classification).	**K3**
CO3	Illustrate the concepts of Multilayer neural network and Decision trees	**K3**
CO4	Describe unsupervised learning concepts and dimensionality reduction techniques	**K3**
CO5	Use appropriate performance measures to evaluate machine learning models	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Machine Learning	Ethem Alpaydin	MIT Press	2nd edition, 2010
2	Data Mining and Analysis: Fundamental Concepts and Algorithms	Mohammed J. Zaki and Wagner Meira	Cambridge University Press	First South Asia edition, 2016

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Machine Learning	Tom Mitchell	McGraw-Hill	1997
2	Neural Networks for Pattern Recognition	Christopher Bishop	Oxford University Press	1995
3	Machine Learning: A Probabilistic Perspective	Kevin P Murphy	MIT Press	2012.
4	The Elements Of Statistical Learning	Trevor Hastie, Robert Tibshirani, Jerome Friedman	Springer	Second edition, 2007

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://youtu.be/fC7V8QsPBec?si=8kqBn-_7x1RG5V1J
2	https://youtu.be/g__LURKuIj4?si=Xj10NPfMfpQSOhVx
3	https://youtu.be/yG1nETGyW2E?si=ySlxpeWuFAUQBf7-
4	https://youtu.be/zop2zuwF_bc?si=W7TpSHLdi4rykva4

SEMESTER 8

ELECTRONICS & COMPUTER ENGINEERING

SEMESTER S8

PLC AND DATA ACQUISITION SYSTEM

Course Code	PEERT861	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Basics of analog and digital electronics	Course Type	Theory

Course Objectives:

1. To understand the fundamental of PLC
2. To develop programs using various functions available with PLC.
3. To understand various industrial applications of PLCs.
4. To understand the basics of data acquisition systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basics of PLC-PLC advantages and disadvantages- Architecture of PLC-Scan Cycles–Types of PLC- PLC Programming languages – Relay logic–Ladder logic–connecting PLC to computer PLC Troubleshooting and Maintenance.	9
2	Programming of Timers – ON delay, OFF delay, Retentive Timers – PLC Timer functions –Examples of timer function Industrial application. Programming Counters – Up/Down counter –Examples of counter function Industrial application. PLC Arithmetic Functions – PLC number Comparison function	9
3	PLC Program Control Instructions: Master Control -Reset - Skip – Jump and Move Instructions. Sequencer instructions - Types of PLC Analog modules and systems, PLC analog signal processing –Case study of Tank level control system, bottle filling system and Sequential switching of motors	9

4	Sampling theorem – Sampling and digitizing – Aliasing – Sample and hold circuit – Practical implementation of sampling and digitizing – Definition, design and need for data acquisition systems – Interfacing ADC and DAC with Microprocessor / Multiplexer - Multiplexed channel operation –Microprocessor/PC based acquisition systems.	**9**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the fundamental of PLC based systems	**K2**
CO2	Develop programs using various functions available with PLC.	**K3**
CO3	Understand various industrial applications of PLCs.	**K2**
CO4	Understand the basics of data acquisition systems.	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping od Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Programmable Logic Controllers	Petrezeulla	McGraw Hill	1989
2	Programmable logic controllers-principles and applications	John W.Webb& Ronald A.Reis	PHI	5e,2010
3	Process Control Instrumentation Technology	Curtis D. Johnson.	PH	8e,2005

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Programmable Logic Controllers	Hughes .T,	ISA Press	1989.
2	Data Converters,	G. B. Clayton	The Mac Millian Press Ltd.,	1982.
3	Linear Integrated circuits	D. Roy Choudhury and Shail B. Jain,	New age International Pvt. Ltd	2003.

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/108105063
2	https://nptel.ac.in/courses/108105088
3	https://nptel.ac.in/courses/112102011

SEMESTER S8

ELECTRONIC PRODUCT DESIGN

Course Code	PEERT862	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3: 0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. The course will help the students to understand the product development process for realization of the product.
2. The course will help the students to understand the packaging and modelling of electronic product

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Definition of a product, Product Classification, New Product development process. Product design methodology, Product planning, data collection, Creativity techniques. Electronic systems and needs Physical integration of circuits, packages, boards and full electronic systems	9
2	Introduction to concepts of reliability, nature of reliability problems in electronic equipment, series configuration, Parallel Configuration, Mixed Configuration, Methods of Solving Complex Systems, Mean Time to Failure (MTTF) and Mean Time between Failures (MTBF) of Systems. Maintainability, Availability Concepts, System Downtime, Mean Time to Repair (MTTR).	9
3	Packaging & Enclosures of Electronic System: Effect of environmental factors on electronic system (environmental specifications), nature of environment and safety measures. Packaging’s influence and its factors.	9
4	Introduction to 3D Printers, Hierarchical Structure of Additive Manufacturing Processes, Integration of Additive Manufacturing in the	9

	Product Development Process, Rapid Prototyping, Rapid Tooling, Rapid manufacturing.	

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Understand the basics of product development process	**K2**
CO2	Understand the reliability problems of electronic equipment	**K2**
CO3	Understand the packaging of electronic systems	**K2**
CO4	Understand the surface modelling and additive manufacturing methods in the product development	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Product Design and Manufacturing	A.K. Chitale, R.C. Gupta	Prentice, Hall of India	5th Edition January 2011
2	Reliability and Failure of Electronic Materials and Devices	Milton Ohring,Lucian Kasprzak	Academic Press Publication	2nd Edition - October 14, 2014
3	Introduction to Electronic Packaging: Unconventional Guide to Product Design	S.A Srinivasa Moorthy	Notion Press	1st edition 2020
4	Additive Manufacturing Technologies 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing	Ian Gibson, David Rosen, Brent Stucker	Springer verlang,Newyork	2nd edition 2015

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Electronic Product Design	V.S. Bagad	Technical Publications	4th edition 2016
2	Electronics product Design	V.B. Baru R.G. Kaduskar	New Delhi: Wiley India Pvt Ltd.	2nd edition 2014
3	Rapid Prototyping, Rapid Tooling and Reverse Engineering: From Biological Models to 3D Bioprinters	Kaushik Kumar,Divya Zindani,Paulo Davim	De Gruyter	5th edition,June2020
4	Reliability and Failure of Electronic Materials and Devices	Milton Ohring, Lucian Kasprzak	Academic Press	2nd edition,October 14, 2014

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/117/108/117108140/
2	https://archive.nptel.ac.in/courses/112/105/112105267/
3	https://nptel.ac.in/courses/112104230
4	https://archive.nptel.ac.in/courses/112/104/112104265/

SEMESTER S8

SYSTEM SOFTWARE

Course Code	PEERT 863	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. Students will be able to understand the basic concepts and use of system software and application software.
2. Students will understand the machine dependent and machine independent system software features and to design/implement system software.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Systems Programming – Background, System software and Application Software.System software-Basic Concepts of Assemblers, Loaders, Linkers, Macro processors, Text editorsSIC & SIC/XE Architecture and Programming.	**9**
2	Assemblers – Basic assembler directives, machine dependent assembler features, machine independent assembler features, Object code generation of SIC and SIC/XE. Assembler design options – one pass assembler, multi pass assembler	**9**
3	Loaders and Linkers - Basic loader functions, machine dependent loader features, machine independent loader features. Loader design options – linkage editors, dynamic linking, bootstrap loaders	**9**
4	Macro processors – Basic macro processor functions, machine dependent and machine independent macro processor features, Design options. Device drivers - Anatomy of a device driver, Character and block device drivers, General design of device drivers. Text Editors- Overview of Editing,	**9**

	User Interface, EditorStructure. Debuggers - Debugging Functions and Capabilities, Relationship with other parts of the system, Debugging Methods- By Induction, Deduction and Backtracking	

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Understand different System Software.	**K2**
CO2	Analyse machine architecture with its instruction sets and capable to do programming	**K3**
CO3	Identify machine dependent and independent features of system software	**K3**
CO4	Design algorithms for system software and analyse the effect of data structures.	**K3**
CO5	Understand the features of device drivers and editing & debugging tools.	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	System Software: An Introduction to Systems Programming	Leland L. Beck	Pearson Education Asia	3/E

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Systems Programming and Operating Systems	D.M. Dhamdhere	Tata McGraw Hill	Second Revised Edition
2	Systems Programming	Donovan J. J	Tata McGraw Hill	2/e
3	System Software	J Nithyashri	Tata McGraw Hill	Second Edition
4	IBM PC Assembly Language and Programming	Peter Abel	Prentice Hall of India	Third Edition

SEMESTER S8

CYBER SECURITY

Course Code	PEECT864	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To understand the fundamental concepts of cybersecurity, including various types of cyber threats and attacks.
2. To learn and apply basic security measures, mechanisms, and best practices to protect systems and data from threats.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction**: **Security basics** – Aspects of network security – Attacks – Different types – Hackers – Crackers – Common intrusion techniques – Trojan Horse, Virus, Worm. **Security threats -** Sources of security threats- Motives **-** Target Assets and vulnerabilities – Consequences of threats- E-mail threats **-** Web-threats **-** Intruders and Hackers, Insider threats, Cybercrimes.	**9**
2	Security services and mechanisms, OS **Security** – Protection Mechanisms – Authentication & Access control – Discretionary and Mandatory access control **Firewall-** Need for firewall, Characteristics, Types of firewall, Firewall Basing, **Intrusion Detection System-** Types, Goals of IDS, IDS strengths and Limitations.	**9**
3	**Cryptography**: **Basic Encryption & Decryption** – Transposition & substitution ciphers – Caesar substitution – Polyalphabetic substitutions –	**9**

	Crypt analysis – **Symmetric key algorithms** – Feistel Networks – Confusion – Diffusion – DES Algorithm – Strength of DES – Comparison & important features of modern symmetric key algorithms – **Public key cryptosystems** – The RSA Algorithm – Diffie Hellman key exchange – comparison of RSA & DES – Message Authentication & Hash functions – Digital signature	
4	**Introduction to Cyber Crime and law:** Cyber Crimes, Types of Cybercrime, Hacking, Attack vectors, Cyberspace and Criminal Behaviour, Clarification of Terms, Traditional Problems Associated with Computer Crime, Introduction to Incident Response, Digital Forensics, Computer Language, Network Language, Realms of the Cyber world, A Brief History of the Internet, Recognizing and Defining Computer Crime, Contemporary Crimes, Comp. as Targets, Contaminants and Destruction of Data, Indian IT ACT 2000.	**9**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the basics of network security, including different types of attacks, common intrusion techniques, and various security threats, including those posed by hackers, crackers, and cybercriminals.	**K2**
CO2	Identify and explain various security services and mechanisms, including OS security, authentication and access control, firewall types and characteristics, and intrusion detection systems	**K2**
CO3	Understand cryptography principles, including encryption, ciphers, symmetric and public key algorithms, RSA, Diffie Hellman, authentication, hash functions, and digital signatures.	**K2**
CO4	Understand cybercrime and related laws, including types, attack vectors, incident response, digital forensics, and the Indian IT Act 2000.	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Computer Network Security	Joseph M Kizza	Springer Verlag	2005
2	Cryptography and Network Security Principles and Practice	William Stallings	Pearson Education Asia(6/e)	2012
3	Network Security Essentials	William Stallings	Pearson Education	4th Edition 2011
4	Fundamentals of Network Security	Eric Maiwald	Tata McGraw-Hill	4th Edition, 2013

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Anti-Hacker Tool Kit	Mike Shema	Mc Graw Hill	(Indian Edition)
2	Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives	Nina Godbole and Sunit Belpure	Wiley	Latest
3	Mark Stamp's Information Security Principles and Practice	Deven N. Shah	Wiley	Reprint 2012

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	Introduction to Cyber Security, by Dr. Jeetendra Pande, Uttarakhand Open University, Haldwani:-https://onlinecourses.swayam2.ac.in/nou19_cs08/preview
2	Firewalls and Intrusion Detection Systems on Computer - Cryptography and Network Security by Prof. D. Mukhopadhyay, Department of Computer Science and Engineering, IIT Kharagpur
3	Cryptography and Network Security, by Prof. Sourav Mukhopadhyay, IIT Kharagpur:- https://onlinecourses.nptel.ac.in/noc22_cs90/preview
4	https://www.meity.gov.in/writereaddata/files/itbill2000.pdf https://www.meity.gov.in/writereaddata/files/it_amendment_act2008%20%281%29_0.pdf

SEMESTER S8

CRYPTOGRAPHY AND NETWORK SECURITY

Course Code	PEERT 866	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Discrete Mathematical Structures	Course Type	Theory

Course Objectives:

1. To introduce fundamental concepts of number theory
2. To understand the basics of symmetric and asymmetric cipher models.
3. To provide a better foundation in network security in today's internet environment.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Cryptography -** Security Goals, Security Services-Classification of Cryptosystems, Cryptanalytic attacks **Basics of Number Theory:** **Integer Arithmetic** -Divisibility – GCD, Linear Diophantine equation, **Modular Arithmetic** - Congruence - Addition and multiplicative inverse, Fermat's and Euler's Theorem - Chinese Remainder Theorem, Primitive roots, Quadratic congruences- quadratic residues, Legrende symbol.	10
2	**Algebraic structures:** groups, rings, Finite fields of the form GF(p) and GF(2^n), polynomial rings over finite field. **Symmetric Ciphers:** Ceaser cipher, Affine cipher, Playfair cipher, Hill cipher, Vigenere cipher etc. Modern Secret Key Ciphers - Substitution Box-Permutation Box-Product Ciphers. Data Encryption standard (DES), Advanced Encryption standard	10

	(AES). Cryptographic Hash Functions - Properties - SHA-512, Message Authentication Code, HMAC and CMAC	
3	**Public key cryptography:** One-way functions, RSA, Discrete Log, Diffie-Helman Key Exchange system, Digital Signature- Signing - Verification, Digital signature forgery- RSA Digital Signature Scheme -El Gamal Signature Scheme. Elliptic curves and elliptic curve cryptosystems	**8**
4	**Distribution of symmetric keys and Distribution of public keys** **Electronic Mail Security** -Pretty Good Privacy- PGP message format - Transmission and Reception of PGP Messages, **IP Security** Overview - IP Authentication Header - Encapsulating Security Payload - Distributed Denial of Service attacks, **Secure Electronic Transaction** – Payment Processing - Dual Signature, **Firewalls** - Firewall Design Principles.	**8**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Apply the concepts of number theory in designing crypto systems	**K3**
CO2	Design and analyze various symmetric key cryptosystems and hash functions.	**K3**
CO3	Design and Analyze various public key cryptosystems and digital signature schemes.	**K3**
CO4	Discuss various network security aspects, protocols to ensure Email Security and Network Security	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping od Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Cryptography and Network.Security	Behrouz A Forouzan &DebdeepMukhopadhyay	Tata McGraw Hill Education Pvt Ltd Publication	2/e, 2010.
2	Cryptography and Network security: Principles and Practice,	Stallings William	Pearson Education Asia,	7/e, 2017
3	A Course in Number Theory and Cryptography	Neal Koblitz:	Springer	2/e, 2012
4	Handbook of Applied Cryptography	Menezes, Paul C. V, Scott A. Vanstone	CRC Press	5/e, 2010

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Elementary Number Theory with Applications	Thomas Koshy	Elsevier India	2/e, 2007
2	Number Theory in Science and Communication	MR Schroeder	Springer	5/e, 2009
3	Cryptography: Theory and Practice	Douglas R. Stinson	Chapman and Hall/CRC	3/e, 2006
4	Guide to Elliptic Curve Cryptography	Hankerson, D.J., Menezes, A., Vanstone, S.A.	Springer	2004
5	Advanced Engineering Mathematics	Merle C. Potter, David C. Wiggert	Wiley	10/e, 2012

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/106105162
2	https://nptel.ac.in/courses/106105162
3	https://nptel.ac.in/courses/106105162
4	https://nptel.ac.in/courses/106105162

SEMESTER S8

CYBER FORENSICS

Course Code	PEERT 865	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	5/3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)		**Course Type**	Theory

Course Objectives:

1. To provide foundational knowledge of cyber forensics, including key concepts, terminology, and the role of forensics in cybersecurity.
2. To equip students with the knowledge and skills to use various forensic tools and techniques for data recovery, analysis, and investigation.
3. To understand the process of responding to cyber incidents, conducting thorough forensic analysis, and presenting findings.
4. To explore advanced topics, emerging trends, and the future landscape of cyber forensics.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fundamentals of Cyber Forensics, The Role of Cyber Forensics in Modern Cybersecurity, Understanding Digital Evidence, Types of Digital Evidence (Data at rest, in transit, etc.), Legal and Ethical Considerations in Cyber Forensics, Cyber Forensics Process: Identification, Preservation, Collection, Examination, Analysis, and Presentation, Chain of Custody and Documentation	9
2	Overview of Forensic Tools (FTK, EnCase, Autopsy, etc.), File Systems and Their Forensic Relevance (FAT32, NTFS, etc.), Data Recovery Techniques, Imaging and Cloning Digital Evidence, Network Forensics: Capturing and Analyzing Network Traffic, Introduction to Mobile Device Forensics	9
3	Incident Response Lifecycle: Preparation, Detection, Containment, Eradication, Recovery, The Role of Forensics in Incident Response,	9

	Analyzing Malware: Static and Dynamic Analysis Techniques, Memory Forensics: Capturing and Analyzing Volatile Data, Forensic Reporting: Writing and Presenting Findings, Legal and Regulatory Compliance in Incident Response	
4	Cloud Forensics: Challenges and Techniques, IoT Forensics: Investigating Smart Devices, AI and Machine Learning in Cyber Forensics, Cyber Forensics in Blockchain and Cryptocurrency Investigations, Future of Cyber Forensics: Predictive Forensics and Beyond, Career Paths in Cyber Forensics: Skills and Certifications	**9**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	***Internal Ex***	***Evaluate***	***Analyse***	***Total***
5	**15**	**10**	**10**	**40**

Criteria for Evaluation (Evaluate and Analyse): 20 marks

Evaluation Methods:

1. Experiments Using Forensic Tools: (10 marks)

Case Studies: Real-world applications of cyber forensics

Exploring Digital Evidence in a Controlled Environment

Hands-on: Creating and Maintaining a Chain of Custody

Hands-on: Creating Forensic Images and Recovering Deleted Data

Analyzing Network Traffic with Wireshark

Simulating a Cyber Incident: Initial Response

Analyzing a Malicious File: Tools and Techniques

Writing a Forensic Report: Key Components and Best Practices

Exploring Cloud Forensics Tools

Analyzing Blockchain Transactions for Forensic Purposes

Criteria for Evaluation: Course Project (10 marks)

1. Project Proposal and Planning (2 marks)
    - Submits a well-defined project proposal outlining objectives, methodology, and expected outcomes.
    - Demonstrates thorough planning and a clear timeline for the project.
2. Design and Implementation (3 marks)
    - Implements the project design accurately using appropriate tools and techniques.
    - The design is functional and meets the project objectives.
2. Innovation and Creativity (2 marks)
    - Introduces innovative ideas or unique approaches in the design and implementation.
    - Demonstrates creativity in solving problems or optimizing designs.
2. Analysis and Testing (2 marks)
    - Effectively analyzes the project design to identify and address any issues.
    - Conducts thorough testing to verify the functionality and performance of the design.
2. Final Report and Presentation (1 mark)
    - Submits a comprehensive final report detailing the project, including objectives, design, methodology, analysis, and results.
    - Clearly presents the project and its outcomes, and effectively communicates the key points.

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 sub divisions. Each question carries 9 marks. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Evaluate the principles and methodologies of cyber forensics, including the identification and classification of digital evidence, and will assess the legal and ethical implications of forensic investigations.	**K4**
CO2	demonstrate advanced proficiency in the application of forensic tools, performing complex data recovery, forensic imaging, and evidence analysis, and will critically evaluate the effectiveness of various forensic techniques in different scenarios.	**K2**
CO3	Develop and implement comprehensive incident response strategies, utilizing forensic analysis to interpret and correlate complex data, and will evaluate the effectiveness of different approaches in incident response and forensic reporting.	**K3**
CO4	Synthesize knowledge of emerging technologies in cyber forensics, such as cloud and IoT forensics, to design and execute innovative forensic investigations, critically analyzing challenges and proposing solutions to overcome them.	**K4**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping od Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Forensics and Incident Response: Incident Response Techniques and Procedures to Respond to Modern Cyber Threats	Gerard Johansen	Packt Publishing	2^{nd} edition, 2020
2	The Basics of Digital Forensics: The Primer for Getting Started in Digital Forensics	John Sammons	Syngress	2^{nd} edition, 2014

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Guide to Computer Forensics and Investigations	Bill Nelson, Amelia Phillips, and Christopher Steuart	Cengage Learning	6^{th} edition, 2016
2	Computer Forensics: Cybercriminals, Laws, and Evidence	Marjie T. Britz	Pearson	3^{rd} edition, 2013
3	Incident Response & Computer Forensics	Jason T. Luttgens, Matthew Pepe, and Kevin Mandia	McGraw-Hill Education	3^{rd} edition, 2014
4	Digital Evidence and Computer Crime: Forensic Science, Computers and the Internet	Eoghan Casey	Academic Press	3^{rd} edition, 2011

SEMESTER S8

BIOMEDICAL SIGNAL PROCESSING

Course Code	OEERT 831	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To make students understand the sources, types & characteristics of different noises and artifacts present in biomedical signals.
2. To make students able to design time domain and frequency domain filters for noise and artifact removal from biomedical signals.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Biomedical Signals-Action Potential and Its Generation, Origin and Waveform Characteristics of Basic Biomedical Signals Like: Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Objectives of Biomedical Signal Analysis, Difficulties in Biomedical Signal Analysis, Computer-Aided Diagnosis.	9
2	Removal of Noise and Artifacts from Biomedical Signal- Random and Structured Noise, Physiological Interference, Stationary and Nonstationary Processes, Noises and Artifacts Present in ECG, Time and Frequency Domain Filtering.	9
3	EEG Signal Processing and Event Detection in Biomedical Signals- EEG Signal and Its Characteristics, EEG Analysis, Linear Prediction Theory, Autoregressive Method, Sleep EEG, Application of Adaptive Filter for Noise Cancellation in ECG and EEG Signals; Detection of P, Q, R, S and T Waves in ECG, EEG Rhythms, Waves and Transients, Detection of Waves and Transients, Correlation Analysis Ad Coherence Analysis of EEG Channels.	9

4	Speech production model, inverse filtering techniques for extraction of vocal tract parameters, glottal inverse filtering; electroglottograpic signals; signal processing techniques for detection of pathologies in speech production system. Medical imaging techniques: CT scan, ultrasound, NMR and PET.	**9**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Identify sources of biopotential generation and to familiarize students with different types of biomedical signals in the human body.	**K1**
CO2	Design time domain and frequency domain filters for noise and artifact removal from biomedical signals.	**K3**
CO3	Analyse ECG, EEG, EMG and PCG signals using data acquisition, data reduction methods.	**K4**
CO4	Analyse speech signals and medical imaging techniques.	**K4**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Biomedical signal analysis	Rangayyan, R.M.	John Wiley & Sons	2015 (Vol. 33)
2	Biomedical signal processing: principles and techniques.	Reddy, D.C.	McGraw-Hill	2005.
3	Biomedical Signal Processing	W. J. Tompkins	Prentice Hall	1995
4	Biomedical Signal Processing and Signal Modelling	E.N. Bruce	John Wiley and Sons,	2001
5	Digital Processing of speech signals	L. Rabinar	Prentice Hall,	1978.

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Advanced Methods and Tools for ECG Data Analysis.,	Clifford, G., F. Azuajae, and P. McSharry	Norwood, MA: Artech House	2006. ISBN: 9871580539661.
2	Discrete-Time Speech Signal Processing: Principles and Practice. Upper Saddle River, NJ:	Quatieri, T. F.	Prentice-Hall,	2001. ISBN: 9780132429429.
3	Medical Imaging Systems. Upper Saddle River, NJ:	Macovski, A.	Prentice Hall,	1983. ISBN: 9780135726853
4	Biomedical Signal Analysis	Rangaraj M Rangayyan	IEEE Press	2001

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	.http://www.biomedicahelp.altervista.org › Segnali
2	https://www.digimat.in/nptel/courses/video/108105101/L12.html

SEMESTER S8

HYBRID AND ELECTRIC VEHICLES

Course Code	OEERT 832	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To introduce the fundamental concepts of electric and hybrid and vehicles, drive trains, electrical machines used, energy storage devices and charging systems

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Hybrid Electric Vehicles**: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. **Conventional Vehicles**: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.	9
2	**Hybrid Electric Drive-trains**: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. **Electric Drive-trains:** Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis	9
3	**Electric Propulsion unit:** Introduction to electric components used in hybrid and electric vehicles **DC Drives:** Review of Separately excited DC Motor control – Speed and torque equations **PMSM Drives:** PMSM motor basics.	9

	Energy Storage: Introduction to energy storage requirements in Hybrid and Electric Vehicles- Battery based energy storage systems, Battery Management System, Types of battery- Fuel Cell based energy storage systems- Super capacitors- Hybridization of different energy storage devices	
4	**Sizing the drive system:** Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, rating of the power electronic components **Vehicle Communication:** Need & requirements, Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies	**9**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the fundamentals of Conventional, Electric and Hybrid EV	**K2**
CO2	Describe different configurations of electric and hybrid electric drive trains	**K2**
CO3	Discuss the propulsion unit, DC and PMSM drives used for electric and hybrid vehicles	**K3**
CO4	Selection and sizing of drive systems for EV	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping oF Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Electric and Hybrid Vehicles: Design Fundamentals	Iqbal Hussein	CRC Press	2e, 2010

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Electric Vehicle Technology Explained	James Larminie, John Lowry	Wiley	2e, 2012
2	Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design,	Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi.	CRC Press	1e, 2004
3	Hybrid Electric Vehicles – Principles and applications with practical perspectives	Chris Mi, M A Masrur, D W Gao	Wiley	2011
4	Autonomous vehicle technology: A guide for policymakers,	Anderson JM, Nidhi K, Stanley KD, Sorensen P, Samaras C, Oluwatola OA	Rand Corporation	2014

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.swayam2.ac.in/nou24_ec10/

SEMESTER S8

FUNDAMENTALS OF COMPUTER NETWORKS

Course Code	**OEERT 833**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To make students understand the fundamentals of computer networks, TCP/IP and OSI models and their different layers.
2. To make students analyse the various layers of OSI Model and its protocols.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	INTRODUCTION: Introduction to computer networks, network hardware, network software, internet protocols and standards, Reference models -OSI and TCP/IP and its different layers, Connection oriented networks - X.25 THE PHYSICAL LAYER: Theoretical basis for communication, analog and digital signals, guided transmission media- twisted pairs, coaxial cable, fiber optics, wireless transmission.	**9**
2	THE DATA LINK LAYER: Design issues, error detection and correction, elementary data link protocols, sliding window protocols, HDLC THE MEDIUM ACCESS SUBLAYER: Channel allocation problem, multiple access protocols-Ethernet, Wireless LAN, Data Link Layer switching.	**9**
3	THE NETWORK LAYER: Network layer -various functions and design issues, adaptive and non-adaptive routing algorithms, Congestion control algorithms-leaky bucket and token bucket algorithms.	**9**

	Internetworking, the network layer in the internet (IPv4 and IPv6), Quality of Service. THE TRANSPORT LAYER: Transport service, elements of transport protocol, Simple Transport Protocol, Internet transport layer protocols: UDP and TCP protocols.	
4	THE APPLICATION LAYER: Domain name system, DNS in internet, electronic mail, World Wide Web: architectural overview, dynamic web document and http, network security APPLICATION LAYER PROTOCOLS: Simple Network Management Protocol, File Transfer Protocol, Simple Mail Transfer Protocol.	9

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the basic computer network technology, OSI and TCP/IP reference models and physical layer transmission methods.	**K2**
CO2	Analyse the design issue problems of data link layer and its protocols; channel allocation problems in medium access control layer and its protocols.	**K4**
CO3	Understand the functions of network layer and transport layer and its associated protocols.	**K2**
CO4	Understand the essentials of application layer in computer networking.	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Computer Networks	Andrew. S. Tanenbaum	Pearson Education, India.	5th edition, 2010
2	Data Communication and Networking	Behrouz A. Forouzan	Mc Graw-Hill, India.	4th Edition, 2006,

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Computer Networking: A top down approach,	Kurose, Ross	Pearson Education, India. 2.	4th Edition 2010
2	An Engineering Approach to Computer Networks-,	S.Keshav	Pearson Education India. 2.	2nd Edition, 2019
3	Data and Computer Communications	William Stallings	PHI	5th edition, 2005

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/106106091
2	https://www.nptelvideos.com/course.php?id=393

SEMESTER S8

CLOUD COMPUTING AND APPLICATIONS

Course Code	**OEERT 834**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	Operating System and Networking	**Course Type**	Theory

Course Objectives:

1. Understand the fundamentals and architecture of cloud computing, including delivery and deployment models.
2. Develop knowledge and skills in cloud security, SLA management, and risk assessment.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Cloud Computing Fundamentals: What is Cloud Computing, Essential Characteristics, Architectural Influences Cloud delivery models, The SPI Framework, Cloud Software as a Service (SaaS), Cloud Platform as a Service (PaaS), Cloud Infrastructure as a Service (IaaS), Cloud deployment models, Public Clouds, Community Clouds, Private clouds, Hybrid clouds.	**9**
2	Understanding cloud architecture- Exploring cloud computing stack. Using virtualization technologies, Load balancing and virtualization, Understanding hypervisors, Understanding machine imaging. Cloud storage- Cloud storage providers, Cloud Computing with the Titans– Google, Amazon. Accessing the cloud: Platforms, Web applications, Web APIs.	**9**
3	Virtual Machines and Containers, Serverless Computing, Using and Managing Containers:-Container Basics, Docker and the Hub. Agents and Microservices: Microservices and Container Resource Managers, Managing Identity in a swarm, A simple Microservices Example, Amazon EC2 Container Service, Google’s Kubernetes.	**9**

4	SLA Management in Cloud Computing-Types of SLA, Life cycle of SLA, SLA management in cloud. Cloud Information Security Objectives, Cloud Security Services, Relevant Cloud Security Design Principles, Secure Cloud Software Requirements. Privacy and Compliance Risks, Threats to Infrastructure Data and Access Control, Cloud Service Provider Risks. Cloud computing Security Architecture- architecture considerations, identity management and access control	**9**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Describe the principles of cloud computing.	**K2**
CO2	Explain the technologies used in cloud computing and virtualization.	**K2**
CO3	Describe cloud computing and microservices.	**K2**
CO4	Describe cloud management and cloud security features.	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Cloud Security -A Comprehensive Guide to Secure Cloud Computing	Ronald L Krutz and Russell Dean Vines	Wiley Publishing, Inc.	2010
2	Cloud Computing Bible	Barrie Sosinsky	Wiley Publishing	2011
3	Cloud Computing: A Practical Approach	Anthony T. Velte Toby J. Velte, Robert Elsenpeter	The McGraw-Hill	2010
4	Cloud Computing for Science and Engineering https://cloud4scieng.org/chapters/	Ian Foster and Dennis B.Gannon	The MIT Press	2017
5	Cloud Computing: Principles and Paradigms	Rajkumar Buyya, James Broberg and Andrzej M. Goscinski	Wiley Publishing	2011

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Distributed and Cloud Computing: From parallel processing to Internet ofThings	Kai Hwang, Geoffrey C. Fox, Jack K.Dongarra	Morgen Kauffmann	2013
2	Getting Started with Kubernetes: 2nd Edition	Jonathan Baier	Packt publishers	2nd, 2015

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://en.wikipedia.org/wiki/Cloud_computing https://nptel.ac.in/courses/106105167
2	https://nptel.ac.in/courses/106105167
3	https://nptel.ac.in/courses/106105167
4	https://nptel.ac.in/courses/106105167

SEMESTER S8

INTRODUCTION TO DEEP LEARNING

Course Code	**OEERT 835**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To introduce the basic concepts in machine learning
2. To introduce the idea of artificial neural networks and their architecture
3. To introduce techniques used for training artificial neural networks
4. To enable design of an artificial neural network for classification
5. To enable design and deployment of deep learning models for machine learning problems

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Key components - Data, models, objective functions, optimization algorithms, Learning algorithms. Supervised learning- regression, classification, tagging, web search, page ranking, recommender systems, sequence learning, Unsupervised learning, Reinforcement learning, Historical Trends in Deep Learning. Other Concepts - overfitting, underfitting, hyperparameters and validation sets, estimators, bias and variance.	**10**
2	Neural Networks –Perceptron, Gradient Descent solution for Perceptron, Multilayer perceptron, activation functions, architecture design, chain rule, back propagation, gradient based learning. Introduction to optimization– Gradient based optimization, linear least squares. Stochastic gradient descent, Building ML algorithms and challenges	**10**

3	Convolutional Neural Networks – convolution operation, motivation, pooling, Convolution and Pooling as an infinitely strong prior, variants of convolution functions, structured outputs, data types, efficient convolution algorithms.	**8**
4	Recurrent neural networks – Computational graphs, RNN design, encoder – decoder sequence to sequence architectures, deep recurrent networks, recursive neural networks, modern RNNs LSTM and GRU, Practical use cases for RNNs. Applications – computer vision, speech recognition, natural language processing. Autoencoders, Representation learning, Boltzmann Machines, Deep belief networks.	**8**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Demonstrate basic concepts in machine learning.	**K2**
CO2	Illustrate the validation process of machine learning models using hyper-parameters and validation sets.	**K2**
CO3	Demonstrate the concept of the feed forward neural network and its training process.	**K3**
CO4	Build CNN and Recurrent Neural Network (RNN) models for different use cases.	**K3**
CO5	Use different neural network/deep learning models for practical applications.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Deep Learning.	Ian Goodfellow. Yoshua Bengio and Aaron Courville.	MIT Press	2016.
2	Dive deep into machine learning	Astan Zhang and Zachary and Alexander semola	Cambridge university press https://d2l.ai/	2019
3	Neural Networks and Deep Learning: A Textbook	Charu C. Aggarwal.	Springer	. 2019

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Practical Convolutional Neural Networks	Mohit Sewak, Md. Rezaul Karim, Pradeep Pujari	Packt Publishing Ltd	1st edition, 2018
2	Hands-On Deep Learning Algorithms with Python	Sudharsan Ravichandran	Packt Publishing Ltd.	1st edition, 2019
3	Deep Learning with Python	Francois Chollet	Manning Publications Co	2nd edition, 2018
4	Generative Deep Learning	David Foster	OReilly	2022
5	Hands-on Machine learning with Sc-kit Learn Keras and Tensorflow	Aurelien Geron	Oreilly	Second edition 2019
6	Neural Networks for deep learning	Michael Nielsen	http://neuralnetworksanddeeplearning.com/	2019

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://www.cse.iitm.ac.in/~miteshk/CS6910.html
2	https://www.deeplearningbook.org/contents/convnets.html
3	https://wiki.pathmind.com/lstm http://colah.github.io/posts/2015-08-Understanding-LSTMs/
4	https://jalammar.github.io/illustrated-transformer/ Jay Almar