SEMESTER 7

ELECTRONICS & COMMUNICATION ENGINEERING

SEMESTER S7

ADVANCED MOBILE COMMUNICATION

Course Code	PEECT741	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To understand basics of 5G
2. To analyze 5G networks for future challenges

SYLLABUS

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

	Adaptation Protocol (SDAP); centralized RAN, open RAN; multi-access edge computing (MEC); software defined networking (SDN), network function virtualization (NFV); network slicing; restful API for service-based interface; private networks.	
4	Current state and Challenges ahead. 5G penetration in developed countries; deployment challenges in low-middle income countries, stronger backhaul requirements, dynamic spectrum access and usage of unlicensed spectrum, contrasting radio resource requirements; large cell usage: LMLC; possible solutions for connectivity in rural areas (BharatNet, TVWS, Long-range WiFi, FSO); non-terrestrial fronthaul/backhaul solutions: LEOs, HAP/UAV.	**9**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Illustrate the evolution from 1G to 5G	**K2**
CO2	Explain the basics of 5G	**K2**
CO3	Illustrate 5G network	**K2**
CO4	Describe the current state and challenges ahead in 5G	**K2**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	4G, LTE-Advanced Pro and The Road to 5G	Erik Dahlman, Johan Skold, and Stefan Parkvall	Academic Press	3rd Edition, 2016
2	5G NR: Architecture, Technology, Implementation, and Operation of 3GPP New Radio Standards	Dr. Sassan Ahmadi	Academic Press	2019

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

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

SEMESTER S7

DEEP LEARNING

Course Code	PEECT742	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Understand the theoretical basics of neural networks and deep learning

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Review of ANN: Perceptrons Convolutional Neural Networks: Convolution operation , CNN Architecture kernels, padding- Convolutional layers-, Pooling Layers, fully connected layers. Feature and weight visualization, t-SNE	7
2	Loss functions-Mean Squared Error, Cross Entropy Activation functions, Sigmoid Relu , Softmax Training CNNs:-Initialization Back-propagation Optimization algorithms:-SGD, Momentum, Adagrad, RMS Prop, Adam, Hyper parameter optimization-Learning rate Regularization methods: L1, L2 regularizaton dropout, Data Augmentation, Early stopping batch normalization Introduction to Transfer learning, feature extraction , fine tuning. Case study: CNN architectures*: AlexNet, VGG, ResNet,Google net *(Case study only for practical assignments/microprojects)	11
3	Sequence models, Recurrent Neural Networks (RNN): cell structure and architecture, Training RNN, back propagation through time. Vanishing and exploding gradients. Long Short-Term Memory (LSTM), architecture and training.	11

	Gated Recurrent Units (GRU), architectture and training.	
4	Introduction to Generative models: parameter estimation, Maximum Likelyhood Estimation Auto encoders, latent space variational auto encoders. GANs : adversarial training. Discriminator , Generator, up sampling, Transformer models, architecture Word embedding, position encoding , attention , training transformer models Large language models BERT,GPT (Detailed mathematical treatment not required for this module)	**11**

Note:- Assignments/ Micro project should be given for modules 2 ,3 and 4 using standard machine learning frameworks such as tensorflow/keras/ pytorch. They may also be introduced to GPUs and standard data sets on hugging face/kaggle

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the basic concepts of neural networks	**K2**
CO2	Solve real world problems usig CNN	**K2**
CO3	Solve real world problems using RNN	**K2**
CO4	Describe the concepts of GAN	**K2**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Learning Deep Learning	Magnus Ekman	Addison -Wesley	2022
2	Hands-on Machine learning with Sc-kit Learn Keras and Tensorflow	Aurelien Geron	Oreilly	Second edition 2019
3	Dive deep into machine learning	Astan Zhang and Zachary and Alexander semola	Cambridge university press https://d2l.ai/	2019
4	Neural Networks for deep learning	Michael Nielsen	http://neuralnetworksanddeeplearning.com/	2019

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Deep Learning.	Ian Goodfellow. Yoshua Bengio and Aaron Courville.	MIT Press	2016.
2	Neural Networks and Deep Learning: A Textbook..	Charu C. Aggarwal.	Springer	. 2019
3	Generative Deep Learning	David Foster	OReilly	2022
4	Build a Large Language Model	Sebastian Raschka	Manning	2023

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://www.cse.iitm.ac.in/~miteshk/CS6910.html
2	https://wiki.pathmind.com/lstm
3	http://colah.github.io/posts/2015-08-Understanding-LSTMs/
4	https://jalammar.github.io/illustrated-transformer/ Jay Almar

SEMESTER S7

ROBOTICS AND AUTOMATION

Course Code	**PEECT 743**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs .30 Min.
Prerequisites (if any)	None/ (Course code)	**Course Type**	Theory

Course Objectives:

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

SYLLABUS

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

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

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

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Describe the basic components, structural configurations, and degrees of freedom (DOF) of robots.	**K2**
CO2	Apply forward and inverse kinematics for different types of robotic manipulators.	**K3**
CO3	Implement various types of controllers and explain their impact on robot motion control	**K2**
CO4	Identify and compare different types of sensors and actuators used in robotic systems	**K2**
CO5	Describe the basics of robot cell layouts considering multiple robots and machine interfaces.	**K2**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	"Introduction to Robotics: Mechanics and Control"	John J. Craig	PHI	FIRST
2	Robot Modeling and Control	Mark W. Spong, Seth Hutchinson, and M. Vidyasagar	WILEY	FIRST
3	Industrial Robotics	Groover MP	Mc Graw Hill	1987

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

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

SEMESTER S7

CODING THEORY

Course Code	PEECT744	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PCECT 601 Advanced Communication Theory	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

	BCH codes, Reed-Solomon Codes (Properties and encoding only) (2hrs)	
4	Review on Convolution Codes- Systematic Encoders, Decoding of Convolution Codes –Viterbi algorithm, Turbo Codes, Encoding parallel concatenated codes. (3hrs) Low Density Parity Codes, Construction, Tanner Graphs, Message passing decoding. Example of message passing decoding over binary erasure channels. Message passing of LLR and decoding over AWGN channels. (3hrs) Polar Codes – Introduction, polarization of BEC channels, Polar transform and frozen bits. LDPC and Polar codes in 5G. (3hrs)	**9**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain various algebraic structures used in coding theory	**K2**
CO2	Explain the error detection and correction capabilities of linear codes	**K2**
CO3	Apply linear block codes to detect and correct errors.	**K3**
CO4	Use algebraic techniques to construct efficient codes with reduced structural complexity	**K3**
CO5	Apply convolutional code for error detection correction	**K3**
CO6	Illustrate modern error correcting codes like Turbo codes, LDOC code and polar codes	**K2**

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

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

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3									2
CO2	3	2	2									2
CO3	3	2	2									2
CO4	3	2	2									2
CO5	3	2	2									2
CO6	3	2	2									2

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Error Control Coding : Fundamentals and Applications	Shu Lin & Daniel J. Costello. Jr.	Prentice Hall Inc	2nd Edition
2	Communication Systems	Simon Haykin	John Wiley and Sons Inc	4e
3	Modern Coding Theory	T. Richardson, R. Urbanke	Cambridge University Press	

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

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

SEMESTER S7

ADVANCED DIGITAL SIGNAL PROCESSING

Course Code	PEECT746	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Digital Signal Processing	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

3	**Power spectrum estimation**- Rational power spectra representation, Relationships Between the Filter Parameters and the Autocorrelation Sequence, Parametric method of power spectrum estimation-Yule Walker equations, Non parametric method of power spectrum estimation-Periodogram, Averaging periodogram.	**9**
4	**Linear prediction filters**- Forward and backward predictors, lattice filter structure, relationship between linear filter coefficients and reflection coefficients, Normal equations for optimum filter design. Adaptive filters-Weiner filter design, Adaptive filters for adaptive channel equalization, adaptive noise cancellation and Linear Predictive Coding of Speech Signals, Steepest descent algorithm, LMS algorithm.	**9**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Classify continuous and discrete time signals and systems based on their properties and perform basic operations on signals.	**K2**
CO2	Determine the stability and causality of LTI systems using convolution operations.	**K3**
CO3	Analyze signals in frequency domain using Laplace, Fourier and z-transforms and examine the properties of transforms.	**K3**
CO4	Interpret the use of various transforms to analyze continuous and discrete time LTI systems.	**K3**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Signals and Systems	Alan V. Oppenheim and Alan Willsky	Pearson Education	2/e, 2015
2	Signals and Systems	Simon Haykin	John Wiley	2/e, 2021

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

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

SEMESTER S7

CRYPTOGRAPHY

Course Code	PEECT 747	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None/ (Course code)	Course Type	Theory

Course Objectives:

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

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to cryptology**: Stream and block ciphers- secret and public key cryptography. **Introduction to Complexity of Algorithm**- P, NP, NP-Complete classes. **Number theory:** Primes, divisibility, linear diaphantine equations, congruences, system of linear congruences, Wilson theorem, Fermat's little theorem, Euler's theorem. Multiplicative functions, Primitive roots, Quadratic congruences- quadratic residues, Legrende symbol.	**10**
2	**Review of algebraic structures:** groups, rings, finite fields, polynomial rings over finite field. **Symmetric Ciphers:** Affine cipher, Hill cipher, Enciphering matrices. Data Encryption standard (DES), Advanced Encryption standard (AES).	**8**
3	**Public key cryptography:** One-way functions, RSA, Discrete Log, Diffie-Helman Key Exchange system, Digital signature standards. Knapsack Crypto system, Zero-knowledge protocols. Elliptic curves and elliptic curve cryptosystems	**9**
4	**Cryptanalysis:** Primality testing- pseudo primes- the rho method. **Cryptanalysis methods**: linear, differential, higher order differential, quadratic. Factoring Algorithms- Trial Division, Dixon's Algorithm, Quadratic Sieve.	**9**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Apply the principles of number theory and abstract algebra in cryptology.	**K3**
CO2	Design and analyze various symmetric ciphers	**K3**
CO3	Design and analyze various asymmetric ciphers	**K3**
CO4	Apply the mathematical techniques for the cryptanalysis of symmetric and asymmetric ciphers.	**K3**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	A Course in Number Theory and Cryptography	Neal Koblitz:	Springer	2/e, 2012
2	Elementary Number Theory with Applications	Thomas Koshy	Elsevier India	2/e, 2007
3	Handbook of Applied Cryptography	Menezes, Paul C. V, Scott A. Vanstone	CRC Press	5/e, 2010

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Number Theory in Science and Communication	MR Schroeder	Springer	5th Edition, 2009
2	Cryptography: Theory and Practice	Douglas R. Stinson	Chapman and Hall/CRC	3rd Edition, 2006
3	Guide to Elliptic Curve Cryptography	Hankerson, D.J., Menezes, A., Vanstone, S.A.	Springer	2004
4	Advanced Engineering Mathematics	Merle C. Potter, David C. Wiggert	Wiley	10th Edition, 2012

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/106105162
2	https://nptel.ac.in/courses/106105162
3	https://nptel.ac.in/courses/106105162
4	https://nptel.ac.in/courses/106105162

SEMESTER S7

DEEP LEARNING TECHNIQUES

Course Code	PEECT 745	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	5/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Review of ANN: Perceptrons Convolutional Neural Networks: Convolution operation , CNN Architecture kernels, padding- Convolutional layers-, Pooling Layers, fully connected layers. Feature and weight visualization, t-SNE	7
2	Loss functions-Mean Squared Error, Cross Entropy Activation functions, Sigmoid Relu , Softmax Training CNNs:-Initialization Back-propagation Optimization algorithms:-SGD, Momentum, Adagrad, RMS Prop, Adam, Hyper parameter optimization-Learning rate Regularization methods: L1, L2 regularizaton dropout, Data Augmentation, Early stopping batch normalization Introduction to Transfer learning, feature extraction , fine tuning. Case study: CNN architectures*: AlexNet, VGG, ResNet,Google net *(Case study only for practical assignments/microprojects)	10
3	Sequence models, Recurrent Neural Networks (RNN): cell structure and architecture, Training RNN, back propagation through time. Vanishing	9

	and exploding gradients. Long Short-Term Memory (LSTM), architecture and training. Gated Recurrent Units (GRU), architectture and training.	
4	Introduction to Generative models: parameter estimation, Maximum Likelyhood Estimation Auto encoders, latent space variational auto encoders. GANs : adversarial training. Discriminator , Generator, up sampling, Transformer models, architecture Word embedding, position encoding , attention , training transformer models Large language models BERT,GPT (Detailed mathematical treatment not required for this module)	**10**

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

Continuous Internal Evaluation Marks (CIE):

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

Criteria for Evaluation (Evaluate and Analyse): 20 marks

Evaluation Methods:

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

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

2: Course Project (10 marks)

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

Sample Experiments:

Experiment 1: Building a Convolutional Neural Network (CNN)

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

Experiment 2: Visualizing Feature Maps and Weight Distributions

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

Experiment 3: Transfer Learning and Fine-Tuning

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

Experiment 4: Exploring Recurrent Neural Networks

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

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

Sample Project Topics:

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

Criteria for Evaluation: Lab Experiments (10 marks)

Understanding of Concepts (3 marks)

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

Implementation and Accuracy (3 marks)

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

Analysis and Problem-Solving (2 marks)

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

Documentation and Reporting (1 mark)

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

Presentation and Communication (1 mark)

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

Course Project (10 marks)

Project Proposal and Planning (2 marks)

- Submits a well-defined project proposal outlining objectives, methodology, and expected outcomes.
- Demonstrates thorough planning and a clear timeline for the project.

Design and Implementation (3 marks)

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

Innovation and Creativity (2 marks)

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

Analysis and Testing (2 marks)

- Effectively analyzes the project design to identify and address any issues.
- Conducts thorough testing to verify the functionality and performance of the model.

Final Report and Presentation (1 mark)

- Submits a comprehensive final report detailing the project, including objectives, design, methodology, analysis, and results.
- Clearly presents the project and its outcomes, and effectively communicates the key points.

End Semester Examination Marks (ESE):

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

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

Course Outcomes (COs)

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

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Analyze and differentiate between various neural network components.	**K3**
CO2	Develop and implement strategies for training neural networks	**K4**
CO3	Apply and Integrate Sequence and Generative Models	**K3**
CO4	Evaluate the effectiveness of transformer models, including BERT and GPT, and assess the impact of transfer learning techniquess	**K5**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Learning Deep Learning	Magnus Ekman	Addison -Wesley	2022
2	Hands-on Machine learning with Sc-kit Learn Keras and Tensorflow	Aurelien Geron	Oreilly	Second edition 2019
3	Dive deep into machine learning	Astan Zhang and Zachary and Alexander semola	Cambridge university press https://d2l.ai/	2019
4	Neural Networks for deep learning	Michael Nielsen	http://neuralnetworksanddeeplearning.com/	2019

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Deep Learning.	Ian Goodfellow. Yoshua Bengio and Aaron Courville.	MIT Press	2016.
2	Neural Networks and Deep Learning: A Textbook..	Charu C. Aggarwal.	Springer	. 2019
3	Generative Deep Learning	David Foster	OReilly	2022
4	Build a Large Language Model	Sebastian Raschka	Manning	2023
5	Deep Learning with Python second Edition	Francois chollet	Manning	2021

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://www.cse.iitm.ac.in/~miteshk/CS6910.html
2	https://cs231n.github.io/
3	https://wiki.pathmind.com/lstm http://colah.github.io/posts/2015-08-Understanding-LSTMs/
4	https://jalammar.github.io/illustrated-transformer/ Jay Almar

SEMESTER S7

SATELLITE AND RADAR COMMUNICATION

Course Code	PCECT751	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None/ (Course code)	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

4	CW and Frequency Modulated Radar: Doppler Effect, CW Radar – Block Diagram, Applications of CW radar. FM-CW Radar: FM-CW Radar, Range and Doppler Measurement, Block Diagram and Characteristics (Approaching/ Receding Targets), FM-CW altimeter, Multiple Frequency CW Radar. MTI and Pulse Doppler Radar: Introduction, Principle. MTI versus Pulse Doppler Radar. Tracking Radar: various techniques of Tracking with Radar	**9**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Illustrate the principles of satellite communication	**K2**
CO2	Design and analysis of satellite link	**K3**
CO3	Illustrate Radar Fundamentals like Radar Equation and Applications.	**K2**
CO4	Compare various types of Radars and tracking techniques	**K2**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Satellite Communications	Timothy Pratt, Jeremy Allnutt	Wiley	3rd Edition, 2021
2	Introduction to Radar Systems	Merrill I. Skolnik	Tata McGraw-Hill	2nd Edition, 2017

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

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

SEMESTER S7

INTERNET OF THINGS

Course Code	PEECT 752	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None/ (Course code)	Course Type	Theory

Course Objectives:

1. This course aims to introduce IoT fundamentals.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to IoT technology:** Definitions of IoT, Characteristics of IoT devices – power, computational constraints, IoT Architectural view – Middleware based architecture, Service oriented architecture, M2M Communication and IoT, Typical application areas of IoT technology (case studies of at least four domains) - Energy management and Smart grid, IoT for Home, Cities, Environment monitoring, Agriculture, Supply chain and customer monitoring	9
2	**Components of IoT technology:** Identification/Addressing - Electronic Product Codes, RFID, ubiquitous code, IPv4, IPv6. Sensors and Actuators*. IoT Hardware**, IoT Software – overview of Operating systems, Firmware, Middle ware, Application software used in IoT. Connectivity for IoT devices – characteristics.	9
3	**Communication technologies for IoT :** Zigbee - key features, architecture, limitations, Bluetooth technology - bluetooth stack, piconet, scatternet, limitations, Bluetooth Low Energy (key features, architecture, limitations), Wifi (IEEE 802.11) technology – key features, limitations, Cellular technology – GSM, 3G, 4GLTE (overview), features, limitations, LoRa	9

	technology – features, LoRaWAN architecture, 6LoWPAN – features, protocol stack, Narrow Band (NB- IoT) – features, applications, Sigfox – features, applications	
4	**IoT Data Management :** Storage technologies for IoT hardware – Volatile, Non-volatile, Embedded (MTP/OTP), external flash (NAND/NOR), DRAM, eflash, UFS, eMMC (overview of technologies). Cloud and IoT, Cloud computing – architecture, advantages of cloud computing, Software as a Service (SaaS), Platform as a Service (PaaS), Infrastructure as a Service (IaaS). Case study of commercial cloud computing platforms like - Microsoft Azure IoT Suite, Google Cloud's IoT Platform, IBM Watson IoT Platform. IoT analytics	**9**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain in a concise manner the architecture of IoT	**K2**
CO2	Identify various hardware and software components used in IoT	**K3**
CO3	Describe the various communication technologies and interfaces in IoT	**K2**
CO4	Describe the usage of modern technologies like cloud computing for data management in IoT	**K2**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Internet of Things : Architecture and Design Principles"	Rajkamal	McGraw Hill (India) Private Limited.	2nd edition,2022
2	"Internet of Things (A Hands-on- Approach)"	Vijay Madisetti and Arshdeep Bahga	Orient Blackswan Private Limited - New Delhi	1st Edition,2015

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	. Internet of things: A survey on enabling technologies, protocols, and applications	Al-Fuqaha	IEEE Communications Surveys & Tutorials	2015
2	The Internet of Things	Samuel Greengard	The MIT Press Essential Knowledge series Paperback	March 20, 2015
3	The Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems	Ovidu Vermesan and Peter Friess	River Publishers	1st Edition, 2013
4	. Internet of Things - From Research and Innovation to Market Deployment	Peter Friess, Ovidiu Vermesan	River Publishers	1st Edition,2014

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://youtu.be/WUYAjxnwjU4?si=s58W-NKMrEQMaJ8m https://youtu.be/BXDxYh1EV2w?si=8oFtQB9vycC_c-t2
2	https://youtu.be/z3VEZPwl5gA?si=tNuzG_By-KBU3ks_ https://youtu.be/SXz0XR68dwE?si=1tVN1g9FQcGp87li https://youtu.be/TvzgzO6xKrY?si=gYzJstW51MTNsgKj
3	https://youtu.be/qko-f1VDhCM?si=0tWM_OHS395ESV_w https://youtu.be/d9QfVpCG00Y?si=qeHk8tPg_torr2yX https://youtu.be/1zQ8wbBozqI?si=7vOSHMt8OT3nQINO
4	https://youtube.com/playlist?list=PLE7VH8RC_N3bpVn-e8QzOAHziEgmjQ2qE&si=rr5Fpuew5q9_Y4qg

SEMESTER S7

REAL TIME OPERATING SYSTEM

Course Code	PEECT 753	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None/ (Course code)	Course Type	Theory

Course Objectives:

1. Introduce Real Time Operating Systems, its basic structure, building blocks and various operations
2. Summarize the different scheduling algorithms used in RTOS.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Real-Time Systems** **Overview of Real-Time Systems:** Definition and types of real-time systems, Hard vs. soft real-time systems. **Basic Concepts:** Real-time tasks and their characteristics, Task scheduling, Timing constraints and requirements. **RTOS Architectures:** Monolithic kernels vs. microkernels. **RTOS examples:** commercial vs Open RTOS and their comparison, examples. **Inter-Process Communication (IPC):** Shared memory, Message passing. **RTOS Environment Setup:** Installation and setup of an RTOS on a microcontroller (e.g., ARM Cortex-M), **Task Creation and Management:** Writing simple tasks, Task states and transitions, **Scheduling and Context Switching:** Implementing basic scheduling algorithms, Demonstrating context switching with example tasks	**9**
2	**Real-Time Scheduling and Synchronization** **Real-Time Scheduling Algorithms:** Fixed-priority scheduling (Rate-	**9**

	Monotonic, Deadline-Monotonic), Dynamic priority scheduling (Earliest Deadline First), Priority based preemption, Round Robin, **Task Synchronization:** Mutual exclusion, Priority inversion and inheritance **Inter-Task Communication:** Semaphores, Mutexes, Event flags **Implementing Scheduling Algorithms:** Practical implementation of scheduling, **Synchronization Mechanisms:** Practical implementation of semaphores and mutexes in task synchronization, Demonstrating priority inversion and its mitigation: **Real-Time Task Communication:** Implementing inter-task communication using queues and mailboxes	
3	**Real-Time System Design and Analysis** **System Design Principles:** Modular design, Time-triggered vs. event-triggered systems, **Worst-Case Execution Time (WCET) Analysis:** Techniques for WCET estimation, Timing analysis, **Reliability and Fault Tolerance:** Redundancy, Error detection and recovery. **Designing a Real-Time System:** Case study: Designing a real-time control system, **WCET Analysis Tools:** Using tools for WCET analysis and timing verification, **Implementing Fault Tolerance:** Practical implementation of redundancy and error recovery mechanism	**9**
4	**Real-Time Operating System Services and Applications** **Real-Time Operating System Services:** Memory management, I/O management. **Real-Time Middleware:** Middleware services for real-time systems, **Case Studies and Applications:** Automotive systems, Aerospace and defense, Medical devices **Memory Management in RTOS:** Implementing dynamic memory allocation, **Real-Time Middleware Implementation:** Developing middleware components for a real-time application **Case Study Implementation:** Implementing a real-time system for a specific application (e.g., real-time data acquisition)	**9**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the fundamental concepts and characteristics of real-time systems.	**K1, K2**
CO2	Analyze and implement real-time scheduling algorithms and techniques.	**K4**
CO3	Conduct worst-case execution time (WCET) analysis for real-time tasks.	**K3, K4**
CO4	Utilize RTOS services and middleware for developing real-time applications	**K3,K4**
CO5	Develop practical real-time applications in various domains such as automotive, aerospace, and medical devices.	**K3, K4**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Real-Time Operating Systems Book 1: The Theory	Jim Cooling	CreateSpace Independent Publishing Platform	1st 2018
2	Real-Time Systems: Theory and Practice	Rajib Mall	Pearson Education	2007
3	Real-Time Systems: Design Principles for Distributed Embedded Applications	Hermann Kopetz	Springer	2nd 2011
4	Embedded Systems: Real-Time Operating Systems for Arm Cortex-M Microcontrollers	Jonathan W. Valvano	CreateSpace Independent Publishing Platform	3rd, 2017

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Real-Time Systems	C. M. Krishna, Kang G. Shin,	McGraw-Hill	2010
2	Real-Time Systems	Jane W. S. Liu	Pearson Education	2009
3	Real-Time Systems Design and Analysis	Philip A. Laplante, Seppo J. Ovaska,	Wiley	2012
4	Embedded Systems with ARM Cortex-M Microcontrollers in Assembly Language and C	Yifeng Zhu	E-Man Press LLC	3rd , 2017

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://elearn.nptel.ac.in/shop/iit-workshops/completed/lab-workshop-on-embedded-rtos/?v=c86ee0d9d7ed https://onlinecourses.nptel.ac.in/noc21_cs98/preview
2	https://elearn.nptel.ac.in/shop/iit-workshops/completed/lab-workshop-on-embedded-rtos/?v=c86ee0d9d7ed
3	https://elearn.nptel.ac.in/shop/nptel/real-time-operating-system/?v=c86ee0d9d7ed https://onlinecourses.nptel.ac.in/noc21_cs98/preview
4	https://elearn.nptel.ac.in/shop/iit-workshops/completed/lab-workshop-on-embedded-rtos/?v=c86ee0d9d7ed

SEMESTER S7

MIXED SIGNAL CIRCUITS

Course Code	PEECT754	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

4	**Data Converters:** DAC specifications, ADC specifications **DAC Architecture -** Resistor String, R-2R Ladder Networks, Current Steering, Charge Scaling, cyclic and Pipeline types. **ADC Architecture-** Flash type, The Successive approximation type and oversampling ADCs.	**9**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain various Single stage Amplifiers with different types of loads	**K2**
CO2	Explain Differential Amplifiers & Current Mirrors	**K2**
CO3	Apply the knowledge of amplifiers in the design of two stage OPAMP	**K3**
CO4	Illustrate the concept of frequency compensation in OPAMP	**K2**
CO5	Describe the specifications and architectures of data converter circuits	**K2**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Design of Analog CMOS Integrated Circuits	Behzad Razavi	McGraw-Hill	2/e, 2002
2	CMOS: Circuits Design, Layout and Simulation,	Baker, Li, Boyce,	Prentice Hall India,	2000
3	Microelectronic Circuits	Sedra & Smith	Oxford University Press	6/e,2017

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	CMOS Analog Circuit Design,	Phillip E. Allen, Douglas R. Holbery	Oxford University Press	3/e
2	Fundamentals of Microelectronics	Behzad Razavi	Wiley student Edition	2014
3	Analysis and Design of Analog Integrated Circuits	Meyer Gray , Hurst, Lewis	Wiley	5/e, 2009

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	www.youtube.com/@b_razavi, www.youtube.com/@analogicdesign-iitm5234
2	www.youtube.com/@b_razavi, www.youtube.com/@analogicdesign-iitm5234
3	www.youtube.com/@b_razavi, www.youtube.com/@analogicdesign-iitm5234
4	Switching Circuits and Logic Design by Prof. Indranil Sengupta Lectures 47-51

SEMESTER S7

SPEECH AND AUDIO PROCESSING

Course Code	PEECT 756	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None/ (Course code)	Course Type	Theory

Course Objectives:

1. To impart the basic concepts of speech signal processing
2. To familiarize the auditory mechanism and speech perception

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Speech Production: - Acoustic theory of speech production- -Source/Filter model - Pitch, Formant, Spectrogram-- Discrete model for speech production, Articulatory Phonetics -Acoustic Phonetics- Basic speech units and their classification.	9
2	Short-Time Speech Analysis, Windowing, STFT, spectra of windows- Wide and narrow band spectrogram -Time domain parameters (Short time energy, short time zero crossing Rate, ACF). Frequency domain parameters-Filter bank analysis. STFT Analysis. Prosody of speech. MFCC-computation, LPC Model, Pitch and Formant Estimation.	9
3	Speech Enhancement: Spectral subtraction and Filtering, Harmonic filtering, parametric resynthesis. Speaker Recognition: Speaker verification and speaker identification- log-likelihood. Machine learning models in Speaker Recognition. Language identification: implicit and explicit models.	9
4	Signal Processing models of audio perception: Basic anatomy of hearing System: Basilar membrane behaviour. Sound perception: Auditory Filter Banks, Critical Band Structure, Absolute Threshold of Hearing, Masking-Simultaneous Masking, Temporal Masking. Models of speech perception	9

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	To describe the fundamental concepts, principles, and theories of speech production	**K1**
CO2	To analyse the speech signal in the time and frequency domain	**K2**
CO3	To apply speech processing concepts in real-world applications	**K3**
CO4	To describe the fundamental concepts, principles, and theories of hearing mechanism	**K1**
CO5	To develop applications by combining concepts of speech production and hearing mechanism	**K3**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Speech Communications: Human and Machine, 2nd Edition	Douglas O'Shaughnessy	Wiley-IEEE Press	2nd edition
2	Discrete-Time Speech Signal Processing: Principles and Practice	Thomas F. Quatieri	Prentice-Hall Signal Processing Series	2001

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Processing of Speech Signals	Rabinar	Pearson	2003

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	Speech and Audio Processing 1: Introduction to Speech Processing - Professor E. Ambikairajah https://www.youtube.com/watch?v=Xjzm7S__kBU
2	Speech Analysis - Professor E. Ambikairajah https://www.youtube.com/watch?v=Y_mSQ7tTlvQ&t=38s
3	Speech and Audio Processing 1: Introduction to Speech Processing - Professor E. Ambikairajah https://www.youtube.com/watch?v=Xjzm7S__kBU
4	Video Links available on hearing anatomy

SEMESTER S7

MICROWAVE DEVICES & CIRCUITS

Course Code	PEECT 757	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Microwave & Antennas (Course code)	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

	Filter design by image parameter method – Constant k, m-derived and composite. Filter design by insertion loss method. Filter transformation and implementation	
4	Introduction to MICSs:-Technology of hybrid MICs, monolithic MICs. Comparison of both MICs. Planar transmission lines such as strip line, microstripline, and slot line. Distributed and lumped elements of integrated circuits -capacitors, inductors, resistors, terminations, attenuators, resonators and discontinuities.	**9**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Describe the basic principles of Microwave solid state diodes, transistors, generators and amplifiers.	**K2**
CO2	Analyse Microwave Networks using signal flow graphs	**K3**
CO3	Design microwave filters by different methods	**K3**
CO4	Illustrate the basic concepts of Monolithic Integrated Circuits	**K2**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Microwave Engineering,,	David M. Pozar,	Wiley India	4/e,2012.
2	, Foundation of Microwave Engineering,,	Robert E. Collin	Wiley India,	2/e,2012.
3	Microwave Devices & Circuits	Samuel Y. Liao,	Pearson	3/e
4	Microwave Integrated Circuits	Yoshihiro Konishi	Taylor & Francis	

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

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

SEMESTER S 7

MIXED SIGNAL CIRCUIT DESIGN

Course Code	PEECT755	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	5/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Solid State Devices, Network Theory	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

4	**Data Converters:** DAC specifications, ADC specifications **DAC Architecture -** Resistor String, R-2R Ladder Networks, Current Steering, Charge Scaling, cyclic and Pipeline types. **ADC Architecture-** Flash type, The Successive approximation type and oversampling ADCs.	**9**

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

Continuous Internal Evaluation Marks (CIE):

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

Criteria for Evaluation (Evaluate and Analyse): 20 marks

Criteria for Evaluation (Evaluate and Analyse): 20 marks
Evaluation Methods:

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

Students can perform specific experiments using tools QUCS, KiCad or PSPICE or LT Spice or CADENCE etc.
Each experiment can focus on designing and simulating different types of circuits

2. Course Project:
Comprehensive project involving design, modeling, and analysis of a Mixed Signal Circuit. (10 marks)
Project phases: Proposal, Design, Implementation, Testing, Final Report.Presentations and Viva Voce:
Students present their projects and experiments, explaining design choices, methodologies, and results.
Viva voce to assess understanding and ability to answer related questions.

The following topics may be identified for Assignments/ Miniproject

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

Criteria for Evaluation: Experiments (10 marks)

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

Criteria for Evaluation: Course Project (10 marks)

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

techniques.

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

3. Innovation and Creativity (2 marks)

a. Introduces innovative ideas or unique approaches in the design and implementation.

b. Demonstrates creativity in solving problems or optimizing designs.

4. Analysis and Testing (2 marks)

a. Effectively analyzes the project design to identify and address any issues.

b. Conducts thorough testing to verify the functionality and performance of the design.

5. Final Report and Presentation (1 mark)

a. Submits a comprehensive final report detailing the project, including objectives, design, methodology, analysis, and results.

b. Clearly presents the project and its outcomes, and effectively communicates the key points.

End Semester Examination Marks (ESE):

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Analyze the effect of different types of loads on the performance of various MOS Amplifiers	**K4**
CO2	Apply the knowledge of amplifiers in the design of two stage OPAMP	**K3**
CO3	Demonstrate the concept of frequency compensation in OPAMP	**K3**
CO4	Implement various types of data converter circuits	**K3**
CO5	Design and Implement amplifiers, OPAMPs, ADCs, DACs etc. with given specifications	**K3**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Design of Analog CMOS Integrated Circuits	Behzad Razavi	McGraw-Hill	2/e, 2002
2	CMOS: Circuits Design, Layout and Simulation,	Baker, Li, Boyce,	Prentice Hall India,	2000
3	Microelectronic Circuits	Sedra & Smith	Oxford University Press	6/e,2017

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	CMOS Analog Circuit Design,	Phillip E. Allen, Douglas R. Holbery	Oxford University Press	3/e
2	Fundamentals of Microelectronics	Behzad Razavi	Wiley student Edition	2014
3	Analysis and Design of Analog Integrated Circuits	Meyer Gray , Hurst, Lewis	Wiley	5/e, 2009

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	www.youtube.com/@b_razavi, www.youtube.com/@analogicdesign-iitm5234
2	www.youtube.com/@b_razavi, www.youtube.com/@analogicdesign-iitm5234
3	www.youtube.com/@b_razavi, www.youtube.com/@analogicdesign-iitm5234
4	Switching Circuits and Logic Design by Prof. Indranil Sengupta Lectures 47-51

SEMESTER S7

OPTICAL COMMUNICATION

Course Code	OEECT721	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PHYSICS	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

	analysis Coherent detection principles. **Optical Amplifiers:** EDFA - Principle, structure and working, Raman amplifiers	
4	**Multiplexing Strategies:** OTDM, SCM, OFDM, WDM and Optical CDMA: concepts, components - couplers, splitters, Add/ Drop multiplexers, Fiber grating filters, tunable filters. **Optical networks** – General description of SONET/SDH **Free space optics:** Principle of LiFi technology. Visible Light Communication **Other applications of optical fibers**: Entertainment, Sensors – Types & principles	**9**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the structure, fabrication, principle of operation and classifications of optical fibers	**K2**
CO2	Describe the transmission characteristics and evaluate losses in optical fiber	**K2**
CO3	Explain the working of sources, detectors and optical amplifiers used in optical communication system	**K2**
CO4	Describe the concepts of Multiplexing, Optical Networks and Free Space Communication	**K2**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Optical Fiber Communications	Gerd Keiser	McGraw Hill	5th/e, 2021
2	Optical Fiber Communication: Principles and Practice	John M Senior	Pearson Education	3rd/e, 2014
3	Fibre Optic Communications	Joseph C. Palais	Pearson Education	5th/e, 2013
4	Fibre optic Communication: Systems and Components	Mishra and Ugale,	Wiley	2019
5	Fibre Optic Communications Systems	G P Agrawal	WILEY	4th Ed

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

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

SEMESTER S7

DIGITAL IMAGE PROCESSING

Course Code	OEECT 722	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None/ (Course code)	Course Type	Theory

Course Objectives:

1. To introduce the fundamental concepts of Digital Image Processing and study the various transforms required for image processing.
2. To study spatial and frequency domain image enhancement and image restoration methods.
3. To understand image compression and segmentation techniques.,

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Digital Image Fundamentals: Image representation, Types of images, Elements of DIP system, Basic relationship between pixels, Distance Measures, Simple image formation model. Brightness, contrast, hue, saturation, Mach band effect. Colour image fundamentals-RGB, CMY, HIS models, 2D sampling and quantization.	9
2	2D Image transforms: DFT, Properties, Walsh transform, Hadamard transform, Haar transform, DCT, KL transform and Singular Value Decomposition. Image Compression: Image compression model, Lossy, lossless compression, Concept of transform coding, JPEG Image compression standard.	9
3	Image Enhancement: Spatial domain methods: Basic Gray Level Transformations, Histogram Processing, Enhancement Using Arithmetic/Logic Operations, Basics of Spatial Filtering, Smoothing spatial Filters, Sharpening spatial Filters. Frequency domain methods: low pass filtering, high pass filtering, homomorphic filtering.	9

4	Image Restoration: Degradation model, Inverse filtering- removal of blur caused by uniform linear motion, Minimum Mean Square Error (Wiener) Filtering. Image segmentation: Region based approach, clustering , Segmentation based on thresholding, edge based segmentation, Hough Transform.	**9**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain different components of image processing system	**K2**
CO2	Analyse the various concepts and mathematical transforms necessary for image processing	**K3**
CO3	Illustrate the various schemes of image compression	**K3**
CO4	Analyze the filtering and restoration of images	**K3**
CO5	Describe the basic image segmentation techniques	**K2**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Image Processing	Gonzalez Rafel C	PEARSON	4TH
2	Digital Image Processing	S Jayaraman, S Esakkirajan, T Veerakumar	McGraw Hill	Ist

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Image Processing	Kenneth R Castleman	Pearson Education	2/e,2003
2	Fundamentals of digital image processing	Anil K Jain	PHI	1988
3	Digital Image Processing	Pratt William K	John Wiley	4/e,2007

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc24_ee133/preview
2	https://nptel.ac.in/courses/117105135
3	https://www.youtube.com/watch?v=KiJo4-IijL4
4	https://archive.nptel.ac.in/courses/117/105/117105135/

SEMESTER S7

OPTIMIZATION TECHNIQUES

Course Code	**OEECT723**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None/ (Course code)	**Course Type**	Theory

Course Objectives:

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

SYLLABUS

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

3	Optimization algorithms for solving constrained optimization problems– direct methods – penalty function methods, barrier method -Optimization of function of multiple variables subject to equality constraints; Lagrangian function– Inequality constrained techniques-KKT conditions-constrained steepest descent method	**9**
4	Modern methods of Optimization– Metaheuristic techniques: Genetic Algorithms – Simulated Annealing – Particle Swarm optimization –Ant colony optimization– : Use of Matlab/Scilab to solve optimization problem	**9**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Formulate an optimization problem to optimize an engineering application using the principles of basic calculus.	**K2**
CO2	Apply the Simplex method to solve a linear programming problem	**K3**
CO3	Solve the unconstrained optimization problems using gradient based method.	**K3**
CO4	Apply the various optimization techniques to solve a constrained optimization problem	**K3**
CO5	Use metaheuristic algorithms to solve constrained and unconstrained	**K2**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Engineering Optimization, Theory and Practice	S.S RAO	New Age International Publishers	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