SEMESTER 3

ELECTRONICS & COMMUNICATION 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 $w = z^2$, $w = e^z$, $w = \frac{1}{z}$, $w = sinz$. **(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 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)**	**9**

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

SOLID STATE DEVICES

Course Code	PCECT302	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Mins
Prerequisites (if any)	Physics of Electrical Science (GBPHT121)	Course Type	Theory

Course Objectives:

1. This course explains the physical processes and working principles of semiconductor devices, while relating the device performance to material parameters and design criteria.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Review of Semiconductor physics:** Equilibrium and steady state conditions, Concept of effective mass and Fermi level, Density of states & Effective density of states, Equilibrium concentration of electrons and holes. **Excess carriers in semiconductors:** Generation and recombination mechanisms of excess carriers, quasi-Fermi levels. **Carrier transport in semiconductors**: Drift, conductivity and mobility, variation of mobility with temperature and doping, Hall Effect. Diffusion, Einstein relations, Poisson equations, Continuity equations, Current flow equations, Diffusion length, Gradient of quasi-Fermi level.	13
2	**PN junctions**: Contact potential, Electrical Field, Potential and Charge distribution at the junction, Biasing and Energy band diagrams, Ideal diode equation. **Bipolar junction transistor**: Transistor action, Base width modulation, Current components in a BJT, Derivation of current components.	12
3	**Metal Semiconductor contacts**: Electron affinity and work function, Ohmic and Rectifying Contacts, current voltage characteristics. **Ideal MOS capacitor**: band diagrams at equilibrium, accumulation, depletion and inversion, surface potential, CV characteristics, effects of real surfaces,	11

	threshold voltage, body effect. **MOSFET**- Drain current equation of enhancement type MOSFET (derivation)- linear and saturation region, Drain characteristics, transfer characteristics.	
4	**MOSFET scaling**: Need for scaling, constant voltage scaling and constant field scaling. Sub- threshold conduction in MOS. **Short channel effects in MOSFETs**: Channel length modulation, Drain Induced Barrier Lowering, Velocity Saturation, Threshold Voltage Variations and Hot Carrier Effects. **MESFET and FinFET**: Structure, operation and advantages.	**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 Fermi-Dirac statistics to compare equilibrium carrier concentration.	**K3**
CO2	State different carrier transport mechanisms in extrinsic semiconductors and obtain the current densities due to this transport.	**K3**
CO3	Apply the concept of semiconductor physics to solve the current components in semiconductor devices.	**K3**
CO4	Analyze the response of semiconductor devices for different biasing conditions	**K3**
CO5	Outline the effects of scaling in semiconductor devices.	**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											
CO2	3	2										
CO3	3	2										2
CO4	3	2	2									2
CO5	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	Semiconductor device Fundamentals	Robert Pierret	Pearson Education	1/e, 1996
2	Physics of Semiconductor Devices	Michael shur	Pearson Education	1/e, 2019
3	Semiconductor Physics and Devices, 3ed, An Indian Adaptation	S.M. Sze, M.K. Lee	Wiley	3/e, 2021

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Semiconductor Physics and Devices	Neamen	McGraw Hill	4/e, 2017
2	Physics of Semiconductor Devices	Sze S.M	John Wiley	3/e, 2015
3	Semiconductor Devices: Physics and Technology	Sze S.M	John Wiley	3/e, 2016
4	Operation and Modelling of the MOS Transistor	Yannis Tsividis	Oxford University Press	3/e,2010
5	Semiconductor Physics and Devices, ,	Sze S.M., M.K. Lee,	An Indian Adaptation	3ed, 2021
6	Fundamentals of Semiconductor Devices,	Achuthan, K N Bhat,	McGraw Hill	1e,2015

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/117106091
2	https://nptel.ac.in/courses/117106091
3	https://nptel.ac.in/courses/117106091
4	https://nptel.ac.in/courses/117106091

SEMESTER S3

ANALOG CIRCUITS

Course Code	**PCECT303**	**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)	BEE/ (GYEST104)	**Course Type**	Theory

Course Objectives:

1. To introduce and verify basic principles, operation and applications of the various analog electronic circuits and devices
2. To understand and analyze the design and working of amplifiers and their configurations.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Wave Shaping Circuits:** RC differentiating and integrating circuits, Analysis of First order RC low pass and high pass filter for step input -rise time, band width. Diode Clipping and clamping circuits. **BJT/MOSFET Biasing:** Need for biasing, DC load line, operating point, BJT biasing (CE configuration)– fixed bias & voltage divider bias (Design & analysis). MOSFET biasing,	**10**
2	**BJT Amplifiers:** Design of RC coupled CE amplifier - Small signal analysis of CE amplifier using hybrid- π model (low and mid frequency`). The high-frequency hybrid-π model of BJT, Miller effect, High frequency response of single stage CE amplifier, short circuit current gain, cut-off frequency f_β & unity gain bandwidth f_T . **MOSFET Amplifiers:** Design of CS amplifier, Small signal analysis using hybrid- π model (mid frequency only), Small signal voltage gain, input & output impedance, CS stage with current source load and diode connected load. **Multistage BJT Amplifiers:** Types of multistage amplifiers, Effect of cascading on gain and bandwidth.	**12**

	Small signal voltage gain, input & output impedance of BJT cascode amplifier using hybrid-π model.	
3	**Feedback amplifiers:** The general feedback structure, Effect of negative feedback on gain, bandwidth, noise reduction 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. **Oscillators:** Classification, criterion for oscillation, Wien bridge oscillator, Hartley and Crystal oscillator. (working principle and design equations of the circuits; analysis of Wien bridge oscillator only required).	**11**
4	**Power amplifiers:** Classification, Transformer coupled class A power amplifier, push pull class B and class AB power amplifiers, complementary- symmetry class B and Class AB power amplifiers, class C and D power amplifier - efficiency and distortion (no analysis required) **Linear Voltage Regulators:** Types of voltage regulators- series and shunt - working and design, load & line regulation, short circuit protection and fold back protection.	**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 wave shaping circuits using first order RC network and diodes.	**K3**
CO2	Analyze single stage and multistage BJT amplifier circuits using equivalent models.	**K3**
CO3	Apply the principles of feedback in the design of oscillators.	**K3**
CO4	Design power amplifiers and voltage regulator circuits.	**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		2							2
CO2	3	3			2							2
CO3	3	3	`2		2							2
CO4	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	Electronic Devices and Circuit Theory.	Robert Boylestad and L Nashelsky	Pearson	11th edition, 2015
2	Microelectronic Circuits	Sedra A. S. and K. C. Smith,	Oxford University Press, 2013	6th edition, 2013
3	Electronic Circuits and Devices	Theodore F. Bogart; Beasley, Jeffrey S.; Guillermo Rico	Pearson Education India	6th edition

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	2nd edition, 2015
2	Electronic Devices and Circuits	David A Bell	Oxford University Press	5th edition, 2008
3	Electronic Circuits Analysis and Design 1	D. Meganathan	Yes Dee Publishing	1st edition, 2023
4	Analysis and Design of Electronic Circuits	K. Gopakumar	OWL Books	1st edition, 2023

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/108/106/108106188/
2	https://archive.nptel.ac.in/courses/108/106/108106188/
3	https://archive.nptel.ac.in/courses/108/106/108106188/

SEMESTER S3

LOGIC CIRCUIT DESIGN

Course Code	PBECT304	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)	GYEST104 Introduction to Electrical & Electronics Engineering	Course Type	Theory

Course Objectives:

1. To understand the number systems in digital systems
2. To introduce the basic postulates of Boolean algebra, digital logic gates and Boolean expressions
3. To design and implement combinational and sequential circuits.
4. To design and implement digital circuits using Hardware Descriptive Language like Verilog on FPGA

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to digital circuits:** Review of number systems representation-conversions, Arithmetic of Binary number systems, Signed and unsigned numbers, BCD. **Boolean algebra:** Theorems, sum of product and product of sum - simplification, canonical forms- min term and max term, Simplification of Boolean expressions - Karnaugh map (upto 4 variables), Implementation of Boolean expressions using universal gates.	9
2	**Combinational logic circuits-** Half adder and Full adders, Subtractors, BCD adder, Ripple carry and carry look ahead adders, Decoders, Encoders, Code converters, Comparators, Parity generator, Multiplexers, De-multiplexers, Implementation of Boolean algebra using MUX. Introduction to Verilog HDL – Basic language elements, Basic implementation of logic gates and combinational circuits.	9

3	**Sequential Circuits:** SR Latch, Flip flops - SR, JK, Master-Slave JK, D and T Flip flops. Conversion of Flip flops, Excitation table and characteristic equation. Shift registers-SIPO, SISO, PISO, PIPO and Universal shift registers. Ring and Johnsons counters. Design of Asynchronous, Synchronous and Mod N counters.	**9**
4	**Finite state machines** - Mealy and Moore models, State graphs, State assignment, State table, State reduction. **Logic Families:** -Electrical characteristics of logic gates (Noise margin, Fan-in, Fan-out, Propagation delay, Transition time, Power -delay product) -TTL, ECL, CMOS. Circuit description and working of TTL and CMOS inverter, CMOS NAND and CMOS NOR gates.	**9**

Suggestion on Project Topics

- **A random sequence generator**
- **Traffic light controller**
- **Multiplexer based person priority check in system at airport**
- **Waveform generator**
- **Object/Visitor counter**
- **Fast adders**
- **Hamming code-based parity checker**
- **Arithmetic Logic Unit using FPGA**

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

Continuous Internal Evaluation Marks (CIE):

Attendance	Project	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 =16marks)**	• 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 2 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	Apply the knowledge of digital representation of information and Boolean algebra to deduce optimal digital circuits.	**K3**
CO2	Design and implement combinational logic circuits, sequential logic circuits and finite state machines.	**K5**
CO3	Design and implement digital circuits on FPGA using hardware description language (HDL).	**K5**
CO4	Outline the performance of logic families with Respect to different parameters.	**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	2	2								3
CO2	3	3	3	3	3	3	3	3	3			3
CO3	3	3	3	3	3	3	3	3	3	3	3	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 Fundamentals	Thomas L. Floyd	Pearson Education	11^{th} Edition, 2017
2	Fundamentals of Digital Logic with Verilog Design	Stephen Brown	McGraw Hill Education	2^{nd} Edition

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Design: With an Introduction to the Verilog HDL, VHDL, and System Verilog	M Morris Mano, Michael D. Ciletti	Pearson India	6^{th} Edition, 2018
2	Fundamentals of Digital Circuits	A. Ananthakumar	PHI	4^{th} Edition, 2016
3	Introduction to Logic Circuits & Logic Design with Verilog	Brock J. LaMeres	Springer	2^{nd} Edition, 2019
4	Digital Design Verilog HDL and Fundamentals	Joseph Cavanagh	CRC Press	1^{st} Edition, 2008
5	Digital Circuits and Systems	D.V. Hall	Tata McGraw Hill	1989

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/117/106/117106086/ https://archive.nptel.ac.in/courses/106/105/106105185/
2	https://archive.nptel.ac.in/courses/117/106/117106086/ https://archive.nptel.ac.in/courses/106/105/106105185/
3	https://archive.nptel.ac.in/courses/117/106/117106086/ https://archive.nptel.ac.in/courses/106/105/106105185/
4	https://archive.nptel.ac.in/courses/117/106/117106086/ https://archive.nptel.ac.in/courses/106/105/106105185/

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**

Project Assessment and Evaluation criteria (30 Marks)

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

ENGINEERING ECONOMICS

(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 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: 50 marks, ESE: 50 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, Gendered technologies & innovations**, Ethical values and practices in connection with gender** - equity, diversity & gender justice, **Gender policy and women/transgender empowerment initiatives.**	6
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	6

	ecology, Urbanization and its environmental impact, Sustainable urban planning and green infrastructure.	
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 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.	**6**

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.
	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
ANALOG CIRCUITS LAB

Course Code	**PCECL307**	**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. Familiarise the students with the analog circuits design using discrete components.
2. Familiarise the students with simulation of basic analog circuits

Expt. No.	**Experiments**
	Part A – List of Experiments using discrete components (Any *Six* experiments mandatory)
1	RC Integrating and Differentiating Circuits – (Transient analysis with different inputs and frequency response)
2	Diode Clipping and Clamping Circuits (Transient and transfer characteristics)
3	CE amplifier – Design for a specific voltage gain and plot frequency response characteristics
4	CS MOSFET amplifier - Design for a specific voltage gain and plot frequency response characteristics
5	Cascaded amplifier (CE – CE) - Design for a specific voltage gain and plot frequency response characteristics
6	Cascode amplifier - Design for a specific voltage gain and plot frequency response characteristics
7	Feedback amplifiers (current series & voltage series) - Design for a specific voltage gain and plot frequency response characteristics
8	RC oscillators – RC phase shift or wien bridge oscillator
9	Power amplifiers (Transformer less) – Class B & Class AB

10	Transistor series voltage regulator – Design for a specific output voltage with & without short circuit protection (plot load & line regulation characteristics).
Part B – Simulation Experiments (Any *Six* experiments mandatory) The experiments shall be conducted using Open-Source Tools such as QUCS, KiCad, LT SPICE, or variants of SPICE tools.	
1	RC Integrating and Differentiating Circuits – (Transient analysis with different inputs and frequency response)
2	Diode Clipping and Clamping Circuits (Transient and transfer characteristics)
3	CE amplifier – Design for a specific voltage gain and plot frequency response characteristics
4	CS MOSFET amplifier - Design for a specific voltage gain and plot frequency response characteristics
5	Cascaded amplifier (CE – CE) - Design for a specific voltage gain and plot frequency response characteristics
6	Cascode amplifier - Design for a specific voltage gain and plot frequency response characteristics
7	Feedback amplifiers (current series & voltage series) - Design for a specific voltage gain and plot frequency response characteristics
8	RC oscillators – RC phase shift or wien bridge oscillator
9	Power amplifiers (Transformer less) – Class B & Class AB
10	Transistor series voltage regulator – Design for a specific output voltage with & without short circuit protection (plot load & line regulation characteristics).

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	Design and demonstrate the functioning of basic analog circuits using discrete components.	**K3**
CO2	Design and simulate the functioning of basic analog circuits using simulation tools	**K3**
CO3	Conduct troubleshooting of a given circuit and to analyze it	**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						3			3
CO2	3	2	2		3				3			3
CO3	3	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	Electronic Devices and Circuits	David A Bell	Oxford University Press, 2008	5th edition
2	Electronic Circuits Analysis and Design 1	D. Meganathan	Yes Dee Publishing, 2023	1st edition

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.

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.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and

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.

3. **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.

4. **Record (5 Marks)**

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

SEMESTER S3
LOGIC CIRCUIT DESIGN LABORATORY

Course Code	**PCECL308**	**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. Familiarise the students with the Digital Logic Design through the implementation of Logic Circuits.
2. Familiarise the students with the HDL based Digital Design and FPGA boards

Expt. No.	**Experiments**
Part A – List of Experiments using digital components (Any *Six* experiments mandatory)	
1	Realization of functions using basic and universal gates (SOP and POS forms).
2	Design and Realization of half/full adder and subtractor using basic gates and universal gates.
3	4 bit adder/subtractor and BCD adder using 7483
4	Study of Flip Flops : S-R, D, T, JK and Master slave JK FF using NAND gates
5	Asynchronous Counter : 3 bit up/down counter, Realization of Mod N Counter
6	Synchronous Counter: Realization of 4-bit up/down counter, Realization of Mod-N counters
7	Ring counter and Johnson Counter.
8	Realization of counters using IC's (7490, 7492, 7493).
9	Realization of combinational circuits using MUX & DEMUX, using ICs (74150, 74154)
10	Sequence Generator / Detector
Part B – Simulation Experiments (Any *Six* experiments mandatory) The experiments shall be conducted using Verilog and implementation using small FPGA	
1	Experiment 1: Realization of Logic Gates and Familiarization of FPGAs

	(a) Familiarization of a small FPGA board and its ports and interface. (b) Create the .pcf files for your FPGA board. (c) Familiarization of the basic syntax of verilog Development of verilog modules for basic gates, synthesis and implementation in the above FPGA to verify the truth tables. (e) Verify the universality and non associativity of NAND and NOR gates by uploading the corresponding verilog files to the FPGA boards.
2	Experiment 2: Adders in Verilog (a) Development of verilog modules for half adder in any of the 3 modeling styles (b) Development of verilog modules for full adder in structural modeling using half adder.
3	Experiment 3: Mux and Demux in Verilog (a) Development of verilog modules for a 4x1 MUX. (b) Development of verilog modules for a 1x4 DEMUX.
4	Experiment 4: Flipflops and counters (a) Development of verilog modules for SR, JK and D flipflops. (b) Development of verilog modules for a binary decade/Johnson/Ring counters
5	Experiment 5. Multiplexer and Logic Implementation in FPGA (a) Make a gate level design of an 8 : 1 multiplexer, write to FPGA and test its functionality. (b) Use the above module to realize any logic function
6	Experiment 6. Flip-Flops and their Conversion in FPGA (a) Make gate level designs of J-K, J-K master-slave, T and D flip-flops, implement and test them on the FPGA board. (b) Implement and test the conversions such as T to D, D to T, J-K to T and J-K to D
7	Experiment 7: Asynchronous and Synchronous Counters in FPGA (a) Make a design of a 4-bit up down ripple counter using T-flip-flops in the previous experiment, implement and test them on the FPGA board. (b) Make a design of a 4-bit up down synchronous counter using T-flip-lops in the previous experiment, implement and test them on the FPGA board.
8	Experiment 8: Universal Shift Register in FPGA (a) Make a design of a 4-bit universal shift register using D-flip-flops in the previous experiment, implement and test them on the FPGA board. (b) Implement ring and Johnson counters with it.
9	Experiment 9. BCD to Seven Segment Decoder in FPGA (a) Make a gate level design of a seven segment decoder, write to FPGA and test its functionality. (b) Test it with switches and seven segment display. Use ouput ports for connection to the display.

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	Design and demonstrate the functioning of various combinational and sequential circuits using ICs	**K3**
CO2	Apply an industry compatible hardware description language to implement digital circuits	**K3**
CO3	Implement digital circuits on FPGA boards and connect external hardware to the boards	**K3**
CO4	Function effectively as an individual and in a team to accomplish the given task.	**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	2					3			3
CO2	3	1	1	3	3				3	1		3
CO3	3	1	1	3	3				3	1		3
CO4	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	Verilog HDL Synthesis: A Practical Primer	J. Bhasker	B. S. Publications,	2001
2	Fundamentals of Logic Design	Roth C.H	Jaico Publishers. V Ed., 2009	5th Edition

Reference 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	Palnitkar S.	Prentice Hall; 2003.	2nd Edn.,

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 4

ELECTRONICS & COMMUNICATION ENGINEERING

SEMESTER S4

MATHEMATICS FOR ELECTRICAL SCIENCE – 4

Course Code	**GBMAT401**	**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 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	**9**

	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]**	
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/ Micro project	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 the concept, properties and important models of discrete random variables and to apply in suitable random phenomena.	**K3**
CO2	Describe 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/
4	https://archive.nptel.ac.in/courses/117/105/117105085/

SEMESTER S4

SIGNALS AND SYSTEMS

Course Code	PCECT402	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)	Mathematics for Electrical and Physical Sciences (GYMAT101, GYMAT201)	Course Type	Theory

Course Objectives:

1. To provide sufficient understanding of different types of signals and systems in time and frequency domain.
2. Analyze LTI systems in time and frequency domain using different transforms

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to signals and systems:** Continuous time and discrete time signals - Elementary signals, Classification of signals, Basic signal operations. Continuous time and discrete time systems – Representation and Classification (memory, causal, stable, linear, time-invariant, invertible) Convolution integral and convolution sum operations. Continuous time and discrete time LTI systems-Stability and causality of LTI systems.	11
2	**Frequency domain representation of continuous time signals:** Continuous time Fourier series - Exponential Fourier series representation of periodic signals. Continuous time Fourier transform - Convergence and Gibbs phenomenon, Continuous time Fourier transform of standard signals, Properties of Continuous time Fourier transform, Inverse Transform. Bilateral Laplace Transform, Concept of ROC, Relation of Laplace transform to Fourier Transform.	11

3	**Sampling of continuous time signals to discrete signals and frequency domain representation of discrete time signals:** Conversion of continuous time signal to discrete time signal, Sampling theorem for low pass signals, Nyquist criteria, Aliasing. Discrete time Fourier series for discrete periodic signals. Discrete time Fourier transform (DTFT)-Convergence condition, DTFT of standard signals, Properties of DTFT, Inverse transform. Z transform- ROC, Properties (Proof not needed), Inverse transform, Relation between DTFT and Z-Transform.	**11**
4	**Analysis of LTI systems using Transforms** Concept of transfer function-Frequency response, Magnitude response and phase response. Analysis of Continuous time LTI systems using Laplace and Fourier transforms. Analysis of discrete time LTI systems using DTFT and Z transforms, Stability and causality using Z transform.	**11**

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

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	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	Classify continuous and discrete time signals and systems based on their properties and perform basic operations on signals.	**K2**
CO2	Determine the stability and causality of LTI systems using convolution operations.	**K3**
CO3	Analyze signals in frequency domain using various transforms and examine their properties.	**K3**
CO4	Interpret the use of various transforms to analyze continuous and discrete time LTI systems.	**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			2							1
CO2	3	3	2	2	2							2
CO3	3	3	3	2	2							3
CO4	3	3	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	Signals and Systems	Alan V. Oppenheim and Alan Willsky	Pearson	2/e, 2015
2	Signals and Systems	Simon Haykin	John Wiley	2/e, 2021

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Signals and Systems	Anand Kumar	PHI	3/e, 2013
2	Principles of Signal Processing & Linear systems	B P. Lathi	Oxford University Press	2/e, 2009
3	Signals & Systems - Continuous and Discrete	Rodger E. Ziemer	Pearson	4/e, 2013
4	Analog and Digital Signal Processing	Ashok Ambardar	Brooks/Cole Publishing Company	2/e, 2013
5	Signals and systems - Principles and Applications	Shaila Dinkar Apte	Cambridge University Press	1/e, 2016

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/117101055 https://nptel.ac.in/courses/117104074 https://nptel.ac.in/courses/108104100
2	Same as above
3	Same as above
4	Same as above

SEMESTER S4

LINEAR INTEGRATED CIRCUITS

Course Code	**PCECT403**	**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)	Analog Circuits (PCECT303)	**Course Type**	Theory

Course Objectives:

1. To develop skills to design and analyze circuits using operational amplifiers for various applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Differential Amplifiers:** Differential amplifier configurations using BJT, DC Analysis - transfer characteristics; AC analysis - differential and common mode gains, CMRR, input and output resistance, voltage gain, constant current bias, constant current source. **Concept of current mirror**: two-transistor current mirror, Wilson and Widlar current mirrors. **Operational amplifiers (Op Amps):** The 741 Op Amp, Block diagram, Ideal Op Amp parameters, typical parameter values for 741, equivalent circuit, open loop configurations, voltage transfer curve, frequency response curve.	**11**
2	**Op Amp with negative feedback:** General concept of Voltage Series, Voltage Shunt, Current Series and Current Shunt negative feedback, Op Amp circuits with Voltage Series and Voltage Shunt feedback, Virtual ground concept. Analysis of inverting and non-inverting amplifier for closed loop gain, Input Resistance and Output Resistance. **Op Amp applications:** Summer, Voltage Follower, Differential and Instrumentation Amplifiers, Voltage to Current and Current to Voltage converters, Integrator, Differentiator, Precision Rectifiers, Comparators, Schmitt Triggers, Log and Antilog amplifiers.	**11**

3	**Oscillators and Multivibrators:** Phase Shift and Wien-bridge Oscillators, Triangular and Sawtooth waveform generators, Astable and Monostable multivibrators. **Active filters:** Comparison with passive filters, First and Second order Low pass, High pass, Band pass and Band Reject active filters, State Variable filters. **Voltage Regulators:** Fixed and Adjustable voltage regulators, IC 723 – Low voltage and High voltage configurations, Current boosting, Current limiting, Short circuit and Fold-back protection.	**11**
4	**Timer and VCO:** Timer IC 555 - Functional diagram, Astable and monostable operations, Basic concepts of Voltage Controlled Oscillator and application of VCO IC LM566. **Phase Locked Loop**: Basic building block, Operation, Closed loop analysis, Lock and capture range, Applications of PLL, PLL IC565. **Data Converters:** Digital to Analog converters, Specifications, Weighted resistor type and R-2R Ladder type. Analog to Digital Converters: Specifications, Flash type and Successive approximation type.	**11**

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

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	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 concepts of operational amplifiers and differential amplifier configurations	**K2**
CO2	Design operational amplifier circuits for various applications.	**K3**
CO3	Choose integrated circuit chips for various linear circuit applications.	**K2**
CO4	Implement various applications using specific integrated circuit chips	**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										1
CO2	3	2	3	3	2							2
CO3	3				2							2
CO4	3	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	Linear Integrated Circuits	Roy D. C. and S. B. Jain	New Age International	5/e, 2018

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Design with Operational Amplifiers and Analog Integrated Circuits	Sergio Franco	Tata McGraw Hill	3/e, 2017
2	Op-Amps and Linear Integrated Circuits	Gayakwad R. A.	Prentice Hall	4/e, 2015
3	Integrated Circuits	Botkar K. R.	Khanna Publishers	10/e, 2013
4	Operational Amplifiers	C.G. Clayton	Butterworth & Company Publ. Ltd. Elsevier	5/e, 2005
5	Operational Amplifiers & Linear Integrated Circuits	R.F. Coughlin & Fredrick Driscoll	PHI	6/e, 2000
6	Operational Amplifiers & Linear ICs	David A. Bell	Oxford University Press	3/e, 2011
7	Microelectronic Circuits	Sedra A. S. and K. C. Smith	Oxford University Press	6/e, 2013

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/117101106
2	https://nptel.ac.in/courses/117101106
3	https://nptel.ac.in/courses/117101106
4	https://nptel.ac.in/courses/117101106

SEMESTER S4

MICROCONTROLLERS

Course Code	PBECT404	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)	PBECT304-Logic Circuit Design	**Course Type**	Theory

Course Objectives:

1. To learn Microcontroller architecture and its programming
2. To learn embedded system design to develop a product.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Microcontroller Architecture – General internal architecture, Address bus, Data bus, control bus. The Microcontroller 8051: Features of 8051 microcontroller, Block diagram of 8051- program status word (PSW), accumulator, program counter. Memory organization – RAM & ROM, register banks and stack, Special Function Registers (SFRs), I/O port organization, Interrupts.	**9**
2	Instruction Set of 8051 & Addressing modes: Classification of instruction set - Data transfer group, arithmetic group, logical group, branching group. Addressing modes - Types. Accessing the data from internal and external memory.	**9**
3	Programming 8051 Using Assembly Language: Introduction to 8051 assembly language programming. Data types & directives, Concept of subroutine. Software delay programming. Programming 8051 Using Embedded C Language: Introduction to embedded C – advantages.	**9**
4	Timer / Counter in 8051: Timer registers - Timer0, Timer1. Configuration of timer registers. Timer mode programming. Counter mode.	**9**

	Serial Communication in 8051: Serial communication – modes and protocols, RS-232 pin configuration and connection. Serial port programming – transmitting and receiving. Programming the interrupts: Use external, timer and serial port interrupts. Interrupt priority settings.	

Suggestion on Project Topics

1. Interface any known ADC chip to 8051 uC. Read the variation in voltage from a potentiometer and display it on an LCD module.
2. Interface any known DAC chip to 8051 uC. Generate a Sine waveform of 1KHz at any port pin.
3. DC motor interface for speed and direction control.
4. Stepper motor interface - Unit step control, Rotation angle control, Speed control, Direction control
5. Read the Temperature sensor and display it on LCD.

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	Outline Architecture of Microcontroller	**K2**
CO2	Develop Microcontroller programs	**K5**
CO3	Design various interfaces to Microcontroller	**K5**
CO4	Design and implement an Embedded System	**K6**

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											
CO2	3	3	3	2	3			2				2
CO3	3	3	3	3	3			2				2
CO4	3	3	3	3	3	3	3	3	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	The 8051 Microcontroller and Embedded Systems Using Assembly and C	Muhammad Ali Mazidi Janice Gillispie Mazidi Rolin D. McKinlay	Prentice Hall -Inc	Second, 2007
2	The 8051 Microcontroller Architecture, Programming and Applications	Kenneth J Ayala Dhananjay V Gadre	Cengage Learning	2010

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	8051 hardware Description	Datasheet	Intel Corporation	1992
2	Microprocessors and Microcontrollers	Lyla B. Das	Pearson Education	2011

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	Microprocessors and Microcontrollers - https://nptel.ac.in/courses/106108100
2	Microcontrollers and Applications - https://nptel.ac.in/courses/117104072

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

INSTRUMENTATION

Course Code	PEECT 411	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 code)	**Course Type**	Theory

Course Objectives:

1. This course aims to introduce the basic concepts of electronic measuring instruments.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to measuring instruments** Generalized Configurations and Functional elements of Instrumentation systems, Need for Measurement Systems, Classification of Types of Measuring instruments. Static and Dynamic characteristics of measuring instruments.	9
2	**Sensors and Transducers** Classification and selection criteria of Transducers Principles of operation, construction, theory, advantages and disadvantages, applications of **Resistive Transducers:** Potentiometers, strain gauges, (metallic and semi-conductor type), Resistance Thermometer, Thermistors. **Inductive Transducers:** LVDT (Linear variable differential transformer). **Capacitive Transducers:** various capacitive transducers based upon familiar equation of capacitance (capacitive microphone)	9
3	**Electronic Measuring Instruments** Digital storage oscilloscope, Working principle and applications of waveform analyser, digital frequency meter, harmonic distortion meter, harmonic analyser, spectrum analyser and logic state analyser IEEE -	9

	488 General Purpose Interface Bus (GPIB) Instruments with application. EMI, Grounding and Shielding	
4	**PLC Programming** Basic PLC Programming: Programming ON/OFF Inputs, Creating Ladder diagrams, Register Basics, PLC Timers and Counters, PLC Arithmetic functions, Number comparison functions, Data handling Functions: Skip function and applications; master control relay function and applications; jump with non-return and return; data table, register and other move functions, PLC functions with BITS.	**9**

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

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	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	Interpret the basic concepts of measuring instruments, its classification, and selection criteria.	**K2**
CO2	Outline the principle, construction and working of transducers for measuring physical variables.	**K2**
CO3	Comprehend the principle, construction and working of various electronic measuring instruments.	**K2**
CO4	Apply PLC programming for selected industrial processes.	**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										
CO2	3	3	3									
CO3	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	Doebelin's Measurement Systems	Ernest Doebelin, Dhanesh N. Manik	Tata McGraw Hill	6/e, 2011
2	Electronic Instrumentation	Kalsi H S	Tata McGraw Hill	4/e, 2019
3	Programmable Logic controllers Programming Methods and Applications	John R Hackworth, Frederick D Hackworth	Pearson Education	3/e, 2022

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	"Electrical and Electronics Measurements and Instrumentation,"	Sawhney AK,	Dhanpat Rai and Sons	2023
2	"Programmable Logic Controllers- Principles and applications	John W Webb, Ronald A. Reis,	Pearson	5/e, 2015

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/108/105/108105064/
2	https://archive.nptel.ac.in/courses/108/105/108105153/

SEMESTER S4

POWER ELECTRONICS

Course Code	**PEECT 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)	Analog Circuits (PCECT303)	**Course Type**	Theory

Course Objectives:

1. To study the characteristics of power electronic devices.
2. To study different power converter circuits.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction:** Scope and applications of Power Electronics, Properties of ideal switch. **Structure and static characteristics:** Power diodes, Power BJT, Power MOSFET & IGBT – comparison. Basic principles of wide band gap devices – SiC & GaN. **Safe Operating Area:** Power BJT, Power MOSFET & IGBT. **Drive Circuits:** Power BJT and Power MOSFET (any two example circuits – no analysis).	9
2	**SCR:** Structure, two transistor analogy, static characteristics. **Rectifiers:** Three phase diode bridge rectifiers, Single phase half-controlled rectifier with R load – Single phase fully controlled bridge rectifier (continuous conduction) – output voltage equation. Principle of three phase half wave controlled rectifier– (average output voltage equation for continuous load current) – related simple problems (1-phase & 3-phase).	9
3	**DC – DC Switch Mode Converters:** Buck, Boost and Buck-boost DC-DC converters. Waveforms and expression of DC-DC converters for output voltage, voltage and current ripple under continuous conduction mode.	9

	Isolated converters: Flyback, Forward, Push Pull, Half bridge and Full bridge converters – Waveforms and governing equations.	
4	**DC-AC Switch Mode Inverters:** Inverter topologies, Driven Inverters: Push-Pull, Half bridge and Full bridge configurations, Single phase PWM inverters (Single pulse width and sinusoidal pulse width modulation) – rms output voltage equation and output voltage waveforms.	**9**

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

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	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	Outline the operation of power semiconductor devices and its characteristics.	**K2**
CO2	Design and analyze various rectifier circuits for power devices	**K3**
CO3	Analyze different power converter circuits	**K3**
CO4	Illustrate different types of inverter circuits	**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		3	3						2
CO3	3		3	3	3	3	3					2
CO4	3		3	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	Power Electronics Essentials & Applications	L Umanand	Wiley India	Reprint Edition 2014
2	Power Electronics Circuits, Devices, and Applications	Muhammad H Rashid	Pearson India	Third Edition

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Power Electronics Converters, Applications, and Design	Ned Mohan, Tore M Undeland, William P. Robbins	Wiley India	Third Edition
2	Power Electronics Principles and Applications	Joseph Vithayathil	Tata McGraw-HILL	Second Reprint 2010
3	Power Electronics	Daniel W Hart	McGraw-HILL	2011
4	SiC and GaN Wide Bandgap Device Technology Overview,	Milligan, J. W., Sheppard, S., Pribble, W., Wu, Y.-F., Muller, G., &Palmour, J. W	2007 IEEE Radar Conference.	doi:10.1109/radar.2007.374395.

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	
2	https://www.youtube.com/watch?v=fOZ8bUrFJGk
3	https://archive.nptel.ac.in/courses/117/108/117108124/
4	https://www.youtube.com/watch?v=Dg5AIy0bY1A

SEMESTER S4

MACHINE LEARNING

Course Code	PEECT413	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 provide a comprehensive understanding of machine learning principles and techniques.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Review**: supervised, unsupervised machine learning techniques, dimensionality reduction techniques-PCA, SVD Instance-Based vs Model-Based Learning, Machine Learning models, Hyper parameters, regularization, Training - Batch and Online Learning, Challenges of Machine Learning: Data Issues-Quality, Relevancy, Over fitting, under fitting. Bias, variance, Performance metrics: Accuracy Recall, Precision, ROC curve	9
2	Regression: linear regression, logistic regression error functions in regression, MSE, L1, L2, Cross entropy multivariate regression. Classification: Naive Bayes classifier, Support Vector machines, Decision trees -random forests, Ensemble methods: boosting, bagging.	9
3	Unsupervised learning: Clustering-K-means, High, Hierarchical clustering, criterion functions for clustering, proximity measures, *Euclidean, Manhattan, Minkowski Distances, Cosine Similarity.* Reinforcement Learning: Agent based learning, Q-learning, Introduction to HMM models	7

4	Introduction to Artificial Neural Networks: Biological Neuron, Perceptron, Training, limitations, XOR problem, Multilayer perceptron, Gradient based learning, stochastic gradient descent, Activation Functions-Sigmoid, ReLU, tanh. Back propagation- Chain rule, Regularization- L1, L2,	**11**

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

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	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	Analyze and apply supervised and unsupervised machine learning techniques to solve various data-driven problems.	**K4**
CO2	Develop, train, and optimize regression and classification models	**K3**
CO3	Design and execute clustering techniques, and assess their effectiveness using various proximity measures.	**K3**
CO4	Apply unsupervised learning techniques and understand reinforcement learning for complex problem-solving.	**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								2
CO2	3	2	2	1	2							2
CO3	3	2	2	1	2	1	1					2
CO4	3	2	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	Hands-on Machine learning with Sc-kit Learn Keras and Tensorflow (module 1)	Aurelien Geron	Oreilly	Second edition 2019
2	Machine learning for absolute beginners	Oliver Theobald		Second edition
3	Learning Deep Learning (for module 4)	Magnus Ekman	Addison -Wesley	2022
4	Introduction to Machine learning with Python	Andreas C. Müller & Sarah Guido	O'Reilly	2017

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"	. Bishop, C. M.	Springer, New York,	2006.
2	"Pattern Recognition".	Theodoridis, S. and Koutroumbas, K.	Academic Press, San Diego,.	2003
3	Artificial Intelligence : a Modern Approach.	Russell, Stuart J.	:Prentice Hall,	2010.
4	CS229 Lecture Notes	Andrew Ng and Tengyu Ma	https://cs229.stanford.edu/main_notes.pdf	2023

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc23_cs18/preview (For modules 1,2 and 3)
2	https://see.stanford.edu/Course/CS229
3	https://onlinecourses.nptel.ac.in/noc23_cs18/preview
4	https://www.3blue1brown.com/topics/neural-networks

SEMESTER S4

OBJECT ORIENTED PROGRAMMING

Course Code	**PEECT414**	**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)	PROGRAMMING IN C	**Course Type**	Theory

Course Objectives:

1. To introduce the basic concepts of object-oriented design techniques.
2. To give a thorough understanding of the basics of Java programming

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction:** **Approaches to Software Design -** Functional Oriented Design, Object Oriented Design, Case Study of Automated Fire Alarm System. **Introduction to Java -** Java Buzzwords, Java program structure, Java compiler, Bytecode, Java Virtual Machine (JVM), Comments, Lexical Issues.	7
2	**Core Java Fundamentals:** **Primitive Data types -** Integers, Floating Point Types, Characters, Boolean. Literals, Variables, Type Conversion and Casting, Arrays, Strings- String Handling functions. **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
	Object Oriented Programming in Java - Class Fundamentals, Declaring Objects, Object Reference, Access Control, Introduction to	

	Methods, Constructors, this Keyword, Method Overloading. Inheritance - Super Class, Sub Class, The Keyword super, protected Members, Method Overriding.	
3	**More features of Java:** **Packages -** Defining Package, CLASSPATH, Importing Packages. **Exception Handling -** Checked Exceptions, Unchecked Exceptions, try Block and catch Clause, Multiple catch Clauses, Nested try Statements, throw, throws and finally. **Input/output -** I/O Basics, Reading Console Input, Writing Console Output, Print Writer Class, Working with Files.	**10**
4	**Advanced features of Java:** **Swings fundamentals -** Swing Key Features, Model View Controller (MVC), Swing Controls, Components and Containers, Swing Packages, Event Handling in Swings, Swing Layout Managers, Exploring Swings –JFrame, JLabel, The Swing Buttons, JtextField.. **Java DataBase Connectivity (JDBC) -** JDBC overview, Creating and Executing Queries – create table, delete, insert, select.	**10**

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

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	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 object-oriented concepts - classes, objects, constructors, data hiding, inheritance and polymorphism and to illustrate it using UML diagrams.	**K2**
CO2	Utilise datatypes, operators, control statements, object oriented class, object concepts in Java to develop programs.	**K3**
CO3	Illustrate how robust programs can be written in Java using packages, exception handling mechanism and Input/ Output Streams with Files.	**K3**
CO4	Identify and utilize various Swing controls, components, and containers.	**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	Java: The Complete Reference	Herbert Schildt	Tata McGraw Hill	8/e, 2011.
2	Fundamentals of Software Engineering,	Rajib Mall	PHI	4th edition, 2014.
3	Java How to Program, Early Objects	Paul Deitel, Harvey Deitel,	Pearson,	11th Edition, 2018.

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Programming JAVA a Primer	Balagurusamy E	McGraw Hill	5/e, 2014.
2	Object Oriented Systems Development using the Unified Modeling Language	Ali Bahrami	McGraw-Hill Int.	2017
3	Introduction to Java Programming	Y. Daniel Liang	Pearson	7/e, 2013.
4	Core Java: An Integrated Approach	Nageswararao R.	Dreamtech Press	2008
5	Java in A Nutshell	Flanagan D	O'Reilly	5/e, 2005.
6	Object Oriented Design with UML and Java	Barclay K.J. Savage,	Elsevier	2004
7	Head First Java	Sierra K.	O'Reilly	2/e, 2005.

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc20_cs08/preview

SEMESTER S4

DIGITAL SYSTEM DESIGN

Course Code	PEECT416	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)	PBECT304: Logic Circuit Design	**Course Type**	Theory

Course Objectives:

1. To acquire knowledge about Asynchronous and clocked Synchronous sequential circuit design.
2. To detect the faults and hazards in digital circuit design
3. To design and implement digital circuits using VHDL.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Clocked Synchronous Networks, Analysis of Clocked Synchronous Sequential Networks (CSSN), Modeling of CSSN, State assignment and reduction, Design of CSSN.	**10**
2	ASM Chart and its realization. Asynchronous Sequential Circuits, Analysis of Asynchronous Sequential Circuits (ASC), Flow table reduction, Races in ASC, State assignment problem and the transition table.	**10**
3	Hazards – static and dynamic hazards in combinational networks, Essential Hazards, Design of Hazard free circuits, Data synchronizers, Mixed operating mode asynchronous circuits, Practical issues- clock skew and jitter, Synchronous and asynchronous inputs. Faults: Fault table method – path sensitization method – Boolean difference method.	**8**
4	VLSI Design flow: Design entry: Schematic, Data types and objects, different modelling styles in VHDL - Dataflow, Behavioural and Structural Modelling. VHDL constructs and codes for combinational and sequential circuits.	**8**

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

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	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	Analyze asynchronous and clocked synchronous sequential circuits	**K3**
CO2	Design hazard-free digital circuits	**K3**
CO3	Identify faults in digital circuits	**K3**
CO4	Apply VHDL programming in digital system design	**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
CO2	3	2	2	2								3
CO3	3	3	2		2							3
CO4	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	Digital Principles & Design	Donald G Givone	Tata McGraw Hill	1/e 2002
2	Digital Design with an introduction to HDL, VHDL and Verilog	M.Morris Mano and Michel.D.Ciletti	Pearson education	6/e, 2018
3	Digital Design	John F Wakerly	Pearson Education	4/e 2008
4	Digital Logic Applications and Design	John M Yarbrough	Cengage India	1/e 2006

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Systems Testing and Testable Design	Miron Abramovici, Melvin A. Breuer and Arthur D. Friedman	John Wiley & Sons Inc	1994
2	Logic Design Theory	N. N. Biswas	PHI	1992
3	Introduction to Digital Design Using Digilent FPGA Boards	Richard E. Haskell, Darrin M. Hanna	LBE Books- LLC	2009
4	Digital Circuits and Logic Design	Samuel C. Lee	PHI	1980
5	Digital System Design Using VHDL	R. Anand	Khanna Book Publishing Company	FIRST,2013
6	Digital System Design using VHDL	Charles Roth	PWS PUBLISHING	1997
7	Digital System Design Using VHDL	Lizy Kurian John, Charles H. Roth	Cengage	1st, 2012

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/117/106/117106086/
2	https://archive.nptel.ac.in/courses/117/106/117106086/
3	https://archive.nptel.ac.in/courses/108/105/108105132/ Lecture 15
4	https://nptel.ac.in/courses/108106177

SEMESTER S4

DIGITAL SYSTEMS AND VLSI DESIGN

Course Code	PEECT415	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)	PBECT304 Logic Circuit Design	Course Type	Theory

Course Objectives:

1. To equip students with comprehensive knowledge and skills in designing, analysing, modelling, and optimizing clocked synchronous sequential networks (CSSNs).
2. To provide a thorough understanding of the designing, analyzing, and optimizing techniques of asynchronous sequential circuits (ASCs).
3. To equip students with the knowledge and skills to identify and mitigate static and dynamic hazards and to understand fault detection and testing methods.
4. To provide students with a comprehensive understanding of the VLSI design flow and the application of VHDL constructs and coding for combinational and sequential circuits.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Clocked Synchronous Networks, Analysis of Clocked Synchronous Sequential Networks (CSSN), Mealy machine, Moore machine, Modelling of CSSN, State assignment and reduction, Design of CSSN, ASM Chart and its realization.	9
2	Asynchronous Sequential Circuits, Analysis of Asynchronous Sequential Circuits (ASC), Flow table reduction, Races in ASC, State assignment problem and the transition table, Design of Asynchronous Sequential Circuits, Design of ALU.	9

3	Hazards – static and dynamic hazards in combinational networks, Essential Hazards, Design of Hazard free circuits, Data synchronizers, Mixed operating mode asynchronous circuits, Practical issues- clock skew and jitter, Synchronous and asynchronous inputs, Flip-Flops and Simple Flip-Flop Applications, switch debouncer. Faults, Fault table method – path sensitization method – Boolean difference method, Kohavi algorithm, Automatic test pattern generation – Built in Self-Test (BIST)	**9**
4	VLSI Design flow: Design entry: Schematic, FSM & HDL, VHDL Hardware Description Language, VHDL Modules, VHDL Processes, Different modeling styles in VHDL, Data types and operators, Objects, Dataflow, Behavioral and Structural Modeling, Synthesis, Simulation. VHDL constructs and codes for combinational and sequential circuits.	**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 Design and Analysis Tools: (10 marks)

Students can perform specific experiments using tools like GHDL, iVerilog, ModelSim, Xilinx ISE, Vivado etc.
Each experiment can focus on designing and simulating different types of circuits (synchronous, asynchronous, combinational, sequential).

2. Course Project:
Comprehensive project involving design, modeling, and analysis of a digital system. (10 marks)

Project phases: Proposal, Design, Implementation, Testing, Final Report.

Presentations and Viva Voce:

Students present their projects and experiments, explaining design choices, methodologies, and results. Viva voce to assess understanding and ability to answer related questions.

Sample Experiments:

Experiment 1: Basic Mealy/Moore Machine Design

- **Objective:** Design a simple Mealy/Moore machine to detect a specific sequence of bits (e.g., "101").
- **Tools:** VHDL/Verilog, GHDL, iVerilog, ModelSim/Xilinx ISE, Vivado.
- **Steps:**
    1. Draw the state diagram for the sequence detector.
    2. Write the VHDL or Verilog code for the Mealy machine.
    3. Simulate the design to verify its functionality.

Experiment 2: Basic Flow Table Reduction

- **Objective:** Reduce the flow table for a simple asynchronous sequential circuit.
- **Tools:** Manual calculation, VHDL/Verilog for verification.
- **Steps:**
    1. Given a flow table, perform flow table reduction.
    2. Assign binary codes to the reduced states.
    3. Implement the reduced state machine in VHDL or Verilog and simulate it.

Experiment 3: Identifying and Eliminating Static Hazards

- **Objective:** Identify and eliminate static hazards in a simple combinational circuit.
- **Tools:** VHDL/Verilog, GHDL, iVerilog, ModelSim/Xilinx ISE, Vivado.
- **Steps:**
    1. Design a combinational circuit with a known static hazard.
    2. Identify the static hazard in the circuit.
    3. Modify the design to eliminate the static hazard and simulate it.

Experiment 4: Fault Detection Using Path Sensitization

- **Objective:** Use the path sensitization method to detect faults in a simple digital circuit.
- **Tools:** VHDL/Verilog, GHDL, iVerilog, ModelSim/Xilinx ISE, Vivado.
- **Steps:**

1. Design a simple digital circuit.
2. Apply the path sensitization method to detect faults.
3. Implement and simulate the circuit in VHDL or Verilog to verify fault detection.

Sample Project Topics:

1. Design and Analysis of a Traffic Light Controller Using Mealy and Moore Machines
2. State Reduction and Assignment for a Sequence Detector
3. Design and Analysis of an Asynchronous Sequence Detector
4. Designing a Simple Arithmetic Logic Unit (ALU) with Flow Table Reduction and Hazard Handling
5. Design of a Hazard-Free Circuit for a Critical Application
6. Implementing Data Synchronizers for Mixed Operating Mode Asynchronous Circuits
7. Comprehensive VLSI Design Project Using VHDL (e.g., Digital Clock, ALU, Traffic Light Controller)
8. Synthesis and Simulation of Complex Sequential Circuits Using Different VHDL Modeling Styles

Criteria for Evaluation: Lab Experiments (10 marks)

1. **Understanding of Concepts (3 marks)**
   - Demonstrates a clear understanding of the theoretical concepts related to the experiment.
   - Correctly explains the purpose and expected outcomes of the experiment.
2. **Implementation and Accuracy (3 marks)**
   - Correctly implements the design using appropriate tools.
   - The design functions as expected without errors.
3. **Analysis and Problem-Solving (2 marks)**
   - Effectively analyse the design to identify and resolve issues.
   - Demonstrates problem-solving skills in addressing any encountered challenges.
4. **Documentation and Reporting (1 mark)**
   - Provides clear and concise documentation of the steps and processes followed.
   - The report includes diagrams, code snippets, and simulation results.

5. **Presentation and Communication (1 mark)**
    - Clearly presents the experiment and its results.
    - Able to answer questions and explain the design choices.

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.
3. **Innovation and Creativity (2 marks)**
    - Introduces innovative ideas or unique approaches in the design and implementation.
    - Demonstrates creativity in solving problems or optimizing designs.
4. **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.
5. **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	Design, analyze, and model clocked synchronous sequential networks (CSSNs), optimize state assignment and reduction, and effectively utilize ASM charts for the realization of complex digital systems.	**K3**
CO2	Design and analyze asynchronous sequential circuits (ASCs), perform flow table reduction, address race conditions and state assignment problems, and design both ASCs and Arithmetic Logic Units (ALUs).	**K3**
CO3	Identify and mitigate static and dynamic hazards in combinational networks, design hazard-free circuits, address practical issues in digital systems and apply fault detection and testing methods.	**K2**
CO4	Explain the VLSI design flow, utilize various design entry methods, apply different VHDL modeling styles, and develop and simulate VHDL constructs for combinational and sequential circuits.	**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									
CO2	3	2	2									
CO3	3	1	2									
CO4	1	1	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	Digital Principles & Design	Donald G Givone	McGraw Hill Education	2017
2	Digital Design: Principles and Practices	John F Wakerly	Pearson India	4^{th}, 2008
3	Digital Logic Applications and Design	John M Yarbrough	Cengage Learning India	$1^{st,}$ 2006
4	Digital Design: With an Introduction to the Verilog HDL, VHDL, and SystemVerilog	M.Morris Mano and Michel.D.Ciletti,	Pearson	6^{th}, 2017

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Systems Testing and Testable Design	Melvin A. Breuer, Miron Abramovici, Arthur D. Friedman	Wiley-IEEE Press	1^{st}, 1994
2	Logic Design Theory	Nripendra N. Biswas	Prentice Hall	1993
3	Introduction to Digital Design Using Digilent FPGA Boards: Block Diagram / VHDL Examples	Richard E. Haskell Darrin M. Hanna	LBE Books- LLC	2019
4	Digital Circuits and Logic Design	Samuel C. Lee	Prentice Hall India Learning Private Limited	1980
5	Switching and Finite Automata Theory	Zvi Kohavi, Niraj K. Jha	CAMBRIDGE UNIVERSITY PRESS	3^{rd} 2009
6	Digital System Design Using VHDL	Rishabh Anand	Khanna Publishing	1^{st}, 2013
7	Digital System Design Using VHDL	Lizy Kurian John, Charles H. Roth	Cengage	1^{st}, 2012

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/117/106/117106086/
2	https://archive.nptel.ac.in/courses/117/106/117106086/
3	https://archive.nptel.ac.in/courses/108/105/108105132/ Lecture 15
4	https://nptel.ac.in/courses/108106177

SEMESTER 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	2.30
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: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Case study/ Micro project	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	Describe 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	7TH 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, Gendered technologies & innovations**, Ethical values and practices in connection with gender** - equity, diversity & gender justice, **Gender policy and women/transgender empowerment initiatives.**	**6**
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.	**6**

	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.	
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 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.	**6**

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.
	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

LINEAR INTEGRATED CIRCUITS LAB

Course Code	**PCECL407**	**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)	PCECT303	**Course Type**	Lab

Course Objectives:

1. To study the design and implementation of various Linear Integrated Circuits.
2. To familiarize the simulation of basic Linear Integrated Circuits.

Details of Experiment

Expt. No.	**Part A – List of Experiments using Op Amps (Minimum seven experiments mandatory)**
1	Familiarization of Operational amplifiers - Inverting and Non inverting amplifiers, Integrator, Differentiator - frequency response, Adder, Comparators
2	Measurement of Op-Amp parameters
3	Difference Amplifier and Instrumentation amplifier
4	Schmitt trigger circuit
5	Astable and Monostable multivibrators
6	Waveform generators using Op Amps - Triangular and Sawtooth
7	Wien bridge oscillator - without & with amplitude stabilization
8	RC Phase shift Oscillator
9	Active first and second order filters (LPF, HPF, BPF and BRF)
10	Active Notch filter to eliminate the 50Hz power line frequency
11	Precision rectifiers
Expt. No	**Part B – Application circuits using ICs [Minimum three experiments are to be done]**
1	Astable and Monostable multivibrator using Timer IC NE555
2	DC power supply using IC 723: Low voltage and high voltage configurations, Short circuit and Fold-back protection.
3	A/D converters- counter ramp and flash type.
4	D/A Converters - R-2R ladder circuit
5	Study of PLL IC: free running, frequency lock range and capture range

Expt No.	**Part C – Simulation experiments** [The experiments shall be conducted using open tools such as QUCS, KiCad or variants of SPICE]]
1	Simulation of any three circuits from experiments 3, 5, 6, 7, 8, 9, 10 and 11 of section I
2	Simulation of experiments 3 or 4 from section II

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	Design and implement basic linear integrated circuits using Op Amps.	**K4**
CO2	Design and implement basic linear integrated circuits using linear ICs.	**K4**
CO3	Design and simulate the functioning of basic linear integrated circuits and linear ICs. using simulation tools.	**K4**
CO4	Effectively troubleshoot a given circuit and analyze it	**K4**

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	2						3			3
CO2	3	3	2						3			3
CO3	3	3	2		3				3			3
CO4	3	3	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	Linear Integrated Circuits	D. Roy Choudhary and Shail B Jain	New Age International Private Limited	6th edition, 2021
2	Introduction to Pspice Using Orcad for Circuits and Electronics	M. H. Rashid	Pearson	3rd edition, 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: Business Management	Gayakwad	PHI	2002
2	Linear Integrated Circuits	D Roy Choudhury, Shail Bala Jain	New Age International	(2018)

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc24_ee73/preview
2	https://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 S4

MICROCONTROLLER LAB

Course Code	**PCECL408**	**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)	PCECL307-Logic Circuit Design and Simulation Lab	**Course Type**	Lab

Course Objectives:

1. To learn Microcontroller Programming using Assembly and C language
2. To learn Microcontroller interfaces to various modules
3. To learn any advanced microcontrollers like ARM or higher.
4. To learn Embedded System Design

Details of Experiment

Expt. No.	Experiments
	PART A – Data manipulation experiments using Assembly language(Min 4 has to be completed)
1	Multiplication of two 16-bit numbers.
2	Largest/smallest from a series.
3	Sorting (Ascending/Descending) of data.
4	Matrix addition.
5	LCM and HCF of two 8-bit numbers.
6	Code conversion – Hex to Decimal/ASCII to Decimal and vice versa.
	PART B - Interface to Microcontroller Assembly/C language (Min 3 has to be completed)
1	Time delay generation and relay interface.
2	Display (LED/Seven segments/LCD) and keyboard interface.
3	ADC interface.
4	DAC interface with waveform generation.
5	Stepper motor and DC motor interface.

	PART C - Interface with Advanced Microcontroller using C language (Min 3 has to be completed)
1	PWM generation for DC motor control.
2	Object/Visitor Counter.
3	UART interface to Bluetooth.
4	SPI/I2C interface to display.
5	Real-time clock.

* A minimum of 12 experiments is to be completed.

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	Develop 8051 Microcontroller programs	**K4**
CO2	Design and implement various interfaces to the 8051 Microcontroller	**K4**
CO3	Design and implement an Embedded System using a 8051 microcontroller	**K4**
CO4	Design and implement an Embedded System using an ARM processor	**K4**

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	2								2
CO2	3	3	3	2	3			2				2
CO3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	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	The 8051 Microcontroller and Embedded Systems Using Assembly and C	Muhammad Ali Mazidi Janice Gillispie Mazidi Rolin D. McKinlay	Printice Hall -Inc	Second, 2007
2	The 8051 Microcontroller Architecture, Programming and Applications	Kenneth J Ayala Dhananjay V Gadre	Cengage Learning	2010

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	8051 Hardware Description	Datasheet	Intel Corporation	1992
2	Microprocessors and Microcontrollers	Lyla B. Das	Pearson Education	2011
3	ARM System-on-Chip Architecture	Steve Furber	Addison-Wesley Educational Publishers Inc	2000
4	System-on-Chip Design with Arm(R) Cortex(R)-M Processors	Joseph Yiu	ARM Education Media	2019

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	Microprocessors and Microcontrollers - https://nptel.ac.in/courses/106108100
2	Microcontrollers and Applications - https://nptel.ac.in/courses/117104072
3	Embedded System Design With ARM - https://onlinecourses.nptel.ac.in/noc22_cs93

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 & COMMUNICATION ENGINEERING

SEMESTER S5

ELECTROMAGNETICS

Course Code	PCECT501	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2Hrs. 30 Min.
Prerequisites (if any)	Physics for Electrical sciences (GBPHT121)	Course Type	Theory

Course Objectives:

1. To impart knowledge on the basic concepts of electric and magnetic fields and its applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Review of coordinate system-Rectangular, cylindrical and spherical coordinate systems. Review of vector calculus- curl, divergence gradient. Review of Coulomb's law, Gauss's law and Ampere's current law. Derivation of capacitance and inductance of two wire transmission line and coaxial cable. Magnetic scalar and vector potential. Poisson and Laplace equations, Determination of voltage and electric field using Laplace and Poisson's equation.	12
2	Maxwell's equation from fundamental laws. Boundary condition of electric field and magnetic field from Maxwell's equations. Solution to wave equation Propagation of plane EM wave in perfect dielectric, lossy medium, good conductor, skin depth. Polarization of waves.	10
3	Reflection and refraction of plane electromagnetic waves at boundaries for normal & oblique incidence (parallel and perpendicular polarization), Snell's law of refraction, Brewster angle. Power density of EM wave, Poynting	10

	vector theorem.	
4	Transmission line as circuit elements (L and C). Transmission line equations and characteristic impedance. Reflection coefficient and VSWR. Derivation of input impedance of transmission line. Calculation of line impedance and VSWR using smith chart. The hollow rectangular waveguide –TE and TM wave-dominant mode, group velocity and phase velocity –derivation and simple problems only.	**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 =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 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 basic mathematical concepts related to electromagnetic vector fields.	**K2**
CO2	Apply Maxwell's equations in different forms to diverse electromagnetic problems.	**K3**
CO3	Analyze reflection, refraction and power density of electromagnetic waves.	**K3**
CO4	Analyse the propagation of EM waves in transmission lines and wave guides.	**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
CO2	3	3	2	2	2							2
CO3	3	3	2	2	2							2
CO4	3	3	2	2	2							2

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Elements of Electromagnetics	Matthew N. O. Sadiku	Oxford University Press	7th edition, 2018
2	Engineering Electromagnetics	William Hayt and John Buck	McGraw-Hill Higher Education	9th edition, 2019
3	Electromagnetic Waves and Transmission Lines	Y Mallikarjuna Reddy	The Orient Blackswan	1st edition 2015

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Schaum's Outline of Elctromagnetics	Mahmood Nahvi; Joseph Edminister	McGraw-Hill	5th edition, 2019
2	Engineering Electromagnetics Essentials	B N Basu	The Orient Blackswan	1st edition 2015

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc21_ee83/preview
2	https://onlinecourses.nptel.ac.in/noc21_ee83/preview
3	https://nptel.ac.in/courses/115101005
4	https://archive.nptel.ac.in/courses/117/101/117101056/#

SEMESTER S5

ANALOG AND DIGITAL COMMUNICATION

Course Code	PCECT502	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3-1-0-0	ESE Marks	60
Credits	4	Exam Hours	2Hrs. 30 Min.
Prerequisites (if any)	PCECT402 Signals and Systems GBMAT401 Probability, Random Process and Numerical Methods	Course Type	Theory

Course Objectives:

1. To analyse different analog and digital communication systems

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Block diagram of a communication system. Need for modulation. Amplitude modulation, Equation and spectrum of AM signal, DSB-SC, SSB -pilot carrier and Vestigial sideband systems. Angle modulation: Narrow and wide band FM and their spectra, relationship between FM and PM, Carson's rule, pre-emphasis and de-emphasis filtering. Comparison of AM and FM, Block diagram of FM receiver. Superheterodyne receivers- Characteristics of receivers –image frequency. Noise: external, internal, White noise.	**12**
2	Sampling and Quantization, SQNR for uniform quantization, Companding Pulse code modulation, Transmitter and receiver. DPCM transmitter and receiver. Delta modulation, Slope overload, Line codes.	**10**
3	Baseband data transmission of digital data through AWGN channel, Mathematical model of ISI, Nyquist criterion for zero ISI, Signal modelling for ISI, Raised cosine spectrum, Equalization,Zero forcing Equaliser. Geometric representation of Signals-Gram-Schmitt procedure, Signal space. Vector model of AWGN channel. Matched filter and correlation receivers, MAP receiver, Maximum likelihood	**12**

	receiver.	
4	Digital band pass modulation schemes-BPSK system and signal constellation. BPSK transmitter and receiver. QPSK system and Signal constellations. BER analysis of BPSK and QPSK in erfc. Plots of BER Vs SNR. QPSK transmitter and receiver. Quadrature amplitude modulation and signal constellation.	**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 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 the principles of analog communication systems	**K2**
CO2	Explain the basic concepts of digital communication	**K2**
CO3	Analyse the baseband transmission of digital data through AWGN channel	**K3**
CO4	Apply various digital modulation techniques in the design of digital 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	-	-	-	2	-	-	-	-	-	-	-
CO2	3	-	-	-	2	-	-	-	-	-	-	-
CO3	3	3	3	3	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	Communication Systems	Simon Haykin and Michael Moher	Wiley	5th Edition, 2020
2	Modern Digital and Analog Communication Systems	B.P. Lathi and Zhi Ding	Oxford University Press	5th Edition, 2018
3	Introduction to Analog and Digital Communication, An Indian adaptation	Simon Haykin and Michael Moher	Wiley	2nd Edition, 2022

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Principles of Communication Systems	Herbert Taub and Donald L. Schilling	McGraw-Hill Education	4th Edition, 2013
2	Digital Communications	John G. Proakis and Masoud Salehi	McGraw-Hill Education	6th Edition, 2020
3	Communication Systems Engineering	John G. Proakis and Masoud Salehi	Pearson	2nd Edition, 2001
4	Digital Communications Systems, An Indian Adaptation	Simon Haykin	John Wiley& Sons	4th Edition, 2021
5	Electronic communication systems	George Kennedy	McGraw Hill	6th Edition, 2017
6	Introduction to Digital Communications	Wayne Stark	Cambridge University Press	1st edition 2023

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://youtu.be/hTAlcrqjNps?si=okoRHdUegx9pbOz3
2	https://youtu.be/s_vmLqT_6NQ?si=MF2OW6AaICiYKTfj

SEMESTER S5

CONTROL SYSTEMS

Course Code	PCECT503	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3-0-0-0	ESE Marks	60
Credits	3	Exam Hours	2Hr. 30 Min.
Prerequisites (if any)	GBMAT301 Mathematics for Electrical Science -3	Course Type	Theory

Course Objectives:

1. To study the elements of control system, modelling and perform stability analysis of systems.
2. To design control systems with compensating techniques.
3. To understand the state variable analysis method.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction:** Basic Components of Control Systems, Open-Loop and Closed-Loop Control Systems with examples. **Mathematical modelling of control systems**: Electrical Systems and Mechanical translational systems. **Transfer Function:** Block diagram reduction techniques, Signal flow graph, Mason's gain formula.	8
2	**Time Domain Analysis of Control Systems:** Standard Test signals, Time response of first order systems (unit impulse, step and ramp inputs) and second order systems (step input only). Time response of undamped, under damped, critically damped second order system to unit step signal, Time domain specifications for a second order underdamped system, Steady state error and static error coefficients.	8
3	**Stability of linear control systems**: Concept of BIBO stability, absolute stability, Routh Hurwitz Criterion. **Root Locus Techniques**: Introduction, properties and its construction.	12

	Frequency domain analysis: Frequency domain specifications **Relative stability**: gain margin and phase margin. Stability analysis using Bode plot and Nyquist stability criterion. **P, PI & PID controllers**: Introduction. **Design of Compensators**: Need for compensators, lag and lead compensators using Bode plots(only design steps)	
4	**State Variable Analysis of Linear Systems:** State variables, state equations, state variable representation of electrical systems. Transfer function from State equation, Solutions of the state equations, state transition matrix, Controllability and observability - Kalman's Test.	**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	Analyze the systems using transfer function approach	**K3**
CO2	Perform time domain analysis and steady state analysis of systems	**K2**
CO3	Determine the absolute stability and relative stability of a system using Routh Hurwitz Criterion and root locus	**K3**
CO4	Apply frequency domain techniques to assess the system stability and to design different compensation techniques	**K3**
CO5	Analyse system Controllability and Observability using state space representation	**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	3		2							2
CO4	3	3	3		2							2
CO5	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	Control Systems Engineering	I.J. Nagarath, M. Gopal	New Age International Publishers	7th Edition 2022
2	Automatic Control Systems	Benjamin C. Kuo, Farid Golnaraghi,	Wiley	10th Edition 2017
3	Modern Control Engineering	Katsuhiko Ogata	Pearson	Fifth Edition 2015

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Feedback and Control Systems	Joseph DiStefano, Allen R. Stubberud, and Ivan J. Williams	McGraw Hill	Third Edition 2013
2	Control systems	Ashok Kumar	Tata McGraw-Hill	Second Edition 2010
3	Control Systems: Principles and Design	M Gopal	McGraw Hill Education	Fourth Edition 2012
4	Nise's Control Systems Engineering	Norman S. Nise	Wiley India	8th Edition 2017

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://youtu.be/Cl23xQrvFhk?feature=shared https://youtu.be/fsxSst10_cE?feature=shared
2	https://youtu.be/cLyT6OWcmyU?feature=shared
3	https://youtu.be/CZL7_Z0i1KQ?feature=shared
4	https://youtu.be/CrXOMBlYFp0?feature=shared

SEMESTER S5

DIGITAL SIGNAL PROCESSING

Course Code	PBECT504	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)	Signals & Systems PCECT402	Course Type	Theory

Course Objectives:

1. To describe signals mathematically and understand how to perform mathematical operations on signals
2. To gain knowledge of Digital filters

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Review of sampling, Z-Transform and DTFT The Discrete Fourier Transform: DFT as a linear transformation (Matrix Relation), IDFT, Properties of DFT and examples (proof not necessary). Circular convolution, linear convolution using circular convolution, Filtering of long data sequences, overlap save and overlap add methods. Frequency Analysis of Signals using the DFT (concept only required)	9
2	Design of FIR Filters - Symmetric and Anti-symmetric FIR Filters, Design of linear phase FIR filters using Window methods, (rectangular, Hamming and Hanning). Design of IIR Digital Filters from Analog Filters (Butterworth), IIR Filter Design by Impulse Invariance, and Bilinear Transformation, Frequency Transformations in the Analog Domain.	9
3	Structures for the realization of Discrete-Time Systems - Block diagram and signal flow graph representations of filters. FIR Filter Structures: Linear structures, Direct Form. IIR Filter Structures: Direct Form, Transposed Form, Cascade Form and Parallel Form. Multi-rate Digital Signal Processing:	9

	Decimation and Interpolation (Time domain and Frequency Domain Interpretation), Anti- aliasing and anti-imaging filter.	
4	Efficient Computation of DFT: Fast Fourier Transform and computational advantage over DFT, Radix-2 Decimation in Time FFT Algorithm. Computer architecture for signal processing: Harvard Architecture, pipelining, MAC, Introduction to TMS320C67xx digital signal processor, Functional Block Diagram. Finite word length effects in DSP systems: Introduction, fixed-point and floating-point DSP arithmetic, ADC quantization noise.	**9**

Suggestion on Project Topics

Projects can include but not limited to, analysing various signals/finding their transforms and designing filters for extracting different frequency components. Projects can be simulated or implemented in hardware.

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	Illustrate fundamental properties and relations relevant to DFT and solve basic problems involving DFT-based filtering methods.	**K2**
CO2	Design linear phase FIR filters and IIR filters of different specifications.	**K3**
CO3	Realise the various FIR and IIR filter structures for a given system function.	**K3**
CO4	Compute DFT efficiently using FFT method and to explain the architecture of a DSP 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	3	2		2							2
CO2	3	3	3		3							2
CO3	3	3	3		3							2
CO4	3	3	2		3							2

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Signal Processing using Matlab	Vinay K. Ingle, John G. Proakis	Cengage Learning	3rd Ed., 2011
2	Think DSP: Digital Signal Processing using Python	Allen B. Downey	Green Tea Press	2nd Ed., 2012
3	Discrete-Time Signal Processing	Alan V Oppenheim, Ronald W. Schafer	Pearson Education	3rd Ed., 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	Shaila D. Apte	Wiley	2nd Ed, 2019
2	Digital Signal Processing: A Computer based Approach	Mitra S. K.	McGraw Hill	4th Ed., 2014
3	Digital Signal Processing: A Practical Approach	Ifeachor E. C., Jervis B. W.	Pearson Education	2nd Ed., 2009
4	Digital Signal Processing	Salivahanan S.	McGraw Hill	4th Ed., 2019

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/117102060 https://nptel.ac.in/courses/108105055
2	same as above
3	same as above
4	same as above

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 S5

BIOMEDICAL ENGINEERING

Course Code	PEECT521	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 will introduce the various aspects of biomedical engineering and its applications described using engineering principles
2. The student will be able to understand the techniques and uses of modern diagnostic and therapeutic equipment.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to bio-medical engineering, Sources of bio-electric potential: Resting and action potential, propagation of action potentials. Various bioelectric potentials (ECG, EEG, EMG, ERG, EOG, EGG concept only.) Electrode theory: Nernst equation, Electrode skin interface Bio-potential electrodes: Microelectrodes, skin surface electrodes, needle electrodes Bio-potential amplifiers: instrumentation amplifiers, carrier amplifiers, isolation amplifiers, chopper amplifiers	9
2	Heart and cardiovascular system: electro conduction system of the heart, ECG lead configurations, Einthoven triangle, Electrocardiography, ECG machine - block diagram, ECG recording system. The human nervous system: Neurons, action potential of brain, brain waves, placement of electrodes, EEG recording, evoked potential,	9

	Electrical activity of muscles: EMG signal acquisition and analysis. Myoelectric control system. Electrical stimulation of the muscle and nerve, Applications of EMG	
3	Instruments for clinical laboratory: Oxymeters, blood cell counter, flame photometer, Spectrophotometer Therapeutic Equipments: Principles, block schematic diagram, working and applications of pacemakers, cardiac defibrillators, heart–lung machine, dialyzers, surgical diathermy equipment, ventilators Biomedical Telemetry system: Components of biotelemetry system, application of telemetry in medicine, single channel telemetry system for ECG.	**9**
4	Medical Imaging systems (Basic Principle only): X-ray imaging - X-ray machine, applications of X-rays in medicine. Computed Tomograpy: Principle, image reconstruction, scanning system and applications Ultrasonic imaging systems: Basic pulse echo system, Different types of Ultrasonics systems:, A-Scan, B-Scan, M-Scan, applications, real-time ultrasonic imaging systems and probes. Magnetic Resonance Imaging – Basic NMR components, Biological effects and advantages of NMR imaging	**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 (K)
CO1	Outline the basic bioelectric potentials and their implications in diagnostics	**K2**
CO2	Summarize the principles used for diagnosis of abnormalities in the cardiovascular system	**K2**
CO3	Identify the techniques used for diagnosis and therapy in the neuromuscular and myoelectric systems.	**K2**
CO4	Illustrate the principle and working of different types of bio medical equipment/devices	**K2**
CO5	State various diagnostic medical imaging techniques.	**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
CO2	3					2						2
CO3	3					2	2					2
CO4	3					2	2					2
CO5	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	Handbook of Biomedical Instrumentation	R. S. Khandpur	Tata Mc Graw Hill	Third edition
2	Biomedical Instrumentation and Measurement	Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer,	PHI	2nd Edition, 2004

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	John G Webster	John Wiley	5^{th} edition 2020
2	Introduction to Biomedical Equipment Technology	J. J. Carr	Pearson Education	4^{th} edition 2020
3	Principle of Biomedical Instrumentation and Measurement	Richard Aston	Merrill Education/Prentice Hall	1^{st} edition 2007
4	Introduction to Biomedical Instrumentation	Barbara Christe	Cambridge University Press,	2^{nd} edition 2017

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://www.youtube.com/watch?v=_fD9gOqiBVE
2	http://www.digimat.in/nptel/courses/video/127106134/L16.html

SEMESTER S5

DATA STRUCTURES

Course Code	PEECT522	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hr. 30 Min.
Prerequisites (if any)	None/ (Course code)	Course Type	Theory

Course Objectives:

1. To familiarise with different data structures and the techniques involved.

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	9
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	9
3	Trees and Graphs: Trees, Binary Trees-Tree Operations, Binary Tree Representation, Tree Traversals, Binary Search Trees- Binary Search Tree Operations Graphs, Representation of Graphs, Depth First Search and Breadth First Search on Graphs, Applications of Graphs	9
4	Sorting and Hashing: Sorting Techniques – Selection Sort, Insertion Sort, Quick Sort, Merge Sort and Heap Sort Hashing- Hashing Techniques, Collision Resolution, Overflow handling, Hashing functions – Mid square, Division, Folding, Digit Analysis	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	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 od 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, Sartaj Sahni 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, 2005
2	Data Structures and Algorithms	Aho A. V., J. E. Hopcroft and J. D. Ullman	Pearson Publication	1/e. 1983
3	Introduction to Data Structures with Applications	Tremblay J. P. and P. G. Sorenson	Tata McGraw Hill	2/e, 1995
4	Advanced Data Structures	Peter Brass	Cambridge University Press	2/e, 2018
5	Theory and Problems of Data Structures	Lipschuts S.	Schaum’s Series	2/e, 2016

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 S5

SENSORS AND ACTUATORS

Course Code	**PEECT 523**	**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 on Sensors and Actuators typically 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 Flow Sensors, Electromagnetic Flow Sensors. 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 =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 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 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	Illustrate the working principles of smart sensors	**K2**
CO4	Explain 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	1/e, 2016
2	Mechatronic systems, Sensors and Actuators Fundamentals and Modelling	Robert H. Bishop	Taylor & Francis Group	3/e, 2022
3	Process Control Instrumentation Technology	Curtis D. Johnson	Pearson/Prentice Hall	8/e, 2019
4	Sensors and Transducers	D. Patranabis	PHI Learning	4/e, 2021

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

ARM ARCHITECTURE AND PROGRAMMING

Course Code	PEECT524	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)	Programming in C	**Course Type**	Theory

Course Objectives:

1. To introduce ARM Cortex M programming in assembly and C
2. To lay the foundation for practical embedded system design

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Embedded C: Fixed-width integer data types in C99, boolean type, mixing types, manipulating bits in memory and IO ports, accessing memory mapped IO using pointers, structures, packed structures, bit fields, casting address of an object, unions. [1] Ch. 4 Review of computer organization: Memory, CPU, IO, Introduction to Arm cortex M architecture: Internal organization-general purpose and special registers, instruction pipelining, memory model, bit banding, Arm assembly language instruction format and operands [1] Ch. 5	**9**
2	Arm assembly language programming: Loading constants into registers, loading memory data into registers, storing data from registers to memory, converting C assignment statements to assembly, memory address calculations, Memory addressing examples: translating C pointer expressions to assembly, translating C subscript expressions to assembly, translating structure references to assembly, Stack instructions, data processing instructions: updating flags in APSR, arithmetic instructions, bit	**9**

	manipulation instructions, shift instructions, bit field manipulation instructions [1] Ch. 6	
3	Control structures in assembly language: instruction sequencing, conditional branch instructions, translating if-then and if-then-else statements to assembly, compound conditionals, implementing loops, speeding up array access, Implementing functions: function call and return, register usage, parameter passing, return values, temporary variables, preserving registers [1] Ch. 7.	**9**
4	IO programming in assembly: Interrupts and exceptions, thread and handler modes, entering the exception handler, returning from exception handler, latency reduction techniques, priorities and nested exceptions, synchronization, transfer rate and latency, buffers and queues, double buffering, polled waiting loops, interrupt driven IO, DMA [1] Ch. 8. System initialization: Memory layout, cpu and vector table, C run-time environment, System Timer [1] Ch. 13	**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 =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 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	Use the features of C that are frequently used in embedded systems	**K3**
CO2	Explain a programmer's view of processor architecture	**K2**
CO3	Choose between programming at the level of assembly or C as appropriate	**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	3	2								
CO2	3	2	3	2								
CO3	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	Fundamentals of Embedded Software with the ARM Cortex M3	Daniel W Lewis	Pearson	2e, 2015

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors	Joseph Yiu	Elsevier	3e, 2014
2	Embedded systems with ARM Cortex M Microcontrollers in Assembly and C	Yifeng Zhu	E-man Press	3e, 2018

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/117/106/117106111/
2	https://archive.nptel.ac.in/courses/106/105/106105193/
3	https://onlinecourses.nptel.ac.in/noc22_cs93/preview

SEMESTER S5

HIGH SPEED DIGITAL DESIGN

Course Code	PEECT526	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 ELECTRONICS	Course Type	Theory

Course Objectives:

1. To understand the fundamentals of the effects of passive circuit elements on signal propagation in high speed digital circuits
2. To understand the high speed properties of logic gates and the measurement techniques at high frequencies
3. To analyse the effects of wiring, source, and load on the signal propagation from one end of a circuit to the other end
4. To design the power supply and clock distribution circuits for high speed devices,

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**High Speed Digital Design:** Fundamentals: Frequency and time, Time and distance, Lumped versus distributed systems, four kinds of reactance-ordinary capacitance and inductance, mutual capacitance and inductance, Relation of mutual capacitance and mutual inductance to cross talk.	9
2	**High Speed properties of Logic gates**: Power, Quiescent vs active dissipation, Active power driving a capacitive load, Active power due to overlapping bias currents, Input power, Speed, Packaging (Power dissipation analysis of only CMOS logic gates are required) **Measurement Techniques:** Rise time and bandwidth of oscilloscope probes, self inductance of probe ground loop, spurious signal pick up from probe ground loops, special probing fixtures, Avoiding pickup from probe shield currents, slowing down of a system clock, observing metastable states.	9

3	**Transmission Lines:** Problems of point to point wiring, signal distortion, EMI, cross talk. Infinite Uniform transmission line; ideal distortion less lossless transmission line, RC transmission line, Skin effect, Proximity effect, Dielectric loss. Effects of source and load impedance. Termination: End terminator, Source terminators, middle terminators, AC biasing for end terminators, Resistor selection, Cross talk in terminators.	**9**
4	**Power system:** Stable voltage reference, Uniform voltage distribution, distribution problems, choosing a bypass capacitor. **Clock Distribution**: Timing margin, Clock skew, Using low impedance drivers, using low impedance distribution lines, delay adjustments, Differential distribution, Clock signal duty cycle, Decoupling clock receivers from the clock bus. Clock Oscillators, Canned clock oscillator, Clock Jitter.	**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 =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 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 the fundamentals of the effects of passive circuit elements on signal propagation in high speed digital circuits	**K2**
CO2	Describe the high speed properties of logic gates and the measurement techniques at high frequencies	**K2**
CO3	Analyze the effects of wiring, source, and load on the signal propagation from one end of a circuit to the other end	**K3**
CO4	Design the power supply and clock distribution circuits for high speed 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	3									3
CO2	3	3	3									3
CO3	3	3	3									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	High Speed Digital Design: A Handbook of Black Magic	Howard Johnson & Martin Graham	Prentice Hall PTR,	Second Edition, 2008
2	Noise Reduction Techniques in Electronic Systems	Henry W. Ott	John Wiley & Sons	Second Edition, 1988

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	High-Speed Digital System Design—A Handbook of Interconnect Theory and Design Practices	Stephen H. Hall Garrett W. Hall James A. McCall	John Wiley & Sons	First Edition, 2000
2	Digital Systems Engineering	William S. Dally & John W. Poulton	Cambridge University Press,	First Edition, 1998
3	High Speed Digital Circuits	Masakazu Shoji	Addison Wesley Publishing Company	First Edition, 1996
4	Digital Integrated Circuits: A Design perspective,	Jan M, Rabaey	Pearson	Second Edition, 2003

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/108105375
2	https://nptel.ac.in/courses/108105375
3	https://nptel.ac.in/courses/108105375, https://nptel.ac.in/courses/108106069
4	https://nptel.ac.in/courses/108105375

SEMESTER S5

ESTIMATION AND DETECTION

Course Code	PEECT527	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 code)	Course Type	Theory

Course Objectives:

1. This course aims to impart the fundamentals of statistical signal processing theory in engineering applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Statistical Estimation Theory I** Fundamentals of estimation theory, the mathematical estimation problem, Minimum variance unbiased estimation, basics of Cramer-Rao Lower Bound, linear models, best linear unbiased estimation, application examples.	9
2	**Statistical Estimation Theory II** Maximum likelihood estimation, least squares, Bayesian philosophy, minimum mean square error estimation, application examples.	9
3	**Statistical Detection Theory I** Fundamentals of detection theory, the mathematical detection problem, Hypothesis testing, classical approach, Neyman-Pearson theorem, likelihood ratio test, receiver operating characteristics, Bayesian approach, minimum probability of error, Bayes risk, multiple hypothesis testing.	10
4	**Statistical Detection Theory II** Detection of deterministic signals, matched filters, detection of random signals, estimator-correlator, linear model, application examples.	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	Summarize the fundamentals of statistical estimation principles used in various engineering problems.	**K2**
CO2	Apply different types of estimation algorithms in engineering applications.	**K3**
CO3	Illustrate the fundamentals of statistical detection principles used in various engineering problems.	**K2**
CO4	Apply various types of statistical decision rules in engineering applications.	**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
CO2	3	3	3	3	3							2
CO3	3											2
CO4	3	3	3	3	3							2

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	“Fundamentals of Statistical Signal Processing” Vol I: Estimation Theory,	S.M. Kay,	Pearson,	3/e, 2010.
2	“Fundamentals of Statistical Signal Processing” Vol II: Detection Theory,	S.M. Kay,	Pearson,	3/e, 2010.

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Detection, Estimation, and Modulation Theory, Vol. I,	H. L. Van Trees	John Wiley & Sons	2/e, 2001
2	Statistical Digital Signal Processing and Modelling	Monson H. Hayes	John Wiley & Sons	2/e, 2018

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/117103018
2	https://nptel.ac.in/courses/117103018
3	https://nptel.ac.in/courses/117103018
4	https://nptel.ac.in/courses/117103018

SEMESTER S5

ARM ARCHITECTURE, PROGRAMMING AND INTERFACING

Course Code	PEECT525	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 ARM Cortex M programming in assembly and C
2. To lay the foundation for practical embedded system design

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Embedded C: Fixed-width integer data types in C99, boolean type, mixing types, manipulating bits in memory and IO ports, accessing memory mapped IO using pointers, structures, packed structures, bit fields, casting address of an object, unions. [1] Ch. 4 Review of computer organization: Memory, CPU, IO, Introduction to Arm cortex M architecture: Internal organization-general purpose and special registers, instruction pipelining, memory model, bit banding, Arm assembly language instruction format and operands [1] Ch. 5	9
2	Arm assembly language programming: Loading constants into registers, loading memory data into registers, storing data from registers to memory, converting C assignment statements to assembly, memory address calculations, Memory addressing examples: translating C pointer expressions to assembly, translating C subscript expressions to assembly, translating structure references to assembly, Stack instructions, data processing	9

	instructions: updating flags in APSR, arithmetic instructions, bit manipulation instructions, shift instructions, bit field manipulation instructions [1] Ch. 6	
3	Control structures in assembly language: instruction sequencing, conditional branch instructions, translating if-then and if-then-else statements to assembly, compound conditionals, implementing loops, speeding up array access, Implementing functions: function call and return, register usage, parameter passing, return values, temporary variables, preserving registers [1] Ch. 7.	**9**
4	IO programming in assembly: Interrupts and exceptions, thread and handler modes, entering the exception handler, returning from exception handler, latency reduction techniques, priorities and nested exceptions, synchronization, transfer rate and latency, buffers and queues, double buffering, polled waiting loops, interrupt driven IO, DMA [1] Ch. 8. System initialization: Memory layout, cpu and vector table, C run-time environment, System Timer [1] Ch. 13	**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

Interfacing experiments on Arm Microcontroller boards TM4C123G/ STM32 Nucleo

GPIO – push button, LED, keypad scan ([2] Ch. 14)

Toggling LED using timers ([2] Ch. 15)

Stepper motor control ([2] Ch. 16)

LCD interfacing ([2] Ch. 17)

ADC and DAC with DMA ([2] Ch. 19, 20, 21)
Serial Communication ([2] Ch. 22)

Course Project involving the design and implementation of an embedded system for a chosen application
Project phases: Proposal, Implementation, Testing, Final Report, Presentations and Viva Voce

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	Use the features of C that are frequently used in embedded systems	**K3**
CO2	Explain a programmer's view of processor architecture	**K2**
CO3	Choose between programming at the level of assembly or C as appropriate	**K3**
CO4	Analyze the interfacing of peripherals	**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
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	Fundamentals of Embedded Software with the ARM Cortex M3	Daniel W Lewis	Pearson	2e, 2015
2	Embedded systems with ARM Cortex M Microcontrollers in Assembly and C	Yifeng Zhu	E-man Press	3e, 2018

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors	Joseph Yiu	Elsevier	3e, 2014

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	Modern Embedded Systems Programming Course Quantum Leaps, LLC https://youtube.com/playlist?list=PLPW8O6W-1chwyTzI3BHwBLbGQoPFxPAPM&si=vmU66G3vMmQihUPk
2	Modern Embedded Systems Programming Course Quantum Leaps, LLC https://youtube.com/playlist?list=PLPW8O6W-1chwyTzI3BHwBLbGQoPFxPAPM&si=vmU66G3vMmQihUPk
3	Modern Embedded Systems Programming Course Quantum Leaps, LLC https://youtube.com/playlist?list=PLPW8O6W-1chwyTzI3BHwBLbGQoPFxPAPM&si=vmU66G3vMmQihUPk
4	Modern Embedded Systems Programming Course Quantum Leaps, LLC https://youtube.com/playlist?list=PLPW8O6W-1chwyTzI3BHwBLbGQoPFxPAPM&si=vmU66G3vMmQihUPk

SEMESTER S5

DIGITAL SIGNAL PROCESSING LAB

Course Code	PBECL507	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)	Signals & Systems, DSP	Course Type	Lab

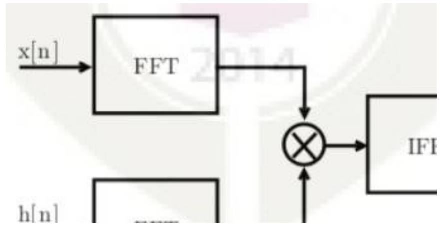
Course Objectives:

1. To realize the DFT, filtering techniques and familiarize DSP hardware
2. To implement Digital Filter.

Details of Experiment

Expt.	Experiment
1	**Simulation of Signals** Simulate the following signals using Python/ Scilab/MATLAB. 1. Unit impulse signal 2. Unit pulse signal 3. Unit ramp signal 4. Bipolar pulse 5. Triangular signal
2	**Verification of the Properties of DFT** 1. Generate a DFT matrix and apply it to an example sequence. 2. Write a function that returns the N point DFT matrix VN for a given N. 3. Plot its real and imaginary parts of VN as images using matshow or imshow commands (in Python) for N = 16, N = 64 and N = 1024 4. Compute the DFTs of 16 point, 64 point and 1024 point random sequences using the above matrices. 5. Observe the time of computations for N = 2σ for different values of σ. (You may use the time module in Python). 6. Use some iterations to plot the times of computation against x. Plot and understand this curve. Plot the computation times for the FFT function over this curve and observe the computational advantage of FFT. Circular Convolution. 1. Write a python function *circcon.py* that returns the circular convolution of an *N*1 point

	sequence and an $N2$ point sequence given at the input. The easiest way is to convert a linear convolution into circular convolution with $N = max(N1, N2)$. Parseval's Theorem Take two complex random sequences $x1[n]$ and $x2[n]$, and verify Parseval's Theorem.
3	**Familarization of DSP Hardware** 1. Familiarization of the code composer studio (in the case of TI hard- ware) or Visual DSP (in the case of Analog Devices hardware) or any equivalent cross-compiler for DSP programming. 2. Familiarization of the analog and digital input and output ports of the DSP board. 3. Generation and cross compilation and execution of the C code to connect the input digital switches to the output LEDs. 4. Generation and cross compilation and execution of the C code to connect the input analog port to the output. Connect a microphone, speak into it and observe the output electrical signal on a DSO and store it.
4	**Linear convolution** 1. Write a C function for the linear convolution of two arrays. 2. The arrays may be kept in different files and downloaded to the DSP hardware. 3. Store the result as a file and observe the output.
5	**FFT of signals** 1. Write a C function for N - point FFT. 2. Connect a precision signal generator and apply 1 mV, 1 kHz sinusoid at the analog port. 3. Apply the FFT on the input signal with appropriate window size and observe the result. 4. Connect microphone to the analog port and read in real time speech. 5. Observe and store the FFT values.
6	**IFFT with FFT** 1. Use the FFT function in the previous experiment to compute the IFFT of the input signal. 2. Apply IFFT on the stored FFT values from the previous experiments and observe the reconstruction.
7	**FIR low pass filter** 1. Use Python/scilab to implement the FIR filter response $h[n] = \omega c\ n)/\pi$ for a filter size $N = 50$, $\omega c = 0.1\pi$ and $\omega c = 0.3\pi$. 2. Realize the hamming ($wH\ [n]$) and kaiser ($wK[n]$) windows. 3. Compute $h[n]w[n]$ in both cases and store as file. 4. Observe the low pass response in the simulator. 5. Download the filter on to the DSP target board and test with 1 mV sinusoid from a signal generator connected to the analog port.

	6. Test the operation of the filters with speech signals.
8	**Overlap Save Block Convolution** 1. Use the file of filter coefficients from the previous experiment. 2. Realize the system shown below for the input speech signal $x[n]$.  3. Segment the signal values into blocks of length $N = 2000$. Pad the last block with zeros, if necessary. 4. Implement the *overlap save* block convolution method
9	**9. Overlap Add Block Convolution** 1. Use the file of filter coefficients from the previous experiment. 2. Realize the system shown in the previous experiment for the input speech signal $x[n]$. 3. Segment the signal values into blocks of length $N = 2000$. Pad the last block with zeros, if necessary. 4. Implement the *overlap add* block convolution method.

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	Generate basic signal waveforms	**K2**
CO2	Verify the properties of DFT	**K2**
CO3	Familiarize with DSP hardware and interface with Computer	**K2**
CO4	Implement LTI systems	**K3**
CO5	Design and Implement FIR low-pass filters	**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	1	2	3							1
CO2	3	3	1	3	3							1
CO3	3	2	3	3	3							1
CO4	3	3	2	3	3							1
CO5	3	3	3	2	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 using Matlab	Vinay K. Ingle, John G. Proakis	Cengage Learning	3rd Ed., 2011
2	Think DSP: Digital Signal Processing using Python	Allen B. Downey	Green Tea Press	1st Ed. 2019
3	DSP applications using C and the TMS320C6x DSK	Chassaing, Rulph	Wiley & Sons	2/e. 2008

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Discrete-Time Signal Processing	Alan V Oppenheim, Ronald W. Schafer	Pearson Education	4th Ed.,2018

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://www.youtube.com/watch?v=6dFnpz_AEyA
2	https://onlinecourses.nptel.ac.in/noc21_ee20/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

COMMUNICATION LAB I

Course Code	PCECL508	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)	Analog circuits, Signals and systems, Digital Signal Processing	Course Type	Lab

Course Objectives:

1. Understanding and Implementing Modulation and Detection Techniques
2. Analyzing and Evaluating Communication System Performance.

Details of Experiment

Expt. No	Experiment
	PART A: Hardware Experiments
1	**Any one from the following Analog modulation schemes** ● AM modulation and detection using Transistors or ICS ● FM modulation and detection
2	**Hardware Experiment: Any one from the following Digital modulation & Waveform coding Schemes** ● Generation and Detection of PCM signals ● Generation and Detection of Delta modulated signals ● Generation and Detection of BPSK ● Generation and Detection of QPSK
	PART B: Simulation Experiments
1.	Performance of Waveform Coding Using PCM

2.	Pulse Shaping and Matched Filtering
3.	Eye diagram
4.	Error Performance of BPSK
5.	Error Performance of QPSK
	PART C: Software Defined Radio
1.	Familiarization with Software Defined Radio (Hardware and Control Software)
2.	FM reception or FM transmission using SDR

Experiment Details

PART A: Hardware Experiments

The students shall design and setup simple prototype circuits with the help of available ICs. They can observe waveforms produced by these circuits for standard ideal inputs

PART B: Simulation Experiments

The students shall write scripts to simulate components of communication systems for the following experiments.

Performance of Waveform Coding Using PCM

1. Generate a sinusoidal waveform with a DC offset so that it takes only
2. positive amplitude value.
3. Sample and quantize the signal using a uniform quantizer with number of
4. representation levels L. Vary L. Represent each value using decimal to
5. binary encoder.
6. Compute the signal-to-noise ratio in dB.
7. Plot the SNR versus number of bits per symbol. Observe that the SNR
8. increases linearly

Pulse Shaping and Matched Filtering

1. Generate a string of message bits.
2. Use Root Raised Cosine (RRC) pulse p(t) as the shaping pulse, and generate the

3. corresponding baseband signal with a fixed bit duration Tb. You may use roll-off factor as α = 0.4. Vary the roll off rate and study.
4. Simulate transmission of baseband signal via an AWGN channel
5. Apply matched filter with frequency response Pr(f) =P*(f) to the received signal.
6. Sample the signal at mTb and compare it against the message sequence.

Eye diagram

1. Generate a string of message bits.
2. Use raised cosine pulse p(t) as the shaping pulse, and generate the corresponding baseband signal with a fixed bit duration Tb You may use roll-off factor as α= 0.4
3. Use various roll off factors and plot the eye diagram in each case for the received signal. Make a comparison study among them.

Error Performance of BPSK

1. Generate a string of message bits.
2. Encode using BPSK with energy per bit Eb and represent it using points in a signal-space.
3. Simulate transmission of the BPSK modulated signal via an AWGN channel with variance No/2.
4. Detect using an ML, decoder and plot the probability of error as a function of SNR per bit Eb/No.

Error Performance of QPSK

1. Generate a string of message bits.
2. Encode using QPSK with energy per symbol E_b and represent it using points in a signal-space.
3. Simulate transmission of the QPSK modulated signal via an AWGN channel with variance No/2 in both I-channel and Q-channel.
4. Detect using an ML decoder and plot the probability of error as a function of SNR per bit E_b/N_0 where $E_s=2E_b$

PART C: Software Defined Radio

The students shall emulate communication systems with the help of software-defined-radio hardware and necessary control software. Use available blocks in GNU Radio (or similar software's like Simulink/ Lab- View) to implement all the signal processing.

Familiarization with Software Defined Radio (Hardware and Control Software)

1. Familiarize with an SDR hardware for reception and transmission of RF signal
2. Familiarize how it can be interfaced with computer
3. Familiarize with GNU Radio (or similar software's like Simulink/ Lab- View) that can be used to process the signals received through the SDR hardware.
4. Familiarize available blocks in GNU radio. Study how signals can be generated and spectrum (or power spectral density) of signals can be analyzed. Study how filtering can be performed.

FM reception using SDR

1. Receive digitized FM signal (for the clearest channel in the lab) using the SDR board.
2. Set up an LPF and FM receiver using GNU Radio.
3. Use appropriate sink in GNU Radio to display the spectrum of signal.
4. Resample the voice to make it suitable for playing on computer speaker. or playing on compute

FM transmission using SDR

1. Use a wave file source.
2. Set up an FM transmitter using GNU Radio.
3. Resample the voice source and transmit using the SDR.

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	Setup simple prototype circuits for waveform coding and digital modulation techniques working in a team.	**K3**
CO2	Simulate the error performance of a digital communication system using standard binary and M-ary modulation schemes.	**K4**
CO3	Develop hands-on skills to emulate a communication system with software-designed-radio working in a team.	**K5**

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	3	-	-	-	3	2	-	1
CO2	3	3	3	2	3	-	-	-	-	-	-	1
CO3	3	3	3	3	3	-	-	-	3	2	-	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	The Hobbyist's Guide to the RTL-SDR: Really Cheap Software Defined Radio	Carl Laufer	CreateSpace Independent Publishing Platform	2nd Edition, 2015
2	Principles of Communication Systems Simulation with Wireless Applications	WH Tranter, KS Shanmugan, TS Rappaport, KL Kosbar	Prentice Hall	2nd Edition, 2006
3	Digital Modulations using Python	Mathuranathan Viswanathan, "	Independently Published	1st Edition, 2019

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Communication Systems	Simon Haykin and Michael Moher	Wiley	5th Edition, 2020
2	Modern Digital and Analog Communication Systems	B.P. Lathi and Zhi Ding	Oxford University Press	5th Edition, 2018
3	Introduction to Analog and Digital Communication	Simon Haykin and Michael Moher	Wiley	2nd Edition, 2006
4	Electronic communication systems	George Kennedy	McGraw Hil	6th Edition, 2017

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	Neel Pandeya, "Implementation of a Simple FM Receiver in GNU Ra- dio," https://kb.ettus.com/
2	Michael Ossmann, "Software Defined Radio with HackRF," YouTube Tutorial, https://www.youtube.com/watch?v=BeeSN14JUYU
3	Nptel videos on Software Defined radio, https://www.youtube.com/watch?v=0KQWPFwFByU
4	Experimenting with software defined radio, https://www.youtube.com/watch?v=tx5xofG2Fxg

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 & COMMUNICATION ENGINEERING

SEMESTER S6

ADVANCED COMMUNICATION THEORY

Course Code	PCECT 601	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)	ADC (PCECT 502)	Course Type	Theory

Course Objectives:

1. To impart basics of information theory introducing both source coding and channel coding.
2. To impart the basic concepts of wireless communication system.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Entropy: Entropy, Properties of Entropy, Joint and Conditional Entropy, Mutual Information, Properties of Mutual Information Discrete memoryless sources, Source code, Average length of source code, Bounds on average length, uniquely decodable and prefix-free source codes. Kraft Inequality (with proof) Shannon's source coding theorem (both achievability and converse), Huffman code, operational meaning of entropy. Channel capacity, Capacity of discrete memoryless channels, Binary symmetric channels (BSC), Binary Erasure channels (BEC). Capacity of BSC and BEC, Shannon's channel coding theorem	11
2	Channel Capacity of AWGN Channel: Differential entropy, Differential Entropy of Gaussian random variable, Shannon-Hartley theorem (with proof), Shannon limit Block codes: Error detecting and correcting capability. Linear block codes. Generator and parity-check matrix. (Systematic form only). Encoding circuit, Maximum likelihood decoding of linear block codes.	11

	Bounded distance decoding. Syndrome, Standard array decoding. Convolutional Codes. State diagram. Trellis diagram. Maximum likelihood decoding. Viterbi algorithm.	
3	Introduction to Wireless Communication: - Introduction, Evolution, Paging. Wireless LAN, Bluetooth, Zig-Bee and Personal Area networks. Broadband Wireless Access-WiMax Technology. Wireless Spectrum allocation, Standards. Cellular System Design Fundamentals: Frequency Reuse, channel assignment strategies, Handoff strategies, Interference and system capacity, trunking and grade off service, improving coverage and capacity – cell splitting, sectoring, microcells Introduction to Multiple Access techniques: FDMA, TDMA, Code-Division Multiple Access (CDMA), Orthogonal Frequency-Division Multiple Access (OFDMA)	**11**
4	Path loss and shadowing: Free space path loss, Two-Ray model, Shadowing Statistical Multipath Channel Models: Time-varying channel impulse response (Analysis not required) , Narrowband fading, Wideband fading models, Delay spread and Coherence bandwidth, Doppler spread and Coherence time, Flat fading versus frequency selective fading, Slow fading versus fast fading Multi-carrier Modulation: Data transmission using multicarrier modulation for frequency-selective fading channels, overlapping subchannels, Mitigation of Subcarrier Fading, Discrete Implementation of multicarrier – OFDM Diversity: Receiver diversity – selection combining and maximal ratio combining. Transmitter diversity – Alamouti scheme for 2x2 MIMO. Equalization: Equalization – Linear and non-linear equalization, MMSE equalizers.	**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 =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 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 information theory measures such as entropy, conditional entropy, mutual information	**K2**
CO2	Apply source coding theorem for data compression.	**K3**
CO3	Apply channel coding for error detection and correction	**K3**
CO4	Explain the basic Principle of wireless communication techniques	**K2**
CO5	Describe the wireless channel models and analyse the performance of the modulation techniques for flat fading channels	**K2**
CO6	Identify the advantages of various diversity and equalization techniques for improving the wireless receiver performance .	**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	2	2									2
CO2	3	2	2									2
CO3	3	2	2									2
CO4	3	2	2									2
CO5	3	2	2									2
CO6	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	Wireless Communications	Andrea Goldsmith	Cambridge University Press	1/e, 2005
2	Wireless communication: Principles and Practice	Theodore S. Rappaport	Pearson Education	2/e, 2022
3	Elements of Information Theory	Joy A Thomas, Thomas M Cover	Wiley-Interscience	2/e 2006
4	Communication Systems	Simon Haykin	John Wiley and Sons Inc	4e, 2020

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Fundamentals of Wireless Communication	David Tse and Pramod Viswanath	Cambridge University Press	1st Edition 2005
2	Mobile Communications	Jochen Schiller	Pearson	2nd Edition 2008
3	Wireless Communications	Andreas F Molish	Wiley India Publications	2nd Edition 2013
4	Principles of Mobile Communication	Gordon L. Stuber	Springer	4th Edition 2017
5	Error Control Coding : Fundamentals and Applications	Shu Lin & Daniel J. Costello. Jr.	Prentice Hall Inc	2nd Edition 2011
6	Digital Communication Systems, An Indian Adaptation	Simon Haykin	Wiley India	1/e. 2021

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/117101053
2	https://nptel.ac.in/courses/117101053
3	https://onlinecourses.nptel.ac.in/noc21_ee66/preview
4	https://onlinecourses.nptel.ac.in/noc21_ee66/preview

SEMESTER S6

MICROWAVES & ANTENNAS

Course Code	**PCECT602**	**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)	Electromagnetics (PCECT501)	**Course Type**	Theory

Course Objectives:

1. To gain knowledge on the basic parameters, types and design of antennas
2. To gain an insight into the principles of operations of microwave sources, hybrid circuits and semiconductor devices.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Microwaves:** Electromagnetic spectrum, Frequency Bands, Features of microwaves, advantages & disadvantages, Applications, Atmospheric propagation effects. **Cavity Resonator**: TE and TM modes in waveguides (Review only)- Rectangular Cavity Resonator- Resonance frequency, Q factor, Excitation and Tuning, Re-entrant cavity. **Microwave Hybrid Circuits:** E plane Tee, H plane Tee, Hybrid Tee, Hybrid Ring, Two-hole directional coupler, Isolator, Circulator, Phase shifter, Attenuator **Scattering parameters**: Properties of S matrix, S matrix formulation of E plane Tee, H plane Tee, Magic Tee, Directional coupler. **Microwave Semiconductor Devices**: Principle of operation of Tunnel diode, Gunn diode- Different modes.	**9**
2	**Microwave tubes:** Types, Structure and Principles of operation of Two Cavity Klystron- Velocity Modulation, Bunching	**9**

	Reflex Klystron- Velocity Modulation, Power output and efficiency Traveling Wave Tube Amplifier- Slow wave structures, Helix TWT amplification process. Magnetron Oscillator- Cylindrical magnetron, Cyclotron angular frequency, **Microwave measurements:** Measurement of Power, VSWR, frequency, wavelength, insertion loss, impedance and attenuation; Basic concept of Network Analyzer and Anechoic chamber	
3	**Antennas**: Definition, Radiation mechanism, Polarisation, Types, Applications **Basic antenna parameters**: Radiation Pattern, Radiation Power Density, Radiation Intensity, Radiation resistance, Beamwidth, Directivity, Antenna Efficiency, Gain, Beam Efficiency, Bandwidth, Input Impedance, Antenna Radiation Efficiency, Effective aperture area, Effective height, Antenna noise temperature Reciprocity theorem, Helmholtz theorem, Duality Theorem (No proof required) Field, directivity and radiation resistance of a short dipole and half wave dipole (far field derivation).	**9**
4	**Antenna arrays**: Field of two isotropic point sources, Principle of pattern multiplication, Array factor, Linear arrays of 'n' isotropic point sources with equal amplitude, Grating lobes, Design of Broadside and End fire arrays, Phased array principle, Adaptive antenna array principle. **Broad band antennas**: Log periodic antenna array – Principle and design equations Helical antenna: Design equations, modes Micro strip Rectangular Patch Antennas -Design equations, important feeding methods. Horn antenna- Types, principles, expressions for E, H and gain (no derivation required) Parabolic dish antenna –Principle, Cassegrain feed, expression for E, H and Gain without derivation, Mobile phone antenna – Inverted F antenna.	**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 =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 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 mechanism of operation of cavity resonator and microwave sources	**K2**
CO2	Apply the S parameter theory to obtain the S matrices of various microwave hybrid circuits	**K3**
CO3	Illustrate the basic concepts of antenna radiation antenna parameters and their measurement techniques	**K2**
CO4	Design important broadband antennas and arrays	**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											2
CO2	3	3	3	2	2							2
CO3	3			2	2	1						2
CO4	3	3	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	Microwave Engineering,	Annapurna Das and Sisir K Das	McGraw Hill	4^{th} edition
2	Microwave Devices & Circuits,	Samuel Y Liao,	Pearson Education	3^{rd} edition
3	Antennas for all Applications,	John D. Krauss,Marhefka,Khan	Tata McGraw Hill	4^{th} edition
4	Antennas and Wave Propagation	G S N Raju	Pearson Education	3^{rd} edition

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Electromagnetic Waves and Radiating Systems	Jordan and Balmain, E	Pearson Education	2^{nd} edition
2	Concepts & Applications of Microwave Engineering	Sanjay Kumar Saurabh Shukla	PHI	2014
3	Microwave Engineering	R.S.Rao	PHI	2nd edition 2015
4	Antennas and Wave Propagation	R L yadava	PHI	2^{nd} edition
5	Microwave Engineering: Fundamentals, Design and Applications	Subal Kar	Universities press	2022

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://youtu.be/I2OxOOmE0h8
2	https://youtu.be/NW1NXoM4q5c
3	https://youtu.be/h51mFbIgZRI
4	https://youtu.be/t-AP3ya8Pao

SEMESTER S6

COMPUTER NETWORKS

Course Code	PEECT 631	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 code)	Course Type	Theory

Course Objectives:

1. The course aims to expose students to computer networks taking a top-down approach of viewing from the layer of user applications and zooming into link layer protocols. The principles of various protocols used in every layer are studied in detail.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Computer Networks** Components of computer networks. Transmission modes in computer communication. Switching: circuit switching and packet switching. Performance analysis of packet switched network: Throughput analysis, Delay and loss in packet-switched networks, Types of delay, Packet loss. Introduction to Queueing models in computer networks. Littles theorem. Networks: Network criteria, physical structures, network models, categories of networks, Interconnection of Networks. Layered Architecture: Protocol layering, Internet protocol stack. TCP/IP protocol suite.	9
2	**Application Layer:** Communication between processes, Web application: HTTP, Message format, Email application: SMTP, Message format, MIME, POP3, Domain Name System (DNS).	9

	Transport Layer connectionless and connection-oriented protocols. UDP- Protocols for reliable data transfer: ARQ protocols, stop-and-wait protocol, alternating-bit protocol, Go-back- N, Selective Repeat. TCP Connection, segment structure, RTT estimate, Flow control. **Congestion Control** General approaches. TCP congestion control. Congestion control mechanisms and Quality of service.	
3	**Network Layer:** Datagram versus virtual-circuit network service, Router architecture, Routing and Forwarding, Static routing and Dynamic routing. Address Resolution protocols (ARP, RARP) Subnetting, Classless Routing(CIDR), ICMP. **IPv4:** Datagram format, Fragmentation and reassembly, addressing, address assignment – manual and DHCP. IPv6- Datagram format, Transitioning from IPv4 to IPv6, IP security. **Routing Algorithms** Link-State (Dijkstra's) Algorithm, Distance vector algorithm. Routing in Internet – RIP, OSPF, BGP.	**10**
4	**Link Layer** Services of link layer**,** Error detection and correction – checksum, CRC. Multiple access protocols – Channel partitioning, random access. ALOHA – pure and slotted, efficiency, CSMA, CSMA/CA, CSMA/CD. Link layer addressing: MAC address, Ethernet. Wireless Networks IEEE 802.11 wireless LAN. **Physical Layer**: Guided and unguided transmission media (Co-axial cable, UTP, STP, Fiber optic cable)	**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	Summarize the principles and components of computer networks, switching, basic concepts of delay analysis and the layered network architecture.	**K2**
CO2	Demonstrate protocols and the functions of different layers.	**K2**
CO3	Analyse the concept of routing and addressing protocols in the context of computer networking.	**K3**
CO4	Make use of different physical communication standards in computer networks.	**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
CO2	3					-	-	-	-	-	-	2
CO3	3	2	2	2	2	-	-	-	-	-		3
CO4	3	2	2	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	Computer Networking: A Top-Down Approach Featuring the Internet.	James F. Kurose, Keith W. Ross,	Pearson	Sixth Edition, 2017
2	Data Communications and Networking	Behrouz A Forouzan	Tata McGraw-Hill	Fourth Edition , 2008

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, Bruce S. Davie,	Elsevier,	2012
2	Communication Networking – An Analytical Approach,	A. Kumar, D. Manjunath, J. Kuri,	Morgan Kauffman Series	2004
3	Computer Networks	A. S. Tanenbaum, D. J. Wetherall	Pearson	Fifth
4	Data Networks	D. Bertsekas, RG Gallager	Pearson	2nd

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc22_cs19/preview
2	https://archive.nptel.ac.in/courses/106/105/106105183/
3	https://onlinecourses.swayam2.ac.in/cec21_cs04/preview

SEMESTER S6

DIGITAL IMAGE PROCESSING

Course Code	**PEECT 632**	**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 code)	**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 Filters, Sharpening spatial Filters.	**9**

	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	Explain 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	Analyze the filtering and restoration of images	**K3**
CO5	Describe the basic image segmentation techniques	**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	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	4TH
2	Digital Image Processing	S Jayaraman, S Esakkirajan, T Veerakumar	McGraw Hill	Ist

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://onlinecourses.nptel.ac.in/noc24_ee133/preview
2	https://nptel.ac.in/courses/117105135
3	https://www.youtube.com/watch?v=KiJo4-IijL4
4	https://archive.nptel.ac.in/courses/117/105/117105135/

SEMESTER S6

SECURE COMMUNICATION

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

Course Objectives:

1. Understand and discuss the fundamental concepts of encryption
2. Provide insight into different types of encryption standards
3. Understand basic concepts of Cryptography

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction and Classic Encryption Techniques:-OSI security architecture, Security attacks – Passive attacks, Active attacks, Security services-Authentication, Access Control, Data Confidentiality, Data integrity, Nonrepudiation, Availability service. Model for network security. Symmetric cipher model, Cryptography, Substitution techniques- Hill Cipher, Transposition Techniques. Finite Fields: -Groups, Rings and Fields, Modular arithmetic, Euclidian algorithm, Finite Fields of the form GF(p), Polynomial arithmetic	9
2	Block Ciphers: - Data Encryption Standard, Block Cipher Principles – Stream Ciphers and Block Ciphers, Feistel Cipher, Feistel Decryption algorithm, The Data encryption standard, DES Decryption, The AES Cipher, substitute bytes transformation, Shift row transformation, Mix Column transformation.	9
3	Public Key Cryptography: -RSA and Key Management, Principles of public key cryptosystems-Public key cryptosystems, Application for Public key cryptosystem requirements, Fermat's theorem, Euler's Totient Function,	

	Euler's theorem, RSA algorithm, Key management, Distribution of public keys, Publicly available directory, Public key authority, public key certificates, Distribution of secret keys using public key cryptography.	**9**
4	Message Authentication and Hash Function: - Authentication requirements, Authentication functions- Message Encryption, Public Key Encryption, Message Authentication Code, Hash function	**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 network security services and mechanisms and the types of attacks they are designed for and apply the concepts of modular arithmetic, Euclidean algorithm, polynomial arithmetic.	**K3**
CO2	Illustrate the principles of modern symmetric ciphers like Data Encryption Standard and Advanced Encryption Standard.	**K3**
CO3	Outline the concepts of public key cryptography, RSA algorithm, key distribution, and management for public key systems.	**K2**
CO4	Explain the requirements for authentication and the types of functions used to produce an authenticator	**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										2
CO2	3	3										2
CO3	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	Cryptography and Network security: principles and practice	William Stallings	Prentice Hall of India	4^{th} Edition, 2006

Reference 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	Tata McGraw-Hill	2008
2	Abstract Algebra	David S. Dummit & Richard M Foote	Wiley India Pvt. Ltd	2nd Edition, 2008.
3	Cryptography, Theory and Practice	Douglas A. Stinson,	Chapman & Hall CRC Press Company	2nd Edition, 2005.
4	Elliptic Curves: Theory and Cryptography	Lawrence C. Washington	Chapman & Hall, CRCPress Company, Washington	2008
5	A course in Number theory and Cryptography	N. Koeblitz		2008
6	Elementary Number Theory with Applications	Thomas Koshy	Academic Press	2nd Edition, 2007
7	Cryptography and network security	Tyagi and Yadav	Dhanpat Rai & Co	2012

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc21_cs91/preview
2	https://nptel.ac.in/courses/108102117
3	https://onlinecourses.nptel.ac.in/noc22_cs90/preview

SEMESTER S6

NANOELECTRONICS

Course Code	**PEECT634**	**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 code)	**Course Type**	Theory

Course Objectives:

1. To understand the challenges of scaling of devices to Nano-meter scales
2. To design novel transistor devices to reduce the short channel effects and to improve the performance
3. To understand the Nano-scale quantum transport in Nano electronic devices from atom to transistor
4. 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 Nano electronic systems, characteristic lengths **Scaling and short channel effects-**Channel length, Oxide layer thickness, tunneling, power density, non-uniform dopant concentration, threshold voltage scaling, hot electron effects, sub threshold current, velocity saturation, DIBL, channel length modulation. **High-K gate dielectrics-** Effective oxide thickness, Effects of high-K gate dielectrics on MOSFET performance (Text books 1,2,3)	**9**
2	**Novel MOS Devices and Performance Optimization** **Silicon-on-insulator devices--**FD SOI, PD SOI	

	Multiple gate MOSFETs--Double gate MOSFETs, FinFETs, Nanowires-Multi gate MOSFET physics-natural length and short channel effects. **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, Poly silicon Gate, Metal Gate, Tunable Work function metal gate, Mobility and Strain Engineering, Nitride Stress Liners, Embedded SiGe and SiC Source and Drain, Local Strain from Gate Electrode, Substrate Strain, Strained Silicon on Insulator. (Text books 1,4)	**9**
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. (Text books 3,5,6. Use MATLAB codes in the text book "Quantum transport atom to transistor" to illustrate the concepts)	**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, Applications of tunneling. **Hetero junctions** -Modulation-doped hetero junctions- SiGe strained hetero structures- MODFET- Resonant tunnelling-Resonant tunnelling 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 (Text books 3,6)	**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	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 S6

OPTICAL COMMUNICATION

Course Code	PEECT636	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)	PHYSICS	Course Type	Theory

Course Objectives:

1. To introduce the concepts of light transmission through optical fibers
2. To introduce the working of optical components and its usage in optical communication systems

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Optical fiber Communications:** Structure of Optical fiber**,** materials, General block diagram of optical communication system, Advantages. **Optical fiber waveguides:** Principle of light guidance, Numerical Aperture, V number, Step and Graded index fibers, Single and Multi mode fibers. **Transmission Characteristics:** Attenuation, Absorption losses, Linear and Non linear scattering losses, bend losses. Dispersion- Intermodal dispersion, Chromatic dispersion, Dispersion modified fibers, Photonic crystal fibers, Polarization mode dispersion, Nonlinear effects, Solitons.	**9**
2	**Optical fibers and Cables** – Fabrication Techniques- Double crucible method, Outside Vapour phase oxidation, Modified Chemical Vapour Deposition. Optical Fiber Cables- Single and Multi fiber cables. **Optical Fiber Connections:** splices, connectors & couplers. **Optical Fiber Measurements:-** Attenuation and dispersion measurements**,** MZ interferometer, Optical Time Domain Reflectometer – Applications	**9**
3	**Optical sources:** LEDs and LDs, general structures, characteristics**,** modulators using LEDs and LDs. coupling with fibres, **Optical detectors:** Quantum efficiency and Responsivity, Structure and	**9**

	working of PIN and APD **Optical Receivers: -** Direct detection- noise in detectors, SNR, BER analysis Coherent detection principles. **Optical Amplifiers:** EDFA - Principle, structure and working, Raman amplifiers	
4	**Multiplexing Strategies:** OTDM, SCM, OFDM, WDM and Optical CDMA: concepts, components - couplers, splitters, Add/ Drop multiplexers, Fiber grating filters, tunable filters. **Optical networks** – General description of SONET/SDH **Free space optics:** Principle of LiFi technology. Visible Light Communication **Other applications of optical fibers**: Entertainment, Sensors – Types & principles	**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 structure, fabrication, principle of operation and classifications of optical fibers	**K2**
CO2	Describe the transmission characteristics and evaluate losses in optical fiber	**K2**
CO3	Illustrate the working of sources, detectors and optical amplifiers used in optical communication system	**K2**
CO4	Explainthe concepts of Multiplexing, Optical Networks and Free Space Communication	**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									1
CO2	3	3	2	2	1							1
CO3	3	1	2	1	1							1
CO4	3	1	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	Optical Fiber Communications	Gerd Keiser	McGraw Hill	5th/e, 2021
2	Optical Fiber Communication: Principles and Practice	John M Senior	Pearson Education	3rd/e, 2014
3	Fibre Optic Communications	Joseph C. Palais	Pearson Education	5th/e, 2013
4	Fibre optic Communication: Systems and Components	Mishra and Ugale,	Wiley	2019
5	Fibre Optic Communications Systems	G P Agrawal	WILEY	4^{th} Ed

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Fibre Optic Communication: Optical Waveguides, Devices and Applications	Sanjeev Kumar Raghuwanshi	University Press	2015
2	Optical Communication	M Mukunda Rao	University Press	2000

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://www.youtube.com/watch?v=ougKUUM3hJA
2	https://www.digimat.in/nptel/courses/video/117104127/L01.html
3	https://www.youtube.com/watch?v=seHmi6AMWy4
4	https://www.youtube.com/watch?v=4W7hieXDAmc

SEMESTER S6

OPTIMIZATION TECHNIQUES

Course Code	PEECT637	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 code)	**Course Type**	Theory

Course Objectives:

1. Enable the learner to formulate engineering minima/maxima problems as optimization problems
2. Enable the learner to deploy various constrained and unconstrained optimization algorithms to obtain the minima/maxima of engineering problems

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Engineering application of Optimization – Statement of an Optimization problem–Classification, Review of basic calculus concepts –Stationary points; Functions of single and two variables; Convexity and concavity of functions –Definition of Global and Local optima – Optimality criteria, Linear programming methods for optimum design – Standard form of linear programming (LP) problem; Canonical form of LP problem; Simplex Method, Duality, Application of LPP models in engineering	**9**
2	Optimization algorithms for solving unconstrained nonlinear optimization problems – Search based techniques: Direct search: Fibonacci and golden section search , Hookes and Jeeves , Gradient based method: Newton's method	**9**
3	Optimization algorithms for solving constrained optimization problems– direct methods – penalty function methods, barrier method -Optimization of function of multiple variables subject to equality constraints; Lagrangian function– Inequality constrained techniques-KKT conditions-constrained	**9**

	steepest descent method	
4	Modern methods of Optimization– Metaheuristic techniques: Genetic Algorithms – Simulated Annealing – Particle Swarm optimization –Ant colony optimization– : Use of Matlab/Scilab to solve optimization problem	**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	Formulate an optimization problem to optimize an engineering application using the principles of basic calculus.	**K2**
CO2	Apply the Simplex method to solve a linear programming problem	**K3**
CO3	Solve the unconstrained optimization problems using gradient based method.	**K3**
CO4	Apply the various optimization techniques to solve a constrained optimization problem	**K3**
CO5	Use metaheuristic algorithms to solve constrained and unconstrained optimization problems	**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									2
CO2	3	3	3									2
CO3	3	2	3									2
CO4	3	2	3									2
CO5	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	Engineering Optimization, Theory and Practice	S.S RAO	New Age International Publishers	4th Edition ,2012

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Optimization Techniques and Applications with Examples	Xin-She Yang	John Wiley & Sons	2018
2	Optimization for Engineering Design Algorithms and Examples	Deb K	Prentice Hall India	2000
3	Introduction to Optimization Design	Arora J	Elsevier Academic Press, New Delhi	2004
4	Linear Programming	Hardley G	Narosa Book Distributors Private Ltd	2002
5	Genetic Algorithms and engineering optimization	Mitsuo Gen, Runwei Cheng	John Wiley & Sons	2002
6	An introduction to optimization	Edwin KP Chong, Stanislaw, H Hak	John Wiley & Sons	Fourth Edition, 2013

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	NPTEL https://www.youtube.com/watch?v=a2QgdDk4Xjw
2	NPTEL https://www.youtube.com/watch?v=dPQKltPBLfc
3	NPTEL https://www.youtube.com/watch?v=qY-gKL7GxYk
4	NPTEL https://www.youtube.com/watch?v=Z_8MpZeMdD4 https://www.youtube.com/watch?v=FKBgCpJlX48

SEMESTER S6

IMAGE PROCESSING APPLICATIONS

Course Code	PEECT 635	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	5/3	Exam Hours	2Hrs. 30 Min.
Prerequisites (if any)	PBECT504 Digital Signal Processing	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.
4. To apply the principles of image processing techniques in real life images.

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 Filters, Sharpening spatial Filters. Frequency domain methods: low pass filtering, high pass filtering, homomorphic filtering.	**9**
4	Image Restoration: Degradation model, Inverse filtering- removal of blur caused by uniform linear motion, Minimum Mean Square Error (Wiener) Filtering. Constrained Least square filtering, geometric mean 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	Internal Ex	Evaluate	Analyse	Total
5	15	10	10	40

Criteria for Evaluation (Evaluate and Analyse): 20 marks

Students should analyze real world image processing problems and implement using Matlab or any other programming language.

Evaluation Methods:

1. Experiments using software tools: (10 marks)

2. Course Project applying the principles of image processing techniques:(10 marks)

Project phases: Proposal, Implementation, Testing, Final Report, Presentations and Viva Voce:

The following topics may be identified for project.

1. Illustration of different colour image models and its application.

2. Implementation of image transforms and compression algorithms

3. Examine different spatial and frequency domain filtering techniques on real world example images.

4. Implement image restoration techniques, adjust parameters, and evaluate results qualitatively and quantitatively

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	Compare different colour model representations of image processing system	**K4**
CO2	Analyse the various concepts and mathematical transforms and compression schemes necessary for image processing	**K4**
CO3	Illustrate the various schemes of image filtering	**K5**
CO4	Determine the techniques for restoration of images	**K5**

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	Digital Image Processing	Gonzalez Rafel C	Pearson Education	2009
2	Digital Image Processing	S Jayaraman, S Esakkirajan, T Veerakumar	Tata Mc Graw Hill	2015

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://nptel.ac.in/courses/117105079 https://nptel.ac.in/courses/117104069
2	same as above
3	same as above
4	same as above

SEMESTER S6

VLSI CIRCUIT DESIGN

Course Code	**PBECT604**	**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)	PCECT302 Solid State Devices, PCECT303 Analog Circuits, PBECT304 Logic Circuit Design	**Course Type**	Theory

Course Objectives:

1. To provide a comprehensive understanding of VLSI design methodologies, including ASIC types, SoCs and FPGA devices, design flows, methodologies.
2. To provide a comprehensive understanding of VLSI fabrication techniques.
3. To provide a solid foundation in static CMOS logic design and analysis, layout design and the application of design rules in layout design.
4. To cover dynamic logic design principles and the design and operation of storage cells.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**VLSI Design Methodologies**: Introduction, Moore's law, ASIC design, Full custom ASICs, Standard cell based ASICs, Gate array based ASICs, SoCs, FPGA devices, ASIC and FPGA Design flows, Top-Down and Bottom-Up design methodologies, Logical and Physical design.	6
2	**Fabrication techniques:** Material Preparation Purification and Crystal growth (CZ process), Wafer preparation, Epitaxy - molecular beam epitaxy, Thermal Oxidation- Dry and Wet oxidation, Diffusion and ion implantation techniques, Lithography- Photo lithographic sequence, Electron Beam Lithography, Etching, Chemical Vapor Deposition and Physical Vapor Deposition. **MOSFET Fabrication techniques**: Twin-Tub fabrication sequence, Fabrication process flow.	8

3	**Static CMOS Logic Design**: MOSFET Logic Design - NMOS Inverter (Static analysis only), basic logic gates, CMOS logic, Static and transient analysis of CMOS inverter, Static and dynamic power dissipation (detailed analysis not required), Propagation delays. Realization of logic functions with static CMOS logic. **Layout Design and Design rules:** Stick Diagram and Design rules-micron rules and Lambda rules. (definitions only). Layout of CMOS Inverter, two input NAND and NOR gates.	**11**
4	**Pass transistors and Transmission gate logic:** Basic concepts, Realisation of logic gates using pass transistors and complementary pass transistors. **Dynamic logic Design:** Pre charge, Logic evaluation, Issues in dynamic logic, Domino Logic, NP domino logic, Realisation of logic gates circuits using dynamic logic (NAND and NOR). **Sequential Logic and Memory design:** Behaviour of bistable elements, CMOS D latch and edge triggered flip flop, Read Only Memory- 4x4 MOS ROM Cell Arrays (NOR, NAND), Random Access Memory- SRAM-Six transistor CMOS SRAM cell, DRAM-Three transistor and One transistor Dynamic Memory Cell.	**11**

Suggestion on Project Topics

Sample Projects:

1.Create a standard cell library including basic logic gates, flip-flops, and multiplexers.

Tasks:

- Design cells using schematic capture.
- Perform logic synthesis to verify functionality.
- Simulate the cells using Verilog testbenches.

2. Design and implement a simple RISC processor on an FPGA.

Tasks:

- Design the processor architecture using Verilog.
- Implement and synthesize the design using FPGA tools (e.g., Xilinx Vivado).
- Verify functionality through simulation and hardware testing.

3. Simulate the fabrication process of a MOSFET using TCAD tools.

Tasks:

- Model the different stages of MOSFET fabrication (e.g., oxidation, lithography, doping).
- Analyze the effects of various parameters on device characteristics.

4. Create the layout of CMOS logic gates and perform design rule checking.

Tasks:

- Draw the stick diagrams for a CMOS inverter and two-input NAND/NOR gates.
- Create the corresponding layout using layout tools.
- Verify the layout against micron and lambda design rules.

5. Design and simulate basic memory cells including SRAM and DRAM.

Tasks:

- Design a 4x4 MOS ROM cell array and SRAM/DRAM cells using Verilog.
- Simulate the memory cells to verify their read and write operations.
- Analyze the performance and area of different memory cell designs.

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	Explain VLSI design methodologies including ASIC types, SoC and FPGA devices, design flows, methodologies.	**K2**
CO2	Describe VLSI fabrication techniques.	**K2**
CO3	Design, analyse and create the layout of static CMOS logic circuits adhering to design rules and specifications.	**K3**
CO4	Design and analysis of dynamic logic circuits and the implementation of basic storage cells.	**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							
CO2	3											
CO3	3	3	3		2							
CO4	3	3	3		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 & Design	Sung-Mo Kang, Yusuf Leblebici, Chulwoo Kim	Mc Graw Hill	4/e, Indian Edition, 2016
2	VLSI Technology	S.M. SZE	Mc Graw Hill	2/e, Indian Edition, 2017
3	Modern VLSI Design	Wayne Wolf	Prentice Hall; 4th edition	4/e, 2008

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Application Specific Integrated Circuits	Michael John Sebastian Smith	Pearson	1/e, 2002
2	Principles of CMOS VLSI Design -A Systems Perspective	Neil H. E. Weste, Kamran Eshraghian	Pearson	2/e, 2007
3	Digital Integrated Circuits	Jan M. Rabaey	Pearson	2/e, 2016
4	Design of Analog CMOS Integrated Circuits	Behzad Razavi	McGraw Hill Education	2/e, 2017

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/117106092 https://nptel.ac.in/courses/106103116
2	https://nptel.ac.in/courses/108101089
3	https://nptel.ac.in/courses/108107129 https://nptel.ac.in/courses/117101105 Lecture 26 - Layout of Analog Circuit
4	https://nptel.ac.in/courses/108107129

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

DESIGN THINKING AND PRODUCT DEVELOPMENT

(Common to Group A & Group B)

Course Code	**GXEST605**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	2:0:0:0	**ESE Marks**	60
Credits	2	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To guide students through the iterative stages of design thinking, including empathizing with users, defining problems, ideating solutions and developing Proof of Concepts (PoC) and technical feasibility studies.
2. To promote the development of critical thinking skills by engaging students in integrative inquiry, where they ask meaningful questions that connect classroom knowledge with real-world applications.
3. To equip students with the ability to involve in product design considering the sustainability, inclusivity, diversity and equity aspects.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Fundamentals of design thinking and product development:** Overview of stages of product development lifecycle; Design thinking -Definition-Design thinking for product innovation; Bringing social impact in ideation-Identifying societal needs-understanding multi-faceted issues-community engagement and empathetic design- technological innovation meeting societal needs; Understanding and Bridging the divide using Human Centered Design (HCD); Designing for inclusivity in product development-embracing user diversity - Long term impact - sustainability encompassing environmental,economic and social dimensions; Technology Readiness Level in the Innovation Life-cycle; Performing a self-check on innovative	6

	ideas - Originality of idea- understanding innovation landscape - patentability - understanding the economic landscape - Unique Selling Proposition (USP) - Repeatability and Manufacturability - Sustainability - Leveraging business models for comprehensive analysis	
2	**Empathize:** Design thinking phases; Role of empathy in design thinking; Methods of empathize phase - Ask 5 Why/ 5 W+H questions; Empathy maps - Things to be done prior to empathy mapping - Activities during and after the session; Understanding empathy tools - Customer Journey Map - Personas. **Define**: Methods of Define Phase: Storytelling, Critical items diagrams, Define success.	**6**
3	**Ideation** : Stages of ideation; Techniques and tools - Divergent thinking tools - Convergent thinking tools - Idea capturing tools; Cross-industry inspiration; Role of research in ideation - Market research - consumer research - leveraging research for informed ideation; Technological trends - navigating the technological landscape - Integrating emerging technologies; Feasibility studies - technical, economic, market, operational, legal, and ethical feasibility; Ideation session- techniques and tips. **Proof of Concept (PoC) :** Setting objectives; Risk assessment; Technology scouting; Document and process management; Change management; Knowledge Capture; Validating PoC; Story telling in PoC presentation	**6**
4	**Design:** Navigating from PoC to detailed design; Developing Specification Requirement Document (SRD)/Software Requirement Specification (SRS); Design for manufacturability; Industrial standards and readability of code; Design to cost; Pre-compliance; Optimized code; Design Failure Mode and Effects Analysis (DFMEA); Forecasting future design changes. **Prototyping:** Alpha prototypes; Beta prototypes; Transition from design to prototype; Goals and expectations for Alpha and Beta prototypes; Effective strategies for maintaining timeline in prototyping; Testing and refining Alpha prototypes; Transitioning to Beta prototypes. **Pilot build:** Definition and purpose of a pilot build; setting objectives; Identification and selection of manufacturing partner for pilot build; Testing procedures in pilot build; Scaling from pilot build to full-scale production / implementation.	**6**

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

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignments	Internal Examination	Reflective Journal and Portfolio	Total
5	20	10	5	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	Empathize to capture the user needs and define the objectives with due consideration of various aspects including inclusivity, diversity and equity	**K5**
CO2	Ideate using divergent and convergent thinking to arrive at innovative ideas keeping in mind the sustainability, inclusivity, diversity and equity aspects.	**K6**
CO3	Engage in Human Centric Design of innovative products meeting the specifications	**K5**
CO4	Develop Proof of Concepts (PoC), prototypes & pilot build of products and test their performance with respect to the Specification Requirement Document.	**K4**
CO5	Reflect on professional and personal growth through the learnings in the course, identifying areas for further development	**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	2		2	3	3	3	2	2		3
CO2	3	2	3		2	3	3	3	2	2		3
CO3	3	2	3		2	3	3	2	2	2		3
CO4	3	2	2		3	3	3	2	2	2		3
CO5	3					3	3	2	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	Product Sense: Engineering your ideas into reality	Dr. K R Suresh Nair	NotionPress.com	2024
2	Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation	Tim Brown	HarperCollins Publishers Ltd.	2009
3	Design Thinking for Strategic Innovation	Idris Mootee	John Wiley & Sons Inc.	2013

Sample Assignments:

1. Evaluate and prepare a report on how the aspects including inclusivity, diversity and equity are taken into consideration during the empathize and define phases of the Miniproject course.
2. Evaluate and prepare a report on how the aspects including sustainability, inclusivity, diversity and equity are taken into consideration during the ideate phase of the Miniproject course.
3. Evaluate and prepare a report on how User-Centric Design (UCD) is used in the design and development of PoC of the product being developed in the Miniproject course.
4. Prepare a plan for the prototype building of the product being developed in the Miniproject course.
5. Report on the activities during the empathize phase including the maps & other materials created during the sessions.
6. Report on the activities during the define phase including the maps & other materials created during the sessions.
7. Report of all the ideas created during the ideation phase of the Miniproject course through the tools including SCAMPER technique, SWOT analysis, Decision matrix analysis, six thinking hats exercise
8. Prepare a full scale production plan for the product being developed in the Miniproject course.
9. Create a Stanford Business Model Canvas related to the Miniproject.

   An industrial visit of at least a day for experiential learning and submit a report on the learnings, for example industry standards and procedures.

SEMESTER S6

ENTERTAINMENT ELECTRONICS

Course Code	**OEECT611**	**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 provide broad knowledge on various industry standards, algorithms and technologies used to carry out digital audio and video broadcasting in infotainment industry.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Review of Analog Television: Scanning, Horizontal and Vertical Synchronization, Color information, Transmission methods. NTSC and PAL standards. Digital media streaming: Packetized elementary stream of audio-video data, MPEG data stream, MPEG-2 transport stream packet, Accessing a program, scrambled programs, program synchronization. PSI, Additional (Network information and service description) information in data streams for set-top boxes.	9
2	Digital Video Broadcasting (DVB): Satellite TV broadcasting – DVB-S Parameters, DVB-S Modulator, DVB-S set-top box, DVB-S2. Cable TV broadcasting – DVB-C Standard, DVB-C Modulator, DVB- C set-top box. Terrestrial TV broadcasting – DVB-T Standard, DVB-T Modulator, DVB-T Carriers and System Parameters, DVB-T receiver. Broadcasting for Handheld devices – DVB-H Standard DVB tele-text, DVB subtitling system. Digital Audio Broadcasting (DAB): Comparison of DAB with DVB. Physical layer of DAB. DAB Modulator, DAB Data Structure, DAB single frequency networks, Data broad casting using DAB.	9
3	High Definition Video and Audio: Pixel resolution, Comparison with Standard Definition TV, Review of Discrete Cosine Transforms (DCT),	9

	Video Compression - Quantization levels, Horizontal/Vertical blanking interval, Vertical Color resolution, DPCM of moving pictures, DCT, Run-length coding. MPEG-4 Video coding.	
4	Display Technology: Block diagram of video reproduction system in a TV, Cathode Ray tubes, Basic principle of Plasma displays, LC displays, Light-emitting diode displays, Field emission displays, Organic light emitting device displays. Television of future: Holographic TV, Virtual Reality, Augmented Reality.	**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 packetized streaming of digital media happens in the field of infotainment industry.	**K2**
CO2	Realise the critical aspects of DVB and DAB standards used for media broadcasting	**K2**
CO3	Apply video coding/compression algorithms are used to produce high-definition video in MPEG-4 standard	**K3**
CO4	Describe modern display technologies for video reproduction	**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										2
CO2	3	3			2						2	2
CO3	3	3			3						2	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	Digital Video and Audio Broadcasting Technology: A Practical Engineering Guide (Signals and Communication Technology)	W. Fischer	Springer	2020
2	Understanding Digital Television An Introduction to DVB Systems with Satellite, Cable, Broadband and Terrestrial TV,.	Lars-Ingemar Lundström	Focal Press,Elsevier	2006
3	Newnes Guide to Televeision and Video Technology	K F Ibrahim	Newnes	2007
4	Introduction to Flat Panel Displays	Jiun-Haw Lee, David N. Liu, Shin-Tson Wu	Wiley	2008

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Video and HD Algorithms and Interfaces,"	C. Poynton	Morgan Kaufmann	2012.
2	Digital audio broadcasting: principles and applications of DAB, DAB+ and DMB	Wolfgang Hoeg, Thomas Lauterbach	Wiley	2009.
3	Introduction to Digital Audio	John Watkinson	Focal Press	1994.
4	Art of Digital Video,	John Watkinson	Focal Press	2008
5	Introduction to Digital Video,	John Watkinson	Focal Press	2001

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://www.youtube.com/watch?v=M_nTmRtAD98
2	https://www.youtube.com/watch?v=aTDr79yvUus
3	https://www.youtube.com/watch?v=g_ysg46q-jQ
4	https://www.youtube.com/watch?v=4BaDaGTUgIY

SEMESTER S6

COMPUTER NETWORKS

Course Code	OEECT 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	Theory

Course Objectives:

1. The course aims to expose students to computer networks taking a top-down approach of viewing from the layer of user applications and zooming into link layer protocols. The principles of various protocols used in every layer are studied in detail,

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Computer Networks** Components of computer networks. Transmission modes - serial and parallel transmission, asynchronous, synchronous, simplex, half duplex, full duplex communication. Switching: circuit switching and packet switching. Networks: Network criteria, physical structures, network models, categories of networks, Interconnection of Networks. Delay and loss in packet-switched networks, Types of delay, Packet loss. Layered Architecture: OSI model	9
2	**TCP/IP protocol suite:** Introduction **Application Layer:** Communication between processes, Web application: HTTP, Message format, Email application: SMTP, Message format, MIME, POP3, Domain Name System (DNS). **Transport Layer** connectionless and connection-oriented protocols. UDP-Protocols for reliable data transfer: ARQ protocols, stop-and-wait protocol, alternating-bit protocol, Go-back- N, Selective Repeat. TCP Connection, segment structure, RTT estimate, Flow	9

	control. **Congestion Control** General approaches. TCP congestion control.	
3	**Network Layer:** Datagram versus virtual-circuit network service, Router architecture, Routing and Forwarding, Static routing and Dynamic routing. Address Resolution protocols (ARP, RARP) Subnetting, Classless Routing(CIDR), ICMP. **IPv4:** Datagram format, Fragmentation and reassembly, addressing, address assignment – manual and DHCP. IPv6- Datagram format, Transitioning from IPv4 to IPv6, IP security. **Routing Algorithms** Link-State (Dijkstra's) Algorithm, Distance vector algorithm. Routing in Internet – RIP, OSPF, BGP.	**10**
4	**Link Layer** Services of link layer**,** Error detection and correction – checksum, CRC. Multiple access protocols – Channel partitioning, random access. ALOHA – pure and slotted, efficiency, CSMA, CSMA/CA, CSMA/CD. Link layer addressing: MAC address, Ethernet. Wireless Networks IEEE 802.11 wireless LAN. **Physical Layer**: Guided and unguided transmission media (Co-axial cable, UTP,STP, Fiber optic cable)	**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	Summarize the principles and components of computer networks, switching, basic concepts of delay analysis and the layered network architecture.	**K2**
CO2	Demonstrate protocols and the functions of different layers.	**K2**
CO3	Analyse the concept of routing and addressing protocols in the context of computer networking.	**K3**
CO4	Make use of different physical communication standards in computer networks.	**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
CO2	3					-	-	-	-	-	-	2
CO3	3	2	2	2	2	-	-	-	-	-		3
CO4	3	2	2	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	Computer Networking: A Top-Down Approach Featuring the Internet.	James F. Kurose, Keith W. Ross,	Pearson	Sixth Edition, 2017
2	Data Communications and Networking	Behrouz A Forouzan	Tata McGraw-Hill	Fourth Edition , 2008

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, Bruce S. Davie,	Morgan Kauffman	
2	Communication Networking – An Analytical Approach,	A. Kumar, D. Manjunath, J. Kuri,	Morgan Kauffman Series	
3	Computer Networks	A. S. Tanenbaum, D. J. Wetherall	Pearson	
4	Data Networks	D. Bertsekas, RG Gallager	Prentice Hall	

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc22_cs19/preview
2	https://archive.nptel.ac.in/courses/106/105/106105183/
3	https://onlinecourses.swayam2.ac.in/cec21_cs04/preview

SEMESTER S6

BIOMEDICAL ENGINEERING

Course Code	OEECT613	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 will introduce the various aspects of biomedical engineering and its applications escribed using engineering principles
2. The student will be able to understand the techniques and uses of modern diagnostic and therapeutic equipment**.**

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to bio-medical engineering, Sources of bio-electric potential: Resting and action potential, propagation of action potentials. Various bioelectric potentials (ECG, EEG, EMG, ERG, EOG, EGG concept only.) Electrode theory: Nernst equation, Electrode skin interface Bio-potential electrodes: Microelectrodes, skin surface electrodes, needle electrodes Bio-potential amplifiers: instrumentation amplifiers, carrier amplifiers, isolation amplifiers, chopper amplifiers	9

2	Heart and cardiovascular system: electro conduction system of the heart, ECG lead configurations, Einthoven triangle, Electrocardiography, ECG machine - block diagram, ECG recording system.. The human nervous system: Neurons, action potential of brain, brain waves, placement of electrodes, EEG recording, evoked potential, Electrical activity of muscles: EMG signal acquisition and analysis.Myoelectric control system. Electrical stimulation of the muscle and nerve, Applications of EMG	**9**
3	Instruments for clinical laboratory: Oxymeters, blood cell counter, flame photometer, Spectrophotometer Therapeutic Equipments: Principles, block schematic diagram, working and applications of pacemakers, cardiac defibrillators, heart–lung machine, dialyzers, surgical diathermy equipment, ventilators Biomedical Telemetry system: Components of biotelemetry system, application of telemetry in medicine, single channel telemetry system for ECG.	**9**
4	Medical Imaging systems (Basic Principle only): X-ray imaging - X-ray machine, applications of X-rays in medicine. Computed Tomograpy: Principle, image reconstruction, scanning system and applications Ultrasonic imaging systems: Basic pulse echo system, Different types of Ultrasonics systems:, A-Scan, B-Scan, M-Scan, applications, real-time ultrasonic imaging systems and probes. Magnetic Resonance Imaging – Basic NMR components, Biological effects and advantages of NMR imaging	**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	Outline the basic bioelectric potentials and their implications in diagnostics	**K2**
CO2	Summarize the principles used for diagnosis of abnormalities in the cardiovascular system	**K2**
CO3	Identify the techniques used for diagnosis and therapy in the neuromuscular and myoelectric systems.	**K2**
CO4	Illustrate the principle and working of different types of bio medical equipment/devices	**K2**
CO5	State various diagnostic medical imaging techniques.	**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
CO2	3					2						2
CO3	3					2	2					2
CO4	3					2	2					2
CO5	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	, Handbook of Biomedical Instrumentation	R. S. Khandpur	Tata Mc Graw Hill	Third edition
2	Biomedical Instrumentation and Measurement	Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer,	, PHI	2nd Edition, 2004

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”,	John G Webster,	John Wiley	3rd edition
2	Introduction to Biomedical Equipment Technology	J. J. Carr,	Pearson Education	4th edition
3	Principle of Biomedical Instrumentation and Measurement	Richard Aston,	Merrill Education/Prentice Hall	
4	Introduction to Biomedical Instrumentation	Barbara Christe	Cambridge University Press,	2008

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://www.youtube.com/watch?v=_fD9gOqiBVE
2	http://www.digimat.in/nptel/courses/video/127106134/L16.html

SEMESTER S6

COMMUNICATION LAB II

Course Code	PCECL607	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	Theory

Course Objectives:

1. Develop practical skills in microwave and optical communication systems through hands-on experiments involving microwave sources, fiber optics, and optoelectronic components.
2. Enhance understanding and application of antenna and waveguide theories by designing, simulating, and measuring various antenna types and waveguide characteristics.

Details of Experiment

Expt. No	Experiment
	MICROWAVE EXPERIMENTS (Minimum four experiments are mandatory)
1	Reflex Klystron Mode Characteristics.
2	GUNN diode characteristics.
3	VSWR and Frequency measurement.
4	Verify the relation between Guide wave length, free space wave length and cut off wave length for rectangular wave guide.
5	Unknown load impedance measurement using smith chart and verification using transmission line equation.
6	Measurement of Magic Tee characteristics.
7	Directional Coupler Characteristics.
	OPTICAL EXPERIMENTS (Minimum three experiments are mandatory)
1	Setting up of Fiber optic Digital link.
2	Measurement of Numerical Aperture of an Optical fiber

3	Study of losses in Optical fiber
4	Voltage vs. Current (V-I) characteristics of Laser Diode.
5	Voltage vs. Current (V-I) characteristics of LED.
6	Characteristics of Photodiode
	ANTENNA EXPERIMENTS (Minimum three experiments are mandatory)
1	Familiarization of any antenna simulation software
2	Simulation of Dipole Antenna
3	Simulation of Patch Antenna
4	Simulation of Antenna Array.
5	Study of Vector Network Analyzer.
6	Antenna Pattern Measurement

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	Familiarize the basic Microwave components and to analyse a few microwave measurements and its parameters.	**K4**
CO2	Describe the principles of fiber-optic communications and the different kinds of losses, signal distortion and other signal degradation factors.	**K2**
CO3	Design and simulate basic antenna experiments with simulation tools.	**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	-	-	3
CO2	3	3	3	-	-	-	-	-	3	-	-	3
CO3	3	3	3	2	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	Microwave Devices and Circuits	Samuel Y. Liao	Prentice-Hall Of India Pvt. Limited	3^{rd} Edition, 2008
2	Optical Fiber Communication	Gred Keiser	Mc Graw Hill	5^{th} Edition, 2013
3	Antenna Theory and Design	Constantine A. Balanis Balanis	Wiley Publications	4^{th} Edition, 2016

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Antennas for all Applications	John D. Krauss	McGraw-Hill	4th Edition, 2010
2	Modern Antenna Design	Thomas A. Milligan	Wiley-IEEE Press	2^{nd} Edition, 2005
3	Principles of Electromagnetics	N.O. Sadiku and S.V. Kulkarni	Oxford University Press, India	6^{th} Edition, 2015

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://youtu.be/F07ApLj12sE?si=wN5Al8ERbd52xJ6h
2	https://youtu.be/h51mFbIgZRI?si=GsXQ2sQmaq1HlYui
3	https://www.youtube.com/live/G4DCS2T-hqs?si=3sTAjLEfGR11fNVd

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 & COMMUNICATION ENGINEERING

SEMESTER S7

ADVANCED MOBILE COMMUNICATION

Course Code	**PEECT741**	**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 basics of 5G
2. To analyze 5G networks for future challenges

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Evolution from 1G to 5G. Analog voice systems in 1G; digital radio systems in 2G, voice and messaging services, TDMA based GSM, CDMA, 2.5G (GPRS), 2.75G (EDGE); IMT2000: 3G UMTS, W-CDMA, HSPA, HSPA+, 3G services and data rates; IMT Advanced: 4G, LTE, VoLTE, OFDM, MIMO, LTE Advanced Pro (3GPP Release 13+); IMT2020: 5G, enhancements in comparison to IMT Advanced. Evolution of LTE Technology to 5G Roadmap.	9
2	Basics of 5G. 5G potential and applications; Usage scenarios: enhanced mobile broadband (eMBB), ultra reliable low latency communications (URLLC), massive machine type communications (MMTC), D2D communications, V2X communications; Spectrum for 5G, spectrum access/sharing; millimeter Wave communication, channels and signals/waveforms in 5G, carrier aggregation, small cells, dual connectivity.	9
3	5G Network. New Radio (NR), Standalone and non-standalone mode; non-orthogonal multiple access (NOMA); massive MIMO, beam formation, FAPI: PHY API Specification, flexible frame structure, Service Data	9

	Adaptation Protocol (SDAP); centralized RAN, open RAN; multi-access edge computing (MEC); software defined networking (SDN), network function virtualization (NFV); network slicing; restful API for service-based interface; private networks.	
4	Current state and Challenges ahead. 5G penetration in developed countries; deployment challenges in low-middle income countries, stronger backhaul requirements, dynamic spectrum access and usage of unlicensed spectrum, contrasting radio resource requirements; large cell usage: LMLC; possible solutions for connectivity in rural areas (BharatNet, TVWS, Long-range WiFi, FSO); non-terrestrial fronthaul/backhaul solutions: LEOs, HAP/UAV.	**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 the evolution from 1G to 5G	**K2**
CO2	Explain the basics of 5G	**K2**
CO3	Illustrate 5G network	**K2**
CO4	Describe the current state and challenges ahead in 5G	**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
CO2	3				2	-	-	-	-	-	-	2
CO3	3				2	-	-	-	-	-	-	2
CO4	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	4G, LTE-Advanced Pro and The Road to 5G	Erik Dahlman, Johan Skold, and Stefan Parkvall	Academic Press	3rd Edition, 2016
2	5G NR: Architecture, Technology, Implementation, and Operation of 3GPP New Radio Standards	Dr. Sassan Ahmadi	Academic Press	2019

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	An Introduction to 5G: The New Radio, 5G Network and Beyond	Christopher Cox	Wiley	1st Edition, 2020
2	5G New Radio Non-Orthogonal Multiple Access	Yifei Yuan, Zhifeng Yuan	CRC Press	2022
	5G Outlook – Innovations and Applications	Ramjee Prasad	River Publishers	1st Edition, 2016

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc22_ee56/preview

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)	None	**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. Case study: CNN architectures*: AlexNet, VGG, ResNet,Google net *(Case study only for practical assignments/microprojects)	11
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.	11

	Gated Recurrent Units (GRU), architectture and training.	
4	Introduction to Generative models: parameter estimation, Maximum Likelyhood Estimation Auto encoders, latent space variational auto encoders. 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)	**11**

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://wiki.pathmind.com/lstm
3	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	PEECT 743	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 code)	Course Type	Theory

Course Objectives:

1. Introduce the Fundamental concepts and terminology in Robotics and automation

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Fundamentals of Robotics** **Automation and Robotics**: Definition and history of robotics. Differences between automation and robotics. Applications of robotics in industry and service sectors. **Robot Anatomy**: Basic components: Links, joints, and end effectors. Structural configurations: Cartesian, cylindrical, spherical, SCARA, articulated. Degrees of Freedom (DOF) and their significance. **Configurations of Robots:** Cartesian, Cylindrical, Spherical, Articulated, SCARA. Work Volume and Workspace Analysis: Definition and importance. Factors affecting workspace. **Manipulator Kinematics:** Position representation. Introduction to forward and inverse kinematics. Homogeneous transformations and their application in robot kinematics. **D-H Notations:** Formulating and solving kinematic equations.	9

2	**Control Systems for Robots** **Basic Control System Models:** Open-loop and closed-loop control. Block diagrams and transfer functions. **Robot Motions:** Types of motions: Slew motion, joint-interpolated motion, and straight-line motion. Path planning and trajectory generation. **Controllers:** On/off control. Proportional (P) control. Integral (I) control. Proportional plus integral (PI) control. Proportional plus derivative (PD) control. Proportional plus integral plus derivative (PID) control.	**9**
3	**Actuation and Feedback Mechanisms** **Sensors:** Types of sensors: Position and velocity sensors. Working principles of encoders and resolvers. Potentiometers and tachometers. **Actuators:** Electric actuators: DC motors, stepper motors, and servomotors. Hydraulic actuators. Pneumatic actuators. Power Transmission Devices: Gears, belts, chains. Leadscrews and ball screws. **End Effectors:** Types of grippers: Mechanical, vacuum, magnetic. Design considerations for grippers. Methods of Power and Control Signal Transmission: Electrical, hydraulic, pneumatic transmission.	**9**
4	**Industrial Applications and Work Cell Design** **Material Handling:** General considerations for material handling with robots, Material transfer applications.	**9**

	Pick and Place Operations: Techniques and applications, Integration with production lines. Palletizing and Related Operations: Methods and case studies. **Manufacturing Processes:** Die casting, plastic molding, forging. Machining operations, stamping press operations. Role of robots in automation of these processes. **Robot Cell Layouts:** Design considerations for multiple robots and machine interfaces. Examples of typical robot cell layouts. **Work Cell Control:** Interlocks and safety mechanisms. Error detection and recovery strategies. **Work Cell Controllers:** Types and functions of work cell controllers. Integration with other control systems. **Cycle Time Analysis:** Techniques for analyzing and optimizing robot cycle times. Factors affecting cycle time and productivity.	

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 basic components, structural configurations, and degrees of freedom (DOF) of robots.	**K2**
CO2	Apply forward and inverse kinematics for different types of robotic manipulators.	**K3**
CO3	Implement various types of controllers and explain their impact on robot motion control	**K2**
CO4	Identify and compare different types of sensors and actuators used in robotic systems	**K2**
CO5	Describe the basics of robot cell layouts considering multiple robots and machine interfaces.	**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										
CO2	3	3		2								
CO3	3	2	3	2	2							
CO4	3	3	3	2	3							
CO5	3	2	3	2	2	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	"Introduction to Robotics: Mechanics and Control"	John J. Craig	PHI	FIRST
2	Robot Modeling and Control	Mark W. Spong, Seth Hutchinson, and M. Vidyasagar	WILEY	FIRST
3	Industrial Robotics	Groover MP	Mc Graw Hill	1987

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Robotics fundamental concepts & analysis	Ashitava Ghoshal	Oxford university press	2006
2	Introduction to Robotics	John G Craig	PHI	2005

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc21_me76/preview
2	https://nptel.ac.in/courses/107106090

SEMESTER S7

CODING THEORY

Course Code	PEECT744	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)	PCECT 601 Advanced Communication Theory	Course Type	Theory

Course Objectives:

1. To impart the knowledge of current error control coding techniques used in digital communication networks.
2. To impart the knowledge of encoding and decoding of various error control codes

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Algebra-Overview of Groups, Rings , Finite Fields -Binary field arithmetic, Primitive elements (3hrs) Irreducible and Primitive Polynomials, Conjugate elements and Minimal Polynomials- Field extension-Construction of Finite Fields from Polynomial rings (3hrs) Vector spaces – Subspace and Dual spaces-matrices(3hrs)	9
2	Error Control Coding – Relevance of error control codes in Communication System, concepts of Code rate, Hamming Distance, Minimum Distance, Error detecting and correcting capability. (3hrs) Review on LBC-Generator matrix, Parity Check Matrix. Maximum Likelihood Decoding-syndrome decoding (3hrs) Simple bounds on block codes - Singleton bound, Hamming Bound, Gilbert-Varshamov bound. Maximum-distance-separable (MDS) codes. (3hrs)	9
3	Basic concepts of cyclic codes – Polynomial and matrix description. Interrelation between polynomial and matrix view point (2 hrs) Encoding: Non-systematic and systematic encoding, syndrome decoding-complete decoding of cyclic codes(4hrs) Hamming Codes-properties-Examples (1 hr)	9

	BCH codes, Reed-Solomon Codes (Properties and encoding only) (2hrs)	
4	Review on Convolution Codes- Systematic Encoders, Decoding of Convolution Codes –Viterbi algorithm, Turbo Codes, Encoding parallel concatenated codes. (3hrs) Low Density Parity Codes, Construction, Tanner Graphs, Message passing decoding. Example of message passing decoding over binary erasure channels. Message passing of LLR and decoding over AWGN channels. (3hrs) Polar Codes – Introduction, polarization of BEC channels, Polar transform and frozen bits. LDPC and Polar codes in 5G. (3hrs)	**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 various algebraic structures used in coding theory	**K2**
CO2	Explain the error detection and correction capabilities of linear codes	**K2**
CO3	Apply linear block codes to detect and correct errors.	**K3**
CO4	Use algebraic techniques to construct efficient codes with reduced structural complexity	**K3**
CO5	Apply convolutional code for error detection correction	**K3**
CO6	Illustrate modern error correcting codes like Turbo codes, LDOC code and polar codes	**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									2
CO2	3	2	2									2
CO3	3	2	2									2
CO4	3	2	2									2
CO5	3	2	2									2
CO6	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	Error Control Coding : Fundamentals and Applications	Shu Lin & Daniel J. Costello. Jr.	Prentice Hall Inc	2nd Edition
2	Communication Systems	Simon Haykin	John Wiley and Sons Inc	4e
3	Modern Coding Theory	T. Richardson, R. Urbanke	Cambridge University Press	

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Principles of digital communication	RG Gallager	Cambridge University Press	
2	Introduction to Coding Theory	Ron M Roth	Cambrdige University Press	
3	A Brief Introduction to Polar Codes	H. Pfister	Lec. Notes	
4	Polar Codes: A Non-Trivial Approach to Channel Coding	O. Gazi	Springer	2018
5	LDPC and Polar Codes in 5G Standard, NPTEL Course	A. Thangaraj		

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/117101053
2	https://www.youtube.com/watch?v=f8RvFlr5wRk
3	https://onlinecourses.nptel.ac.in/noc22_ee49/preview
4	https://www.digimat.in/nptel/courses/video/108102117/L01.html

SEMESTER S7

ADVANCED DIGITAL SIGNAL PROCESSING

Course Code	PEECT746	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)	Digital Signal Processing	Course Type	Theory

Course Objectives:

1. To gain an in-depth knowledge of processing of digital signals and their application to modern world problems

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Multi-rate system and filter banks :** Basic multi-rate operations: up sampling and down sampling , time domain and frequency domain analysis, Need for anti aliasing and anti imaging filters. Noble identities. Type 1 and Type 2 polyphase decomposition, Efficient structures for decimation and interpolation filters. Uniform filter banks and its implementation using polyphase decomposition. QMF Filter Bank-conditions for perfect reconstruction, polyphase implementation. Design of perfect reconstruction M- channel Filter Banks. Applications of multirate systems.	9
2	**Wavelet transform:** Time Frequency Trade off in signal analysis, Heisenberg's uncertainty principle. Short Time Fourier transform-Filter Bank representation. Continuous Wavelet Transform- Admissibility condition. Time-frequency diagrams for the STFT and the wavelet transform Discrete Wavelet Transform- Haar Scaling and Wavelet Functions, Haar analysis of signals, concept of nested space. Orthonormal Wavelet Analysis-Filter bank interpretation. Applications of wavelet transform.	9

3	**Power spectrum estimation-** Rational power spectra representation, Relationships Between the Filter Parameters and the Autocorrelation Sequence, Parametric method of power spectrum estimation-Yule Walker equations, Non parametric method of power spectrum estimation-Periodogram, Averaging periodogram.	9
4	**Linear prediction filters-** Forward and backward predictors, lattice filter structure, relationship between linear filter coefficients and reflection coefficients, Normal equations for optimum filter design. Adaptive filters-Weiner filter design, Adaptive filters for adaptive channel equalization, adaptive noise cancellation and Linear Predictive Coding of Speech Signals, Steepest descent algorithm, LMS algorithm.	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	Classify continuous and discrete time signals and systems based on their properties and perform basic operations on signals.	**K2**
CO2	Determine the stability and causality of LTI systems using convolution operations.	**K3**
CO3	Analyze signals in frequency domain using Laplace, Fourier and z-transforms and examine the properties of transforms.	**K3**
CO4	Interpret the use of various transforms to analyze continuous and discrete time LTI 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	2	2		2						2
CO2	3	3	2	2								1
CO3	3	3	3	2	2							1
CO4	3	3	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	Signals and Systems	Alan V. Oppenheim and Alan Willsky	Pearson Education	2/e, 2015
2	Signals and Systems	Simon Haykin	John Wiley	2/e, 2021

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Signals and Systems	Anand Kumar	PHI	3/e, 2013
2	Principles of Signal Processing & Linear systems	B P. Lathi	Oxford University Press	2/e, 2009
3	Signals & Systems - Continuous and Discrete	Rodger E. Ziemer	Pearson	4/e, 2013
4	Analog and Digital Signal Processing	Ashok Ambardar	Brooks/Cole Publishing Company	2/e, 2013
5	Signals and systems - Principles and Applications	Shaila Dinkar Apte	Cambridge University Press	1/e, 2016

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/117101055 https://nptel.ac.in/courses/117104074 https://nptel.ac.in/courses/108104100
2	https://nptel.ac.in/courses/117101055 https://nptel.ac.in/courses/117104074 https://nptel.ac.in/courses/108104100
3	https://nptel.ac.in/courses/117101055 https://nptel.ac.in/courses/117104074 https://nptel.ac.in/courses/108104100
4	https://nptel.ac.in/courses/117101055 https://nptel.ac.in/courses/117104074 https://nptel.ac.in/courses/108104100

SEMESTER S7

CRYPTOGRAPHY

Course Code	**PEECT 747**	**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 code)	**Course Type**	Theory

Course Objectives:

1. To introduce fundamental concepts of symmetric and asymmetric cipher models.
2. To understand the basics of authentication.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to cryptology**: Stream and block ciphers- secret and public key cryptography. **Introduction to Complexity of Algorithm**- P, NP, NP-Complete classes. **Number theory:** Primes, divisibility, linear diaphantine equations, congruences, system of linear congruences, Wilson theorem, Fermat's little theorem, Euler's theorem. Multiplicative functions, Primitive roots, Quadratic congruences- quadratic residues, Legrende symbol.	**10**
2	**Review of algebraic structures:** groups, rings, finite fields, polynomial rings over finite field. **Symmetric Ciphers:** Affine cipher, Hill cipher, Enciphering matrices. Data Encryption standard (DES), Advanced Encryption standard (AES).	**8**
3	**Public key cryptography:** One-way functions, RSA, Discrete Log, Diffie-Helman Key Exchange system, Digital signature standards. Knapsack Crypto system, Zero-knowledge protocols. Elliptic curves and elliptic curve cryptosystems	**9**
4	**Cryptanalysis:** Primality testing- pseudo primes- the rho method. **Cryptanalysis methods**: linear, differential, higher order differential, quadratic. Factoring Algorithms- Trial Division, Dixon's Algorithm, Quadratic Sieve.	**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	Apply the principles of number theory and abstract algebra in cryptology.	**K3**
CO2	Design and analyze various symmetric ciphers	**K3**
CO3	Design and analyze various asymmetric ciphers	**K3**
CO4	Apply the mathematical techniques for the cryptanalysis of symmetric and asymmetric ciphers.	**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		2							2
CO2	3	3	2		2							2
CO3	3	3	2		2							2
CO4	3	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	A Course in Number Theory and Cryptography	Neal Koblitz:	Springer	2/e, 2012
2	Elementary Number Theory with Applications	Thomas Koshy	Elsevier India	2/e, 2007
3	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	Number Theory in Science and Communication	MR Schroeder	Springer	5th Edition, 2009
2	Cryptography: Theory and Practice	Douglas R. Stinson	Chapman and Hall/CRC	3rd Edition, 2006
3	Guide to Elliptic Curve Cryptography	Hankerson, D.J., Menezes, A., Vanstone, S.A.	Springer	2004
4	Advanced Engineering Mathematics	Merle C. Potter, David C. Wiggert	Wiley	10th Edition, 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 S7

DEEP LEARNING TECHNIQUES

Course Code	PEECT 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 provide foundational knowledge of advanced neural network architectures like CNNs, RNNs, and generative models, with practical insights into their training, optimization, and applications in transfer learning and sequence modeling.

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. Case study: CNN architectures*: AlexNet, VGG, ResNet,Google net *(Case study only for practical assignments/microprojects)	**10**
3	Sequence models, Recurrent Neural Networks (RNN): cell structure and architecture, Training RNN, back propagation through time. Vanishing	**9**

	and exploding gradients. Long Short-Term Memory (LSTM), architecture and training. Gated Recurrent Units (GRU), architectture and training.	
4	Introduction to Generative models: parameter estimation, Maximum Likelyhood Estimation Auto encoders, latent space variational auto encoders. 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)	**10**

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: Practical Experiments Using Design and Analysis Tools (10 marks)

Students will perform specific experiments using tools like TensorFlow, PyTorch, or Keras. Each experiment will focus on implementing and analyzing different types of neural network architectures and techniques.

2: Course Project (10 marks)

Comprehensive project involving design, implementation, and analysis of neural network models. Project phases: Proposal, Design, Implementation, Testing, Final Report, Presentation, and Viva Voce.

Sample Experiments:

Experiment 1: Building a Convolutional Neural Network (CNN)

- ***Objective**:* Design and train a CNN for image classification.
- ***Tools**:* TensorFlow/Keras or PyTorch.
- ***Steps**:*
  - Implement a CNN with convolutional layers, pooling layers, and fully connected layers.
  - Train the model on a dataset like CIFAR-10.
  - Analyze the model's performance using evaluation metrics like accuracy and loss curves.

Experiment 2: Visualizing Feature Maps and Weight Distributions

- ***Objective**:* Visualize the internal workings of a neural network.
- ***Tools**:* TensorFlow/Keras or PyTorch, Matplotlib.
- ***Steps:***
  - Train a CNN on a simple dataset.
  - Visualize the feature maps after each convolutional layer.
  - Use t-SNE for feature visualization and analyze the distribution of weights.

Experiment 3: Transfer Learning and Fine-Tuning

- ***Objective**:* Use a pre-trained model for a new task.
- ***Tools**:* TensorFlow/Keras or PyTorch.
- ***Steps:***
  - Use a pre-trained model like VGG or ResNet.
  - Fine-tune the model on a new dataset.
  - Analyze the performance improvement compared to training from scratch.

Experiment 4: Exploring Recurrent Neural Networks

- ***Objective**:*Implement an RNN to predict time-series data(eg. Word prediction).
- ***Tools**:* TensorFlow/Keras or PyTorch.

- ***Steps:***
  - Build an RNN model with LSTM or GRU cells..
  - Train the model on a time-series dataset
  - Visualize and interpret the model's predictions.

Sample Project Topics:

1. Designing a Real-Time Object Detection System Using YOLO
2. Development of a Neural Network for Sentiment Analysis on Social Media
3. Implementing a GAN for Image-to-Image Translation
4. Building a Speech Recognition System Using RNNs and LSTMs
5. Creating a Transfer Learning Model for Medical Image Classification

Criteria for Evaluation: Lab Experiments (10 marks)

Understanding of Concepts (3 marks)

- Demonstrates a thorough understanding of the theoretical concepts related to the experiments.
- Correctly explains the purpose and expected outcomes.

Implementation and Accuracy (3 marks)

- Correctly implements the neural network models using appropriate tools.
- Ensures the design functions as expected with minimal errors.

Analysis and Problem-Solving (2 marks)

- Effectively analyzes the model performance and identifies issues.
- Demonstrates problem-solving skills in addressing challenges encountered during experiments.

Documentation and Reporting (1 mark)

- Provides detailed documentation of the experimental setup, process, and outcomes.
- Includes visualizations, code snippets, and analysis of results.

Presentation and Communication (1 mark)

- Clearly presents the experiments and their results.
- Able to answer questions and explain design choices.

Course Project (10 marks)

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.

Design and Implementation (3 marks)

- Implements the project design accurately using appropriate tools and techniques.
- The design is functional and meets the project objectives.

Innovation and Creativity (2 marks)

- Introduces innovative ideas or unique approaches in the design and implementation.
- Demonstrates creativity in solving problems or optimizing designs.

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 model.

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 differentiate between various neural network components.	**K3**
CO2	Develop and implement strategies for training neural networks	**K4**
CO3	Apply and Integrate Sequence and Generative Models	**K3**
CO4	Evaluate the effectiveness of transformer models, including BERT and GPT, and assess the impact of transfer learning techniquess	**K5**

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**
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
5	Deep Learning with Python second Edition	Francois chollet	Manning	2021

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

SATELLITE AND RADAR COMMUNICATION

Course Code	**PCECT751**	**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 code)	**Course Type**	Theory

Course Objectives:

1. To analyze operational principles of satellite communication systems
2. To apply radar techniques to detect and track targets

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Satellite orbit and orbital equations, Kepler‟s laws of planetary motion, locating satellite in the orbit, locating satellite with respect to earth, Look angle calculation, coverage angle and slant range, orbital perturbations, satellite launching, orbital effects in communication subsystem performance. Satellite subsystems, Attitude and orbit control system, Telemetry tracking command and monitoring, power system, communication subsystem, satellite antennas.	**9**
2	Satellite link design- Basic link analysis, Interference analysis, terrestrial interference, Intermodulation interference, inter-symbol interference and rain induced attenuation, uplink power control, system availability, system design for link without frequency reuse and system design for link with frequency reuse.	**9**
3	Basics of Radar: Introduction, Range, Radar Waveforms, Simple form of Radar Equation, Radar Block Diagram and Operation, Radar Frequencies and Applications, Prediction of Range Performance, Minimum Detectable Signal, Receiver Noise, Modified Radar Range Equation	**9**

4	CW and Frequency Modulated Radar: Doppler Effect, CW Radar – Block Diagram, Applications of CW radar. FM-CW Radar: FM-CW Radar, Range and Doppler Measurement, Block Diagram and Characteristics (Approaching/ Receding Targets), FM-CW altimeter, Multiple Frequency CW Radar. MTI and Pulse Doppler Radar: Introduction, Principle. MTI versus Pulse Doppler Radar. Tracking Radar: various techniques of Tracking with Radar	**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 the principles of satellite communication	**K2**
CO2	Design and analysis of satellite link	**K3**
CO3	Illustrate Radar Fundamentals like Radar Equation and Applications.	**K2**
CO4	Compare various types of Radars and tracking techniques	**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
CO2	3	3	3	3	2	-	-	-	-	-	-	2
CO3	3				2	-	-	-	-	-	-	2
CO4	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	Satellite Communications	Timothy Pratt, Jeremy Allnutt	Wiley	3rd Edition, 2021
2	Introduction to Radar Systems	Merrill I. Skolnik	Tata McGraw-Hill	2nd Edition, 2017

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Satellite Communications	Tri, T.Ha,	McGraw-Hill Education	2nd Edition, 2017
2	Satellite Communications Systems Engineering	Pritchard,	Pearson Education	2nd Edition, 2006
3	Radar: Principles, Technology, Applications	Byron Edde	Pearson	1st Edition, 2004
4	Understanding Radar Systems	Simon Kinsley and Shaun Quegan	John Wiley& Sons	1st Edition 1999

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/117/105/117105131/
2	Same as above
3	https://archive.nptel.ac.in/courses/108/105/108105154/
4	Same as above

SEMESTER S7

INTERNET OF THINGS

Course Code	PEECT 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 code)	**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	9

	technology – features, LoRaWAN architecture, 6LoWPAN – features, protocol stack, Narrow Band (NB- IoT) – features, applications, Sigfox – features, applications	
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	Tota l
● 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	Describe 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 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 code)	**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-	**9**

	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	
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 mechanism	**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	Explain 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, 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										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

MIXED SIGNAL CIRCUITS

Course Code	PEECT754	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 gain knowledge about analysis and design of various analog and digital CMOS circuits

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**CMOS Amplifiers** **MOS small signal model:** **CMOS Amplifiers**: Common source amplifier with resistive and active loads, Common source amplifier with source degeneration, Common gate and Common drain amplifier (only voltage gain and input and output impedances of the circuits). **Cascode Amplifier:** Cascoded amplifier with cascade loads Folded cascode Amplifier.	9
2	**CMOS Differential Amplifiers** **MOS Current Mirror:** Basic circuit, PMOS and NMOS current mirrors Simple and Cascode current mirror circuits. **CMOS Differential Amplifier:** Differential Amplifier with resistive, current source and current mirror loads, MOS telescopic cascode amplifier (only voltage gain and input and output impedance of the circuits)	9
3	**CMOS Operational Amplifier** **Two Stage Operational Amplifiers** Frequency compensation of OPAMPS Miller compensation. **Band gap References-** Supply Independent Biasing, Temperature independent references –band gap reference	9

4	**Data Converters:** DAC specifications, ADC specifications **DAC Architecture -** Resistor String, R-2R Ladder Networks, Current Steering, Charge Scaling, cyclic and Pipeline types. **ADC Architecture-** Flash type, The Successive approximation type and oversampling ADCs.	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 various Single stage Amplifiers with different types of loads	**K2**
CO2	Explain Differential Amplifiers & Current Mirrors	**K2**
CO3	Apply the knowledge of amplifiers in the design of two stage OPAMP	**K3**
CO4	Illustrate the concept of frequency compensation in OPAMP	**K2**
CO5	Describe the specifications and architectures of data converter circuits	**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											
CO2	3	2										2
CO3	3	2	2									2
CO4	3	2		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	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 Sengupta Lectures 47-51

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	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None/ (Course code)	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 of 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

MICROWAVE DEVICES & CIRCUITS

Course Code	PEECT 757	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)	Microwave & Antennas (Course code)	Course Type	Theory

Course Objectives:

1. To understand the principles of active and passive microwave semiconductor devices, components, microwave sources and amplifiers used in microwave communication systems, analysis of microwave networks and microwave integrated circuits.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Limitation of conventional solid state devices at Microwave. Microwave generation and amplification. Structure, Operation, Power output and efficiency of IMPATT and TRAPATT diodes Bipolar transistors – biasing, FET – biasing, MESFET – Structure, Operation. Microwave amplifiers and oscillators – Amplifiers – Gain and stability, Single stage transistor amplifier design. Oscillator design – One port negative resistance oscillators.	9
2	Microwave Network Analysis – Equivalent voltages and currents, Impedance and Admittance matrices, Scattering matrix, The transmission matrix. Signal flow graphs. Impedance matching and tuning – Matching with lumped elements, Single stub tuning, Double stub tuning. Quarter wave transformer, Theory of small reflections.	9
3	Microwave filters – Periodic structures – Analysis of infinite periodic structures and terminated periodic structures	9

	Filter design by image parameter method – Constant k, m-derived and composite. Filter design by insertion loss method. Filter transformation and implementation	
4	Introduction to MICSs:-Technology of hybrid MICs, monolithic MICs. Comparison of both MICs. Planar transmission lines such as strip line, microstripline, and slot line. Distributed and lumped elements of integrated circuits -capacitors, inductors, resistors, terminations, attenuators, resonators and discontinuities.	**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 basic principles of Microwave solid state diodes, transistors, generators and amplifiers.	**K2**
CO2	Analyse Microwave Networks using signal flow graphs	**K3**
CO3	Design microwave filters by different methods	**K3**
CO4	Illustrate the basic concepts of Monolithic Integrated Circuits	**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
CO2	3	3	2	2	2							2
CO3	3	3	3	2	2							2
CO4	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	Microwave Engineering,,	David M. Pozar,	Wiley India	4/e,2012.
2	, Foundation of Microwave Engineering,,	Robert E. Collin	Wiley India,	2/e,2012.
3	Microwave Devices & Circuits	Samuel Y. Liao,	Pearson	3/e
4	Microwave Integrated Circuits	Yoshihiro Konishi	Taylor & Francis	

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Stripline-like Transmission Lines for MIC	Bharathi Bhat and Shiban K. Koul	New Age International (P) Ltd	2007
2	., Microwave Integrated Circuits,,	I. Kneppo, J. Fabian, et al	BSP, India	2006.
3	Passive RF and Microwave Integrated Circuits	Leo Maloratsky,	Elsevier,	2006

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc21_ee34/preview
2	https://archive.nptel.ac.in/courses/108/101/108101112/
3	https://archive.nptel.ac.in/courses/117/105/117105138/
4	https://onlinecourses.nptel.ac.in/noc21_ee34/preview

SEMESTER S 7

MIXED SIGNAL CIRCUIT DESIGN

Course Code	PEECT755	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)	Solid State Devices, Network Theory	**Course Type**	Theory

Course Objectives:

1. To gain indepth knowledge about analysis and design of various analog and digital CMOS circuits

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**CMOS Amplifiers** **MOS small signal model:** **CMOS Amplifiers**: Common source amplifier with resistive and active loads, Common source amplifier with source degeneration, Common gate and Common drain amplifier (only voltage gain and input and output impedances of the circuits). **Cascode Amplifier:** Cascoded amplifier with cascade loads Folded cascode Amplifier.	**9**
2	**CMOS Differential Amplifiers** **MOS Current Mirror:** Basic circuit, PMOS and NMOS current mirrors Simple and Cascode current mirror circuits. **CMOS Differential Amplifier:** Differential Amplifier with resistive, current source and current mirror loads, MOS telescopic cascode amplifier (only voltage gain and input and output impedance of the circuits)	**9**
3	**CMOS Operational Amplifier Two Stage Operational Amplifiers** Frequency compensation of OPAMPS Miller compensation. **Band gap References-** Supply Independent Biasing, Temperature independent references –band gap reference	**9**

4	**Data Converters:** DAC specifications, ADC specifications **DAC Architecture -** Resistor String, R-2R Ladder Networks, Current Steering, Charge Scaling, cyclic and Pipeline types. **ADC Architecture-** Flash type, The Successive approximation type and oversampling ADCs.	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

Criteria for Evaluation (Evaluate and Analyse): 20 marks

Evaluation Methods:

1. Experiments Using Design and Analysis Tools: (10 marks)

Students can perform specific experiments using tools QUCS, KiCad or PSPICE or LT Spice or CADENCE etc.

Each experiment can focus on designing and simulating different types of circuits

2. Course Project:

Comprehensive project involving design, modeling, and analysis of a Mixed Signal Circuit. (10 marks)

Project phases: Proposal, Design, Implementation, Testing, Final Report.Presentations and Viva Voce:

Students present their projects and experiments, explaining design choices, methodologies, and results.

Viva voce to assess understanding and ability to answer related questions.

The following topics may be identified for Assignments/ Miniproject

1. Simulation of a MOSFET Amplifier Circuits
2. Simulation of a Differential Amplifier Circuits
3. Design and Simulation of OPAMP
4. Design and Simulation of ADCs, DACs

Criteria for Evaluation: Experiments (10 marks)

1. Understanding of Concepts (3 marks)
    a. Demonstrates a clear understanding of the theoretical concepts related to the experiment.
    b. Correctly explains the purpose and expected outcomes of the experiment.
2. Implementation and Accuracy (3 marks)
    a. Correctly implements the design using appropriate tools.
    b. The design functions as expected without errors.
3. Analysis and Problem-Solving (2 marks)
    a. Effectively analyse the design to identify and resolve issues.
    b. Demonstrates problem-solving skills in addressing any encountered challenges.
4. Documentation and Reporting (1 mark)
    a. Provides clear and concise documentation of the steps and processes followed.
    b. The report includes diagrams, code snippets, and simulation results.
5. Presentation and Communication (1 mark)
    a. Clearly presents the experiment and its results.
    b. Able to answer questions and explain the design choices.

Criteria for Evaluation: Course Project (10 marks)

1. Project Proposal and Planning (2 marks)
    a. Submits a well-defined project proposal outlining objectives, methodology, and expected outcomes.
    b. Demonstrates thorough planning and a clear timeline for the project.
2. Design and Implementation (3 marks)
    a. Implements the project design accurately using appropriate tools and

techniques.

b. The design is functional and meets the project objectives.

3. Innovation and Creativity (2 marks)
   a. Introduces innovative ideas or unique approaches in the design and implementation.
   b. Demonstrates creativity in solving problems or optimizing designs.
4. Analysis and Testing (2 marks)
   a. Effectively analyzes the project design to identify and address any issues.
   b. Conducts thorough testing to verify the functionality and performance of the design.
5. Final Report and Presentation (1 mark)
   a. Submits a comprehensive final report detailing the project, including objectives, design, methodology, analysis, and results.
   b. 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 the effect of different types of loads on the performance of various MOS Amplifiers	**K4**
CO2	Apply the knowledge of amplifiers in the design of two stage OPAMP	**K3**
CO3	Demonstrate the concept of frequency compensation in OPAMP	**K3**
CO4	Implement various types of data converter circuits	**K3**
CO5	Design and Implement amplifiers, OPAMPs, ADCs, DACs etc. with given specifications	**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	2										2
CO2	3	2										2
CO3	3	2										2
CO4	3	2										2
CO5	3	2	2		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	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 Sengupta Lectures 47-51

SEMESTER S7

OPTICAL COMMUNICATION

Course Code	OEECT721	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)	PHYSICS	**Course Type**	Theory

Course Objectives:

1. To introduce the concepts of light transmission through optical fibers
2. To introduce the working of optical components and its usage in optical communication systems

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Optical fiber Communications:** Structure of Optical fiber, materials, General block diagram of optical communication system, Advantages. **Optical fiber waveguides:** Principle of light guidance, Numerical Aperture, V number, Step and Graded index fibers, Single and Multi mode fibers. **Transmission Characteristics:** Attenuation, Absorption losses, Linear and Non linear scattering losses, bend losses. Dispersion- Intermodal dispersion, Chromatic dispersion, Dispersion modified fibers, Photonic crystal fibers, Polarization mode dispersion, Nonlinear effects, Solitons.	**9**
2	**Optical fibers and Cables** – Fabrication Techniques- Double crucible method, Outside Vapour phase oxidation, Modified Chemical Vapour Deposition. Optical Fiber Cables- Single and Multi fiber cables. **Optical Fiber Connections:** splices, connectors & couplers. **Optical Fiber Measurements:-** Attenuation and dispersion measurements, MZ interferometer, Optical Time Domain Reflectometer – Applications	**9**
3	**Optical sources:** LEDs and LDs, general structures, characteristics, modulators using LEDs and LDs. coupling with fibres, **Optical detectors:** Quantum efficiency and Responsivity, Structure and working of PIN and APD **Optical Receivers: -** Direct detection- noise in detectors, SNR, BER	**9**

	analysis Coherent detection principles. **Optical Amplifiers:** EDFA - Principle, structure and working, Raman amplifiers	
4	**Multiplexing Strategies:** OTDM, SCM, OFDM, WDM and Optical CDMA: concepts, components - couplers, splitters, Add/ Drop multiplexers, Fiber grating filters, tunable filters. **Optical networks** – General description of SONET/SDH **Free space optics:** Principle of LiFi technology. Visible Light Communication **Other applications of optical fibers**: Entertainment, Sensors – Types & principles	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 structure, fabrication, principle of operation and classifications of optical fibers	**K2**
CO2	Describe the transmission characteristics and evaluate losses in optical fiber	**K2**
CO3	Explain the working of sources, detectors and optical amplifiers used in optical communication system	**K2**
CO4	Describe the concepts of Multiplexing, Optical Networks and Free Space Communication	**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	1									1
CO2	3	3	2	2	1							1
CO3	3	1	2	1	1							1
CO4	3	1	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	Optical Fiber Communications	Gerd Keiser	McGraw Hill	5th/e, 2021
2	Optical Fiber Communication: Principles and Practice	John M Senior	Pearson Education	3rd/e, 2014
3	Fibre Optic Communications	Joseph C. Palais	Pearson Education	5th/e, 2013
4	Fibre optic Communication: Systems and Components	Mishra and Ugale,	Wiley	2019
5	Fibre Optic Communications Systems	G P Agrawal	WILEY	4th Ed

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Fibre Optic Communication: Optical Waveguides, Devices and Applications	Sanjeev Kumar Raghuwanshi	University Press	2015
2	Optical Communication	M Mukunda Rao	University Press	2000

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://www.youtube.com/watch?v=ougKUUM3hJA
2	https://www.digimat.in/nptel/courses/video/117104127/L01.html
3	https://www.youtube.com/watch?v=seHmi6AMWy4
4	https://www.youtube.com/watch?v=4W7hieXDAmc

SEMESTER S7

DIGITAL IMAGE PROCESSING

Course Code	**OEECT 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)	None/ (Course code)	**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 Filters, Sharpening spatial Filters. Frequency domain methods: low pass filtering, high pass filtering, homomorphic filtering.	**9**

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	Explain 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	Analyze the filtering and restoration of images	**K3**
CO5	Describe the basic image segmentation techniques	**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	4TH
2	Digital Image Processing	S Jayaraman, S Esakkirajan, T Veerakumar	McGraw Hill	Ist

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://onlinecourses.nptel.ac.in/noc24_ee133/preview
2	https://nptel.ac.in/courses/117105135
3	https://www.youtube.com/watch?v=KiJo4-IijL4
4	https://archive.nptel.ac.in/courses/117/105/117105135/

SEMESTER S7

OPTIMIZATION TECHNIQUES

Course Code	OEECT723	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 code)	**Course Type**	Theory

Course Objectives:

1. Enable the learner to formulate engineering minima/maxima problems as optimization problems
2. Enable the learner to deploy various constrained and unconstrained optimization algorithms to obtain the minima/maxima of engineering problems

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Engineering application of Optimization – Statement of an Optimization problem–Classification, Review of basic calculus concepts –Stationary points; Functions of single and two variables; Convexity and concavity of functions –Definition of Global and Local optima – Optimality criteria, Linear programming methods for optimum design – Standard form of linear programming (LP) problem; Canonical form of LP problem; Simplex Method, Duality, Application of LPP models in engineering	9
2	Optimization algorithms for solving unconstrained nonlinear optimization problems – Search based techniques: Direct search: Fibonacci and golden section search , Hookes and Jeeves , Gradient based method: Newton's method	9

3	Optimization algorithms for solving constrained optimization problems– direct methods – penalty function methods, barrier method -Optimization of function of multiple variables subject to equality constraints; Lagrangian function– Inequality constrained techniques-KKT conditions-constrained steepest descent method	**9**
4	Modern methods of Optimization– Metaheuristic techniques: Genetic Algorithms – Simulated Annealing – Particle Swarm optimization –Ant colony optimization– : Use of Matlab/Scilab to solve optimization problem	**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	Formulate an optimization problem to optimize an engineering application using the principles of basic calculus.	**K2**
CO2	Apply the Simplex method to solve a linear programming problem	**K3**
CO3	Solve the unconstrained optimization problems using gradient based method.	**K3**
CO4	Apply the various optimization techniques to solve a constrained optimization problem	**K3**
CO5	Use metaheuristic algorithms to solve constrained and unconstrained	**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
CO2	3	3	3									2
CO3	3	2	3									2
CO4	3	2	3									2
CO5	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	Engineering Optimization, Theory and Practice	S.S RAO	New Age International Publishers	4^{th} Edition ,2012

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Optimization Techniques and Applications with Examples	Xin-She Yang	John Wiley & Sons	2018
2	Optimization for Engineering Design Algorithms and Examples	Deb K	Prentice Hall India	2000
3	Introduction to Optimization Design	Arora J	Elsevier Academic Press, New Delhi	2004
4	Linear Programming	Hardley G	Narosa Book Distributors Private Ltd	2002
5	Genetic Algorithms and engineering optimization	Mitsuo Gen, Runwei Cheng	John Wiley & Sons	2002
6	An introduction to optimization	Edwin KP Chong, Stanislaw, H Hak	John Wiley & Sons	Fourth Edition, 2013

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	NPTEL https://www.youtube.com/watch?v=a2QgdDk4Xjw
2	NPTEL https://www.youtube.com/watch?v=dPQKltPBLfc
3	NPTEL https://www.youtube.com/watch?v=qY-gKL7GxYk
4	NPTEL https://www.youtube.com/watch?v=Z_8MpZeMdD4 https://www.youtube.com/watch?v=FKBgCpJlX48

SEMESTER 8

ELECTRONICS & COMMUNICATION ENGINEERING

SEMESTER S8

WIRELESS SENSOR NETWORKS

Course Code	**PEECT861**	**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 expose students to computer networks taking a top-down approach of viewing from the layer of user applications and zooming into link layer protocols.

SYLLABUS

Module No.	**Syllabus Description**	**Contact Hours**
1	Introduction, application, and challenges of wireless sensor networks (WSN). **Wireless LANS and PANS:** Introduction, Fundamentals of WLANs, IEEE 802.11 standard, HIPERLAN standard, Bluetooth**,** **Wireless WANs and MANs :** Cellular architecture, 2G/3G/4G/5G Cellular Networks, WLL**, IEEE 802.15 Standard:** Physical layer, Data link layer, MAC protocols **Wireless Internet**	**9**
2	Network architecture: Sensor network scenarios, Optimization goals and figures of merit, Design principles of WSNs, Service interfaces of WSNs. Communication Protocols: Physical layer: Wireless channel and communication fundamentals, Physical layer and transceiver design considerations in WSNs.	**9**

3	Mobile ad hoc networks and wireless sensor networks, Field buses and wireless sensor networks, Enabling technologies for wireless sensor networks. Mobile IP, TCP in wireless domain, TCP-BUS and Ad Hoc TCP, Split TCP, WAP, optimising Web over wireless.	**9**
4	WSN architecture: Single node architecture: Hardware components, Energy consumption of sensor nodes, Low power wireless sensor networks, Routing protocols-LEACH, PEGASIS and RPL, Operating systems and execution environments, Case Study: TinyOS and nesC 50 Other examples.	**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 principles of wireless networks concepts and their standards.	**K2**
CO2	Illustrate various concepts on the basics of wireless sensor networks and mobile adhoc networks.	**K2**
CO3	Develop single node wireless sensor architecture	**K3**
CO4	Analyse the network architecture and the communication protocols of wireless sensor networks	**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	2	2	2	-	-	-	-	-	-	2
CO2	3	2	2	2	2	-	-	-	-	-	-	2
CO3	3	2	2	2	2	-	-	-	-	-		2
CO4	3	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	Ad Hoc Wireless Networks: Architectures and Protocols	Siva Ram Murthy C. and Manoj B. S.	Pearson Education	2nd Edition, 2017
2	Protocols And Architectures for Wireless Sensor Networks	Holger Karl & Andreas Willig	John Wiley	2nd Edition, 2017

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Wireless Communications and Networks	William Stallings	Prentice Hall	2nd Edition, 2017
2	Fundamentals of Wireless Sensor Networks - Theory and Practice	Waltenegus Dargie , Christian Poellabauer	John Wiley & Sons Publications	2nd Edition, 2019

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/106105160
2	https://nptel.ac.in/courses/106105160
3	https://nptel.ac.in/courses/106105160
4	https://nptel.ac.in/courses/106105160

SEMESTER S8

RF ENGINEERING

Course Code	PEECT862	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)	Microwaves &Antennas	Course Type	Theory

Course Objectives:

1. To learn the analysis, design and simulation of Radio Frequency (RF) Circuits and Components for wireless communication systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	RF circuit introduction - Importance of radio frequency design, RF behaviour of resistors inductors and capacitors Planar Transmission Lines – Micro strip lines and Strip lines – Constructional Features Impedance Matching Networks-Design of Matching Circuits using Lumped Elements, Single Stub tuning, Quarter-Wave Transformers, Multi-Section Transformer – Binomial Transformer	9
2	RF Filter Design- Filter Design using insertion loss technique –Active RF components- Bipolar Junction Transistor – Construction-Functionality-Power Frequency Limitations of High Frequency transistors. GaAs devices - Familiarization of RF Field Effect Transistors and High Electron Mobility Transistors–Constructional details RF circuit measurements and characterization- Using Vector Network analyser – S parameter, Reflection Coefficient and Insertion Loss Measurement Modelling and Simulation of RF circuits using – Open source or Commercial EM Simulation Software	11
3	Amplifier design using S-parameters - Characteristics of Amplifier Power Relations, Stability Considerations – Stability Circles, Tests for	8

	Unconditional Stability High frequency amplifier design – Single stage amplifier Design – Design for maximum gain, Low noise amplifier design	
4	Basic oscillator model -Feedback oscillator design—Negative Resistance Oscillator- Dielectric Resonator Oscillator - YIG Tuned Oscillator Mixer - Basic characteristics – Single-Ended Mixer Design, Single-balanced and double-balanced mixers	**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	Explain the basic idea about RF networks and working of RF filter circuits	**K2**
CO2	Describe the behaviour of RF components and application of Network analyser in parameter measurement	**K2**
CO3	Apply the principle of RF networks in the designing of RF amplifiers,	**K3**
CO4	Apply the principle of RF networks in the designing RF Oscillators and Mixers	**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**
CO2	**3**				**3**							**2**
CO3	**3**	**3**	**3**	**3**	**2**							
CO4	**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	RF Circuit Design: Theory & Applications	Ludwig, Reinhold	Pearson Education India	2/e., 2000.
2	Microwave and RF design of wireless systems	Pozar, David M.	John Wiley & Sons	2/e, 2011

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Advanced RF & microwave circuit design: the ultimate guide to superior design.	Radmanesh, Matthew M	Author House,	2/e, 2017
2	Secrets of RF circuit design	Carr, Joseph J.	McGraw-Hill Education.	2/e, 2001
3	Radio-frequency and microwave communication circuits: analysis and design.	Misra, Devendra K	John Wiley & Sons,	2/e, 2019
4	Radio Frequency & Microwave Electronics	Mathew M. Radmanesh	Pearson Education Asia,	2nd Edition, 2017
5	RF/microwave circuit design for wireless applications.	Rohde, Ulrich L., and David P. Newkirk	John Wiley & Sons,	2nd Edition, 2017
6	Radio frequency circuit design.	Davis, W. Alan, and Krishna Kumar Agarwal.	John Wiley,	2nd Edition, 2017
7	RF Circuit Design.	Christopher, Bowick, Ajluni Cheryl, and Blyler John.	Newnes,	2nd Edition, 2015
8	Design of RF and microwave amplifiers and oscillators.	Abrie, Pieter LD.	Artech House	2nd Edition, 2019

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc23_ee36/preview
2	https://archive.nptel.ac.in/courses/108/105/108105189/
3	https://archive.nptel.ac.in/courses/117/102/117102012/

SEMESTER S8

RENEWABLE ENERGY SYSTEMS

Course Code	PEECT 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 code)	Course Type	Theory

Course Objectives:

1. To develop in-depth knowledge for the various renewable energy resources available at a location and assessments of its potential, using tools and techniques.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Renewable Energy (RE)Sources: World energy scenario, Over view of conventional energy sources, their limitation, need of renewable energy, potential & development of renewable energy sources, Renewable energy in India, An overview of types of renewable energy systems - Wind power, Hydropower (micro and mini), Solar energy, Biomass, Bio-fuel, Geothermal Heat energy, Pros and cons; Applications.	9
2	Solar Energy: Introduction to photovoltaic (PV) systems - Principle of PV conversion; Commercial solar cell, Thin film PV device fabrication - LPCVD, APCVD, PECVD; Tandem Solar cell fabrication; Solar power extraction using PV-Cells, I-V Characteristics, PV-Inverters without D.C. to D.C. converters, stand alone and grid collected PV systems, Grid interfacing-with isolation, without isolation, Maximum power point tracking-Methods(MPPT), PV-Inverters with D.C. to D.C. converters-on low frequency side and high frequency side with isolation, without isolation.	9
3	Wind Energy: Sources and potentials, of Wind Intensity, Topography, General Classification of Wind Turbines-Rotor Turbines, Multiple-Blade Turbines, Drag Turbines, Lifting Turbines, System Toroidal Rotor Amplifier Platform (TARP)–Wind amplified rotor platform (WARP), Generators and speed control used in wind power energy: Fixed speed with capacitor bank,	9

	Rotor resistance control, SCIG and DFIG, Synchronous Generator-external magnetized, Synchronous Generator-permanent magnets.	
4	Electronic conversion systems application to renewable energy generation systems: Basic schemes and functional advantages, Power control and management systems for grid integration, island detection systems, synchronizing with the grid; Issues in integration of converter based sources; Network voltage management; Power quality management and Frequency management; Influence of PV/WECS on system transient response. Introduction to grid connectivity of RE systems, smart grid and emerging technologies, operating principles and models of smart gird 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	Explain the need, importance and scope of various Non-Conventional sources of energy	**K2**
CO2	Outline the concepts and technologies related to renewable energy systems using wind and Solar-PV	**K2**
CO3	Illustrate the integration of smart grid with renewable energy systems	**K3**
CO4	Explain the concept of distribution management system.	**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
CO2	2											
CO3	2		1									
CO4	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	Solar Energy: Principles of Thermal Collection and Storage	Nayak J. K. and Sukhatme S. P.	Tata McGraw Hill	3/e. 2008
2	Power Electronics: Circuits, Devices and Applications	Muhannad H. R.	Pearson Prentice Hall	4/e, 2017
3	Smart Grid Technology and Applications	Nick Jenkins, Janaka Ekanayake [et al.]	Wiley India Ltd	1/e, 2015
4	Design of Smart Power Grid Renewable Energy Systems	Ali Keyhani	Wiley-IEEE Press	1/e, 2016

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Handbook of renewable energy technology	Ahmed F Zobaa and Ramesh Bansal	World Scientific	1/e, 2011
2	Solar Energy: Fundamental and Application	Garg H. P. and Prakash S.	Tata McGraw Hill	2/e, 2015
3	The Smart Grid: Enabling Energy Efficiency and Demand Response	Gellings C. W.	CRC Press	1/e, 2009
4	Grid Converters for Photovoltaic and wind Power Systems,	Teodorescu R. Liserre M. Rodriguez P.	Wiley – IEEE press	1/e, 2011

Video Links (NPTEL, SWAYAM…)	
Module No.	Link ID
1	https://onlinecourses.nptel.ac.in/noc21_ph33/preview
2	https://nptel.ac.in/courses/103103206
3	https://onlinecourses.nptel.ac.in/noc22_ch27/preview

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 – 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	9
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	Explain 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	Describe cryptography principles, including encryption, ciphers, symmetric and public key algorithms, RSA, Diffie Hellman, authentication, hash functions, and digital signatures.	**K2**
CO4	Illustrate 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	2	2	-	-	-	-	-	-	-	-	-	2
CO2	2	2	2	3	3	-	-	-	-	-	-	2
CO3	3	3	3	3	2	-	-	-	-	-	-	2
CO4	2	2	-	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	2/e, 2013
2	Cryptography and Network Security Principles and Practice	William Stallings	Pearson Education Asia	10/e, 2022
3	Network Security Essentials	William Stallings	Pearson Education	6/e, 2022
4	Fundamentals of Network Security	Eric Maiwald	Tata McGraw-Hill	2/e, 2012

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	4/e, 2018
2	Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives	Nina Godbole and Sunit Belpure	Wiley	2/e, 2019
2	Mark Stamp's Information Security Principles and Practice	Deven N. Shah	Wiley	4/e, 2021

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

LOW POWER VLSI

Course Code	PEECT866	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 impart knowledge on different sources of power dissipation, power minimization techniques, switched capacitance minimization and working principle of adiabatic logic circuits

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, Tunneling 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 dependency on input rise and fall time, Variation of shortcircuit 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	9

	Static Power Dissipation: Sources of Leakage Power, Effects of V_{dd} and V_t on speed, Constraints on V_t 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	Describe the impact of technology scaling on power dissipation in digital ICs and various short channel effects	**K2**
CO2	Discuss the different sources of power dissipation in digital ICs.	**K2**
CO3	Describe the various approaches for power management in digital ICs.	**K2**
CO4	Apply various clocked and non-clocked design styles for logic implementation	**K3**
CO5	Describe the use of Adiabatic switching for power management in digital ICs.	**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**											**2**
CO3	**3**			**2**								**2**
CO4	**3**	**2**	**3**		**3**							**2**
CO5	**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	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,	4/e, 2015
3	Microelectronic Circuits	Sedra & Smith	Oxford University Press	8/e,2020

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, 2018
2	Fundamentals of Microelectronics	Behzad Razavi	Wiley student Edition	2/e, 2018
3	Analysis and Design of Analog Integrated Circuits	Meyer Gray, Hurst, Lewis	Wiley	6/e, 2020

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 Sengupta Lectures 47-51

SEMESTER S8

BLOCK CHAIN

Course Code	PEECT867	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 create awareness and understanding among students on the foundation of block chain technology

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Blockchain – Definition, architecture, elements of blockchain, benefits and limitations, types of blockchain. Consensus – definition, types, consensus in blockchain. Decentralization – Decentralization using blockchain, Methods of decentralization, Routes to decentralization, Blockchain and full ecosystem decentralization.	9
2	Consensus Algorithms, Crash fault-tolerance (CFT) algorithms – Paxos, Raft. Byzantine fault- tolerance (BFT) algorithms – Practical Byzantine Fault Tolerance (PBFT), Proof of work (PoW), Proof of stake (PoS), Types of PoS. 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.	9
3	Smart Contracts – Definition, Smart contract templates, Oracles, Types of oracles, Deploying smart contracts. Decentralization terminology –	9

	Decentralized applications, Decentralized Autonomous Organizations. Use cases of Blockchain technology – Government, Health care, Finance, Supply chain management. Blockchain and allied technologies – Blockchain and Cloud Computing, Blockchain and Artificial Intelligence.	
4	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/ 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 fundamental concepts of blockchain technology.	**K2**
CO2	Summarize the classification of consensus algorithms.	**K2**
CO3	Explain the concepts of first decentralized cryptocurrency bitcoin.	**K2**
CO4	Explain the use of smart contracts and its use cases.	**K2**
CO5	Develop simple applications using Solidity language on Ethereum platform	**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							2
CO2	3				3							2
CO3	3		3	3	3	2		2				2
CO4	3		3	3	3	2		2				2
CO5	3		3	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	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	Solidity Programming Essentials: A beginner's guide to build smart contracts for Ethereum and blockchain,.	Ritesh Modi,	Packt Publishing,	First edition, 2018
2	Blockchain Technology: Concepts and Applications,	Kumar Saurabh, Ashutosh Saxena,	Wiley Publications,	First Edition, 2020
3	Blockchain Technology, ,	Chandramouli Subramanian, Asha A George, et al	Universities Press (India) Pvt. Ltd	First edition, August 2020.
4	Mastering Blockchain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications,	Lorne Lantz, Daniel Cawrey	O'Reilly Media	First edition, 2020.
5	Mastering Ethereum: Building Smart Contracts and DApps,	Andreas M. Antonopoulos, Gavin Wood	O'Reilly Media	First edition, 2018

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc22_cs44/preview
2	https://onlinecourses.swayam2.ac.in/aic21_ge01/preview
3	https://archive.nptel.ac.in/courses/106/104/106104220/
4	https://onlinecourses.nptel.ac.in/noc20_cs01/preview

SEMESTER S8

ANTENNA THEORY AND WAVE PROPAGATION

Course Code	PEECT868	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)	ELECTROMAGNETICS	Course Type	Theory

Course Objectives:

1. To gain a comprehensive knowledge about design and development of advanced antennas

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Antenna theory**: Radiation mechanism from an antenna, Current Distribution on a Thin Wire Antenna, Friis Transmission Equation and Radar Range Equation. Infinitesimal dipole, small dipole, Small circular loop antenna. Biconical antenna, Triangular sheet and Bow-tie antenna TravelingWave and Broadband Antennas, Fractal Antennas	9
2	**Microstrip antennas**: Radiation mechanism, Rectangular Patch and Circular Patch, Quality Factor, Bandwidth, and Efficiency, Input Impedance, Coupling, Circular Polarisation, Substrates for microstrip antennas **Antenna Measurements** Measurement of Antenna Range, Radiation Patterns, Gain and Directivity, Radiation Efficiency, Impedance, Current Polarization	9

3	**Reconfigurable antennas-types-** principles of frequency, polarisation and pattern reconfigurable antennas **Metamaterial based antennas-** Fundamentals of metamaterials, metasurface, SRR **Smart Antennas:** Introduction, Smart-Antenna Analogy Smart Antennas' Benefits and drawbacks, Antenna Beamforming ,Mobile Ad hoc Networks (MANETs)	9
4	**Radio Wave Propagation** Ground wave propagation, Plane earth reflection, Space wave and surface wave, Spherical earth propagation, Tropospheric waves, Ionospheric propagation, Effects of earth's magnetic field, Critical frequency, Maximum usable Frequency, Virtual height.	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 the radiation mechanism of antennas	**K3**
CO2	Design and measure the parameters of a microstrip antenna	**K4**
CO3	Analyse and design advanced antennas	**K4**
CO4	Explain the different modes and parameters of radio wave propagation	**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	2	3								2
CO2	3	3	3	3	3							2
CO3	3	3	3	3	3							2
CO4	3	2	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	Antenna Theory: Analysis and Design,	Constantine A. Balanis	Wiley	4th Edition, 2016
2	Microstrip Antenna Design Handbook	By Ramesh Garg ·	Artech	1/e, 2001
3	Antennas and radio Wave propagation	R.E.Collin	McGraw Hill	2/e, 2001
4	Metamaterials for Antenna Applications	Amit K. Singh, Mahesh P. Abegaonkar, Shiban Kishen Koul ·	CRC Press	2/e, 2021
5	Reconfigurable antennas	Suvadeep Choudhury	IoP Publishing	2/e, 2023

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Microwave Engineering,	David M. Pozar	Wiley India	4/e, 2012.
2	Antenna and Wave Propagation	Raju GSN	Pearson	1/e, 2009
3	Modern Antenna Design,	Thomas A. Milligan	IEEE PRESS, Wiley Inter science	2/e, 2005
4	Antennas for all applications	J D Kraus	Tata McGraw hill	3/e, 2002

Video Links (NPTEL, SWAYAM…)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/108/101/108101092/
2	https://nptel.ac.in/courses/108101092
3	https://www.youtube.com/watch?v=TziHD1NDQ0I
4	https://archive.nptel.ac.in/courses/112/105/112105165/

SEMESTER S8

ANTENNA THEORY AND DESIGN

Course Code	PEECT865	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)	ELECTROMAGNETICS	Course Type	Theory

Course Objectives:

1. To gain a comprehensive knowledge about design and development of advanced antennas

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Antenna theory: Radiation mechanism from an antenna, Current Distribution on a Thin Wire Antenna, Friis Transmission Equation and Radar Range Equation. Retarded potential concept, Infinitesimal dipole, small dipole, Small circular loop antenna. Biconical antenna, Triangular sheet and Bow-tie antenna Traveling Wave and Broadband Antennas, Fractal Antennas Array antennas; Binomial array, Dolph Chebyshev array, Electronic Beam steering principle	11
2	Microstrip antennas: Radiation mechanism, Rectangular Patch and Circular Patch, Quality Factor, Bandwidth, and Efficiency, Input Impedance, Coupling, Circular Polarisation, Substrates for microstrip antennas, Feeding methods, Transmission line model Broad banding of microstrip antenna using stacked elements, compact circularly polarised antennas, Design of microstrip line (using software) Antenna Measurements Measurement of Antenna Range, Radiation Patterns, Gain and Directivity, Radiation Efficiency, Impedance, Current Polarization	11
3	Reconfigurable antennas-types- principles of frequency, polarisation and pattern reconfigurable antennas	11

	Metamaterial based antennas- Fundamentals of metamaterials, metasurface, SRR Smart Antennas: Introduction, Smart-Antenna Analogy Smart Antennas' Benefits and drawbacks, Antenna Beamforming, Mobile Ad hoc Networks (MANETs)	
4	Radio Wave Propagation Ground wave propagation, Plane earth reflection, Space wave and surface wave, Duct propagation, Spherical earth propagation, Tropospheric waves, Tropospheric scatter, Ionospheric propagation, Effects of earth's magnetic field, Critical frequency, Maximum usable Frequency, Virtual height.	**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

Criteria for Evaluation (Evaluate and Analyse): 20 marks

1. Familiarise design tools for a microstrip antenna; Design and simulate any one of the types of antennas mentioned in the syllabus. The parameters for evaluation are Gain, directivity, radiation efficiency, return loss, radiation patterns etc. (10 marks)
2. Using lithographic techniques and design tools, fabricate the actual prototype of the designed antenna. (5 marks)
3. Measure the performance parameters in terms of return loss gain and radiation pattern using the network analyser, anechoic chamber and associated equipment.(5 marks)

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 the radiation mechanism of antennas	**K3**
CO2	Design and measure the parameters of a microstrip antenna	**K4**
CO3	Analyse and design advanced antennas	**K4**
CO4	Explain the different modes and parameters of radio wave propagation	**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	2	3								2
CO2	3	3	3	3	3							2
CO3	3	3	3	3	3							2
CO4	3	2	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	Antenna Theory: Analysis and Design,	Constantine A. Balanis	Wiley	4th Edition, 2016
2	Microstrip Antenna Design Handbook	By Ramesh Garg ·	Artech	1/e, 2001
3	Antennas and radio Wave propagation	R.E. Collin	McGraw Hill	2/e, 2001
4	Metamaterials for Antenna Applications	Amit K. Singh, Mahesh P. Abegaonkar, Shiban Kishen Koul ·	CRC Press	2/e, 2021
5	Reconfigurable antennas	Suvadeep Choudhury	IoP Publishing	2/e, 2023

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Microwave Engineering,	David M. Pozar	Wiley India	4/e, 2012.
2	Antenna and Wave Propagation	Raju GSN	Pearson	1/e, 2009
3	Modern Antenna Design,	Thomas A. Milligan	IEEE PRESS, Wiley Inter science	2/e, 2005
4	Antennas for all applications	J D Kraus	Tata McGraw hill	3/e, 2002

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/108/101/108101092/
2	https://nptel.ac.in/courses/108101092
3	https://www.youtube.com/watch?v=TziHD1NDQ0I
4	https://archive.nptel.ac.in/courses/112/105/112105165/

SEMESTER S8

INTERNET OF THINGS

Course Code	OEECT 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 code)	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	9

	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	
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	1/e, 2015
2	The Internet of Things	Samuel Greengard	The MIT Press Essential Knowledge series Paperback	1/e, 2015
3	The Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems	Ovidu Vermesan and Peter Friess	River Publishers	1/e, 2013
4	. Internet of Things - From Research and Innovation to Market Deployment	Peter Friess, Ovidiu Vermesan	River Publishers	1/e, 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 S8

SATELLITE AND RADAR COMMUNICATION

Course Code	**OEECT832**	**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 analyze operational principles of satellite communication systems
2. To apply radar techniques to detect and track targets

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Satellite orbit and orbital equations, Kepler"s laws of planetary motion, locating satellite in the orbit, locating satellite with respect to earth, Look angle calculation, coverage angle and slant range, orbital perturbations, satellite launching, orbital effects in communication subsystem performance. Satellite subsystems, Attitude and orbit control system, Telemetry tracking command and monitoring, power system, communication subsystem, satellite antennas.	9
2	Satellite link design- Basic link analysis, Interference analysis, terrestrial interference, Intermodulation interference, inter-symbol interference and rain induced attenuation, uplink power control, system availability, system design for link without frequency reuse and system design for link with frequency reuse.	9
3	Basics of Radar: Introduction, Range, Radar Waveforms, Simple form of Radar Equation, Radar Block Diagram and Operation, Radar Frequencies and Applications, Prediction of Range Performance, Minimum Detectable	9

	Signal, Receiver Noise, Modified Radar Range Equation	
4	CW and Frequency Modulated Radar: Doppler Effect, CW Radar – Block Diagram, Applications of CW radar. FM-CW Radar: FM-CW Radar, Range and Doppler Measurement, Block Diagram and Characteristics (Approaching/ Receding Targets), FM-CW altimeter, Multiple Frequency CW Radar. MTI and Pulse Doppler Radar: Introduction, Principle. MTI versus Pulse Doppler Radar. Tracking Radar: various techniques of Tracking with Radar	**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 the principles of satellite communication	**K2**
CO2	Design and analysis of satellite link	**K3**
CO3	Illustrate Radar Fundamentals like Radar Equation and Applications.	**K2**
CO4	Compare various types of Radars and tracking techniques	**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
CO2	3	3	3	3	2	-	-	-	-	-	-	2
CO3	3				2	-	-	-	-	-	-	2
CO4	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	Satellite Communications	Timothy Pratt, Jeremy Allnutt	Wiley	3rd Edition, 2021
2	Introduction to Radar Systems	Merrill I. Skolnik	Tata McGraw-Hill	2nd Edition, 2017

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Satellite Communications	Tri, T.Ha,	McGraw-Hill Education	2nd Edition, 2017
2	Satellite Communications Systems Engineering	Pritchard,	Pearson Education	2nd Edition, 2006
3	Radar: Principles, Technology, Applications	Byron Edde	Pearson	1st Edition, 2004
4	Understanding Radar Systems	Simon Kinsley and Shaun Quegan	John Wiley& Sons	1st Edition 1999

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/117/105/117105131/
2	Same as above
3	https://archive.nptel.ac.in/courses/108/105/108105154/
4	Same as above