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

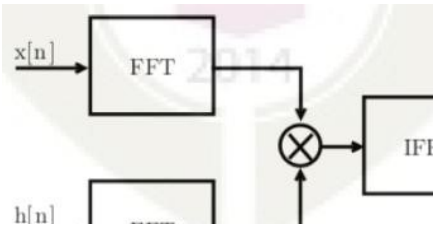
Course Objectives:

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 $\alpha = 0.4$. 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 $\alpha = 0.4$
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	4th edition
2	Microwave Devices & Circuits,	Samuel Y Liao,	Pearson Education	3rd edition
3	Antennas for all Applications,	John D. Krauss,Marhefka,Khan	Tata McGraw Hill	4th edition
4	Antennas and Wave Propagation	G S N Raju	Pearson Education	3rd 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	2nd 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	2nd 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	4th 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	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 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

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 code)	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	9

	Standard Definition TV, Review of Discrete Cosine Transforms (DCT), 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 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 - 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,	9

	Selective Repeat. TCP Connection, segment structure, RTT estimate, Flow 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	**KL2**
CO2	Summarize the principles used for diagnosis of abnormalities in the cardiovascular system	**KL2**
CO3	Identify the techniques used for diagnosis and therapy in the neuromuscular and myoelectric systems.	**KL2**
CO4	Illustrate the principle and working of different types of bio medical equipment/devices	**KL2**
CO5	State various diagnostic medical imaging techniques.	**KL2**

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 code)	**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	3rd Edition, 2008
2	Optical Fiber Communication	Gred Keiser	Mc Graw Hill	5th Edition, 2013
3	Antenna Theory and Design	Constantine A. Balanis Balanis	Wiley Publications	4th 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	2nd Edition, 2005
3	Principles of Electromagnetics	N.O. Sadiku and S.V. Kulkarni	Oxford University Press, India	6th 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