SCHEME OF INSTRUCTION AND EXAMINATION

B. E. (ECE)

VII–Semester

S. No	Code	Course Title	Scheme of Instruction			Contact Hrs/Wk	Scheme of Evaluation			Credits
			L	T	P		Hrs	CIE	SEE	
Theory										
1	PC701EC	IoT Applications	3	-	-	3	3	40	60	3
2	PC702EC	Microwave Techniques	3	-	-	3	3	40	60	3
3	PC703EC	Satellite Communication and Applications	3	-	-	3	3	40	60	3
4	**Professional Elective- II**		3	-	-	3	3	40	60	3
	PE711EC	Artificial Intelligence & Machine Learning								
	PE712EC	Digital Image Processing								
	PE713EC	Object Oriented Programming Using C++								
5	**Professional Elective-III**		3	-	-	3	3	40	60	3
	PE714EC	Deep Learning								
	PE715EC	Low Power VLSI								
	PE716CS	Optical Communications								
Practicals										
6	PC761EC	Antenna and Microwave Lab	-	-	3	3	3	25	50	1.5
7	PC762EC	IoT Applications			3	3	3	25	50	1.5
8	PW761EC	Major project Phase-I	-	-	8	8	-	50	-	4
Total			**15**	**-**	**12**	**14**	**21**	**300**	**400**	**22**

Course Code	Course Title						Core//PE/OE
PC701EC	IOT APPLICATIONS						Core
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives : The course is taught with the objectives of enabling the student to:

1. Discuss fundamentals of IoT and its applications and requisite infrastructure
2. Describe Internet principles and communication technologies relevant to IoT
3. Discuss hardware and software aspects of designing an IoT system
4. Describe concepts of cloud computing and Data Analytics
5. Discuss business models and manufacturing strategies of IoT products

Course Outcomes : On completion of this course, the student will be able to :

1. Understand the various applications of IoT and other enabling technologies.
2. Comprehend various protocols and communication technologies used in IoT
3. Design simple IoT systems with requisite hardware and C programming software
4. Understand the relevance of cloud computing and data analytics to IoT
5. Comprehend the business model of IoT from developing a prototype to launching a product

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

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

Introduction to Internet of Things IOT vision, Strategic research and innovation directions, Iot Applications, Related future technologies, Infrastructure, Networks and communications, Processes, Data Management, Security, Device level energy issues

UNIT–II

Internet Principles and communication technology Internet Communications: An Overview – IP, TCP, IP protocol Suite, UDP. IP addresses – DNS, Static and Dynamic IP addresses, MAC Addresses, TCP and UDP Ports, Application Layer Protocols – HTTP, HTTPS, Cost Vs Ease of Production, Prototypes and Production, Open-Source Vs Closed Source

UNIT–III

Prototyping and programming for IoT Prototyping Embedded Devices – Sensors, Actuators,

Microcontrollers, SoC, Choosing a platform, Prototyping Hardware platforms – Arduino, Raspberry Pi. Prototyping the physical design – Laser Cutting, 3D printing, CNC Milling. Techniques for writing embedded C code: Integer data types in C, Manipulating bits - AND, OR, XOR, NOT, Reading and writing from I/ O ports. Simple Embedded C programs for LED Blinking, Control of motor using switch and temperature sensor for arduino board

UNIT-IV

Cloud computing and Data analytics Introduction to Cloud storage models -SAAS, PAAS, and IAAS. Communication APIs, Amazon webservices for IoT, Skynet IoT Messaging Platform. Introduction to Data Analytics for IoT - Apache hadoop- Map reduce job execution workflow

UNIT – V

IoT Product Manufacturing - From prototype to reality Business model for IoT product manufacturing, Business models canvas, Funding an IoT Startup, Mass manufacturing - designing kits, designing PCB,3D printing, certification, Scaling up software, Ethical issues in IoT- Privacy, Control, Environment, solutions to ethical issues

SUGGESTED READING:

1 Adrian McEwen, Hakim Cassimally, “Designing the Internet of Things”, Wiley India Publishers, 2015

2 Daneil W lewies,”Fundamentals of embedded software: where C meets assembl”, Pearson, 200.

3 Arshdeep Bahga and Vijay Madisetti ,“Internet of Things: A Hands-on Approach”, Orient Blackswan Private publishers, First edition, 2015

Course Id	Course Title				CORE/PE/OE
PC 702 EC	MICROWAVE TECHNIQUES				CORE
Prerequisites	-	L	T	P	C
		3	0	0	3
Evaluation	SEE	60 Marks	CIE		0 Marks

	Course Objectives:
	The course is taught with the objectives of enabling the student to:
1	To learn field calculations between parallel planes.
2	To analyze and study rectangular and circular wave guides using field theory.
3	To Understand the operation of passive waveguide components.
4	To Analyze microwave circuits using scattering parameters.
5	To study the construction and to understand principal of amplification/Oscillation at microwave frequency.

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	Understand electromagnetic wave propagation in parallel plane waveguides.
CO-2	Understand electromagnetic wave propagation in rectangular and circular waveguides and resonators.
CO-3	Understand the formulation of Scattering Matrix and define them for various microwave components.
CO-4	Learn principle of operation and applications of specialized microwave vacuum tubes.
CO-5	Distinguish between transfer electron devices from ordinary low frequency semiconductor devices and learn basic modes of operation of Gunn Diode and its applications.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO-1	3	2	-											
CO-2	2	3												
CO-3	3	-	3		1	1	1	1						
CO-4	2	2				1			1			1		
CO-5	2	2					1	1						

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

Introduction, Microwave Spectrum and Bands, Advantages and Applications of Microwaves, Waves between parallel planes, TE, TM, TEM Waves characteristics, Velocity of propagation, Group and Phase velocity, Wave Impedance, Attenuation in parallel plate guides.

UNIT–II

Rectangular Waveguides: Rectangular waveguides, TM and TE waves, Impossibility of TEM wave in waveguides, Wave Impedance, Attenuation in Rectangular waveguides, Circular Waveguides: Solution of wave equations in cylindrical coordinates, Characteristics of TM and TE modes. Microwave Cavities: Rectangular and Circular Cavity Resonators, Quality factor and applications of cavity resonators.

UNIT–III

Microwave circuit concepts, Introduction to scattering parameters. Properties and Sparameters of reciprocal components – E and H Plane Tees, Magic Tee, Directional Coupler. Non-Reciprocal Components: Ferrites – Composition and Faraday Rotation; Ferrite Components – Isolators, Gyrators and Circulators. S- Parameters of Isolator and Circulator.

UNIT-IV

High Frequency limitations of conventional tubes, Two cavity Klystron, Bunching by velocity modulation, Small signal theory of bunching, Effect of grid interception and debunching. Tran‘s admittance, Reflex Klystron, Mathematical theory of bunching, Admittance spiral and condition of oscillation. Principle of operation, construction and characteristics of TWT Amplifier, Backward wave oscillator (qualitative treatment only).

UNIT – V

Principle of operation, construction and characteristics of multi-cavity magnetron, Microwave Solid-state devices: Introduction, Classification and Applications. TEDs — Introduction, Gunn Diode — Principle, RWH Theory, Characteristics, Basic Modes of Operation, Oscillation Modes, Introduction to Avalanche Transit-Time Devices.

SUGGESTED READING:

1	Samuel Y. Liao , Microwave Devices and Circuits, 3rd Edition(2013), Prentice Hall of India, New Delhi.
2	R.E.Collin, Foundations for Microwave Engineering, 2nd Edition(2011), Mc Graw Hill.
3	Annapurna Das and Sisir K Das “Microwave Engineering” 1st Edition(2000), Tata McGraw-Hill.
4	Rizzi P, “Microwave Devices and Circuits”, 3rd Edition(2003), Pearson Education.
5	M. L. Sisodia, G. S. Raghuvanshi, Microwave Circuits and Passive Devices 1st Edition(1995), Wiley Eastern Ltd. and New Age International Publishers Ltd.

Course Code	Course Title						Core//PE/OE
PC703EC	SATELLITE COMMUNICATION AND APPLICATIONS						Core
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
-	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives : The course is taught with the objectives of enabling the student to:

1. To familiarize with basic concepts related to satellite Communication
2. To understand Sub-Systems of Satellites and Launches
3. To study about the Satellite signal propagation.
4. To know about the Satellite Navigation.
5. To understand about the Deep Space missions and applications of satellites

Course Outcomes : On completion of this course, the student will be able to :

1. Have knowledge about the Satellite communications Principles and Properties
2. Know about the Space craft subsystems, Launch vehicles and Satellite link.
3. Able to design the satellite signal propagation effects
4. Able to analyze the significance and operation of satellite navigation systems.
5. Able to understand the space missions and applications of Satellite Communication

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1	2	-	-	-	3	3	2	1	3	3
CO2	3	2	2	2	3	2	-	-	3	3	3	2	3	2
CO3	3	3	3	3	3	1	-	-	3	3	3	2	2	3
CO4	2	3	3	2	3	2	-	-	3	3	3	2	3	2
CO5	3	3	3	3	2	-	-	-	3	3	1	2	3	3

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

Origin of Satellite communications, A Brief History of Satellite Communication, Basic principles and properties of satellite communication. Earth segment, Space segment, Interpretation of Kepler's Laws, Space craft sub systems, Orbital Mechanics: The Equation of the Orbit, Describing the Orbit, Locating the Satellite in the Orbit, Orbital effects in communication system Performance: Doppler shift, Range variation, Eclipse and Sun-Transit Outage

UNIT–II

Equipment Reliability and Space Qualification: Space Qualification, Reliability, and Redundancy, Satellite launch and launch vehicles and Mechanics of Launching a Synchronous Satellite. Earth Stations – Types of Earth stations- large, medium and small. Satellite Link Design: Basic Transmission Theory, System Noise Temperature and G/T ratio, Noise Temperature, calculation of System Noise Temperature and Noise Figure

UNIT–III

Propagation on Satellite-Earth paths: Attenuation, depolarization, atmospheric absorption, Tropospheric Multipath effects and Land and Sea Multipath, Multipath Effects in System Design, Faraday rotation in the Ionosphere, Ionospheric scintillations, Rain and ice effects. Concept of TDMA

UNIT-IV

Satellite Navigation Applications: Significance, Transit system, Global and Regional Satellite Navigation Systems-Operating Principle, Advantages, Limitations, Current Status and Applications, Remote Sensing Satellites

UNIT – V

Space debris-History,Sources of debris, Hazards, Tracking and measurements, Debris removal Methods. Mars Orbiter mission, Chandrayaan1, 2 and 3 missions, Aditya L1, Gaganyaan, NISAR, Satellites, Indian Satellite Launchers under development, Indian Geo platform of ISRO -Bhuvan, Space applications

SUGGESTED READING:

1. Wilbur L. Pitchand and Henri G. Suyderhoud, Robert A. Nelson, ―Satellite Communication Systems Engineering‖, 2ndedn. 3rd Impression, Pearson Education.2008.
2. Timothy Pratt and Charles Nestian. W, ―Satellite Communication‖, John Wiley and Sons, 1988.
3. Tri T. Ha, ―Digital Satellite Communication‖, Tata McGraw- Hill, Special Indian Edition 2009
4. https://www.isro.gov.in

Course Code	Course Title						Core//PE/OE
PE711EC	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING						PE-II
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
-	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives : The course is taught with the objectives of enabling the student to:

1. Understand different types of Intelligent agents and Various search algorithms
2. Learn game-playing and CSP techniques
3. Learn Knowledge Representation, Reasoning, and Planning
4. Acquire knowledge of Probabilistic Reasoning
5. Understand the concepts of learning and its application

Course Outcomes : On completion of this course, the student will be able to :

1. Apply various search algorithms in real time
2. Apply game-playing and CSP techniques
3. Perform Knowledge Representation, Logical Reasoning and Planning
4. Perform Probabilistic Reasoning
5. Apply different types of learning in applications like NLP, robotics

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

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

Introduction to AI: Introduction, history, intelligent systems, foundations of AI, applications, development of AI languages, current trends.

UNIT–II

Artificial Neural Networks: Biological neurons and artificial neurons. Model of an ANN. Activation functions used in ANNs. Typical classes of network architectures. Mathematical Foundations and Learning mechanisms, Feed forward ANN: Structures of Multi-layer feed forward networks. Back propagation algorithm. Back propagation – training and convergence. Functional approximation with back propagation.

UNIT–III

Supervised Machine Learning: Basics of linear regression, its assumptions, limitations and industry applications. Least square based and Gradient Descent Based Regression, Multiple linear regression, Polynomial regression, Logistic regression.

UNIT-IV

Unsupervised Machine Learning: Different clustering methods (Distance, Density, Hierarchical) , Iterative distance-based clustering; K-Means Clustering Algorithm and Image Quantization, basics of Principal Component Analysis

UNIT – V

Introduction to Deep learning: Analyze the key computations underlying deep learning, Convolutional Neural Network, Building blocks of CNN- Convolutional layers, Pooling layers Dense layers.

SUGGESTED READING:

1 Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Third Edition, Pearson 2016.

2 Elaine Rich, Kevin Knight, Shivashankar B. Nair, Artificial Intelligence", McGraw-Hill, Third Edition, 2009.

3 Dan W. Patterson, "Introduction to Al and ES", Pearson, 2007.

4 Patrick H. Winston, "Artificial Intelligence", Third Edition, Pearson Education, 2006

Course Code	Course Title						Core//PE/OE
PE712EC	DIGITAL IMAGE PROCESSING						PE-II
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
Digital Signal Processing	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives : The course is taught with the objectives of enabling the student to:

1. Understand the image formation and its digital representation
2. Learn digital image fundamentals. Be exposed to simple image processing techniques
3. Learn representation of images in frequency domain and enhancement techniques
4. Be familiar with image compression and segmentation techniques. Learn to represent image in form of features
5. Solve the problems related to image compression and learn the basics of video

Course Outcomes : On completion of this course, the student will be able to :

1. Understand how images are formed, sampled and quantized
2. Apply various transforms like Fourier, DCT, Haar, DWT and Hadamard Transform to different applications
3. Apply image enhancement techniques for practical applications
4. Implement the image restoration techniques
5. Implement image compression techniques by removing the redundancy

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

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

Digital Image Fundamentals: Image sensing, acquisition, Image formation model, sampling and Quantization, Basic relationships between pixels; neighbors of a pixel, adjacency, connectivity, regions and boundaries. Image formation in the eye, its capabilities for brightness adaptation and discrimination. Categorization of images according to their source. Gamma ray imaging, x-ray imaging, imaging in the Ultra Violet band, visible and infrared bands, Microwave band and Radio band.

UNIT–II

Image Transforms: 2D Fourier transform, Properties of 2D Fourier transform, Walsh, Hadamard, Slant, Haar, Discrete cosine transform and Hotelling transform. Color Image Processing: Color Fundamentals, Color Models, Pseudo color Image Processing.

UNIT–III

Image Enhancement: Spatial domain techniques: Contrast stretching, histogram equalization and histogram specification method, Neighborhood averaging and adaptive Median filter. Frequency domain methods: Ideal Low pass, Butterworth and Gaussian Low pass filters. Ideal High pass, Butterworth and Gaussian High pass filters. Homomorphic filtering.

UNIT-IV

Image Restoration: Mathematical expression for degraded image, estimation of degradation functions: Image observation, experimentation and modeling. Inverse filter Wiener filter, Geometric transformation, periodic noise reduction method.

Image Segmentation and Compression: Detection of discontinuities, point detection methods, line detection. Edge detection methods: Gradient operation, Laplacian, Prewitt, Sobel, Laplacian of a Gaussian and Canny edge detectors.

UNIT – V

Image compression: Functional block diagram of a general image compression system and description of each unit, various types of redundancies, coding redundancy, psycho visual redundancy spatial and temporal redundancy, Huffman coding.

Video Sampling: Analog video, Digital Video, Time-varying Image formation models, 3D motion models, Geometric image formation, Photometric image formation, Sampling of video signals

SUGGESTED READING:

1. Rafael C. Gonzales, Richard E. Woods, "*Digital Image Processing*", Third Edition, Pearson Education, 2010.
2. Anil K Jain, "*Fundamentals of Digital Image Processing"*, Prentice-Hall of India Private Limited, New Delhi, 1995
3. . Milan Sonka, Vaclav Havel and Roger Boyle, "*Digital Image Processing and Computer vision"*, Cengage Learning India Pvt. Limited, 2008.
4. M. Tekalp, "Digital Video Processing", Prentice-Hall International, Second Edition,2015
5. ALAN C BOVIK, ―Hand Book of Image and Video Processing, 2nd Edition, Elsevier Academic Press, 2005

Course Code	Course Title						Core//PE/OE
PE713EC	OBJECT ORIENTED PROGRAMMING USING C++						PE-II
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives : The course is taught with the objectives that the student is:

1. Introduced to Object Oriented Programming concepts using the C++ language
2. Introduced to the principles of data abstraction, inheritance and polymorphism
3. Introduced to the principles of virtual functions and polymorphism
4. Introduced with handling formatted I/O and unformatted I/O
5. Introduced to handle exceptions

Course Outcomes : On completion of this course, the student will be able to :

1. Able to develop programs with reusability
2. Understand different types of constructors and initialization of objects
3. Handle exceptions in programming
4. Handle formatted and unformatted I/O
5. Develop applications for a range of problems using object-oriented programming techniques

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

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

Basic Concepts of OOP, Benefits of OOP, Object Oriented Languages, Features of OOP. How OOP Differ from POP. Applications of OOP, A Simple C++ Program, Structure of C++ Program. Keywords, Identifiers and Constants, Basic Data Types, User Defined Data Types, Derived Data Types, Dynamic Initialization of Variables, Reference Variables, Operators in C++, Scope Resolution Operator, Member Dereferencing Operators, Memory Management Operators

UNIT–II

Functions, Classes and Objects: Introduction of Classes, Specifying a Class, Defining a Member Functions, A C++ Program with Class Access Specifies, Inline functions, Nesting of Member Functions, Memory Allocation for Objects, Static Data Members, Static Member Functions, Arrays of Objects, Objects as Function Arguments, Default Arguments, Const Arguments, Function Overloading, Friend Functions.

UNIT–III

Constructors, Destructors, Inheritance: Introduction, Constructors, Parameterized Constructors, Multiple Constructors in a Class, Constructors with Default Arguments, Dynamic initialization of Objects, Copy Constructors, Dynamic Constructors, Destructors. Introduction to inheritance, Defining Derived Classes, Single Inheritance, Multiple Inheritance, Multi-Level Inheritance, Hierarchical Inheritance, Hybrid Inheritance, Abstract Classes, Constructors in Derived Classes, Containership, Operator overloading, Rules for Operator overloading, overloading of binary and unary operators

UNIT-IV

Pointers, Virtual Functions and Polymorphism: Introduction, Memory Management, new Operator and delete Operator, Pointers to Objects, this Pointer, Pointers to Derived Classes, Polymorphism, compile time polymorphism, Run time polymorphism, Virtual Functions, Pure Virtual Functions, Virtual Base Classes, Virtual Destructors

UNIT – V

Templates and Exception handling: Introduction, Class Templates, Class Templates with Multiple Parameters, Function Templates, Function Templates with Multiple Parameters, Member Function Templates. Basics of Exception Handling, Types of exceptions, Exception Handing Mechanism, Throwing and Catching Mechanism, Re-throwing an Exception, Specifying Exceptions

SUGGESTED READING:

1. Walter Savitch, *"Problem Solving with C++",* 6th Edition, Pearson Education Publishing.
2. SB Lippman, J Lajoie, *"C++ Primer"*, 3rd Edition, AW Publishing Company, 2007.
3. Paul Dietel, Harvey Dietel, *"C How to Program"*, 6th Edition, PHI, 2010.
4. BjarneStroustrup, *"The C++ Programming Language",* 3rd Edition, Pearson Education.
5. Ashok N.Kamthane, *"Programming in C++"* 2nd Edition, Pearson Education Publishing.

Course Code	Course Title						Core//PE/OE
PE714EC	DEEP LEARNING						PE-III
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives : The course is taught with the objectives of enabling the student to:

1 To understand complexity of Deep Learning algorithms and their limitations
2. To understand modern notions in data analysis oriented computing;
3. To apply Deep Learning algorithms in practical applications
4. To perform experiments in Deep Learning using real-world data.

Course Outcomes : The student will be able to

1. Understand the concepts of Neural Networks, its main functions, operations and the execution pipeline
2. Implement.
3. Learn topics such as deep learning algorithms, understand neural networks and traverse the layers of data abstraction Convolutional neural networks, recurrent neural networks, training deep networks and modifications
4. Build deep learning models in PyTorch and interpret the results

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

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT-I

Artificial Neural Networks: Introduction, Perceptron, XOR Gate ,Perceptron Training Rule, Activation Functions.

Linear Neural Networks: Linear Regression, Implementation of Linear Regression, Softmax Regression, The Image Classification Dataset , Implementation of Softmax Regression

UNIT-II

Multilayer Perceptrons:

Multilayer Perceptrons, Implementation of Multilayer Perceptrons, Model Selection, Underfitting and Overfitting, Weight Decay, Dropout, Forward Propagation, Backward Propagation, and Computational Graphs, Numerical Stability and Initialization, Considering the Environment, Predicting House Prices on Kaggle.

Optimization Algorithms: Optimization and Deep Learning, Convexity, Gradient Descent, Stochastic Gradient Descent, Mini batch Stochastic Gradient Descent, Momentum, Adagrad, RMS Prop, Ada delta, Adam, Learning Rate Scheduling.

UNIT-III

Introduction to Convolutional Neural Networks

Introduction to CNNs, Kernel filter, Principles behind CNNs, Multiple fillters,

Modern Convolutional Neural Networks

Deep Convolutional Neural Networks (AlexNet), Networks Using Blocks (VGG), Network in Network (NiN), Networks with Parallel Concatenations (GoogLeNet), Batch Normalization, Residual Networks (ResNet), Densely Connected Networks (DenseNet).

UNIT-IV

Recurrent Neural Networks: Sequence Models, Text Preprocessing, Language Models and the Dataset, Recurrent Neural Networks, Implementation of Recurrent Neural Networks from Scratch, Concise Implementation of Recurrent Neural Networks, Back propagation Through Time**.**

Modern Recurrent Neural Networks: Gated Recurrent Units (GRU), Long Short Term Memory (LST), Deep Recurrent Neural Networks, Bidirectional Recurrent Neural Networks, Machine Translation and the Dataset, Encoder-Decoder Architecture, Sequence to Sequence, Beam Search.

UNIT-V

Auto Encoders: Types of Auto Encoders and its applications

Generative Adversarial Networks: Generative Adversarial Network,Deep Convolutional Generative Adversarial Networks

Suggested Readings:

Good fellow, I., Bengio,Y., and Courville, A., "*Deep Learning"*, MIT Press, 2016.

Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, "*Dive into Deep Learning",* 2020.

Course Id	Course Title				Core/PE/OE	
PE715EC	LOW POWER VLSI				PE-III	
Pre-requisites	-		L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	To study the sources of power dissipation and low power design techniques with voltage
2	To study various low power arithmetic units and the design of low power multipliers
3	To study about low power memory technologies

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	Understand various power components
CO-2	Understand and design low power memories
CO-3	Understand and use mathematical models for power analysis in CMOS circuits
CO-4	Design low power architectures
CO-5	Understand and design multipliers

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

Fundamentals: Need for Low Power Circuit Design, Sources of Power Dissipation –

Switching Power Dissipation, Short Circuit Power Dissipation, Leakage Power Dissipation, Glitching Power Dissipation, Short Channel Effects –Drain Induced Barrier Lowering and Punch Through, Surface Scattering, Velocity Saturation, Impact Ionization, Hot Electron Effect.

UNIT–II

Low-Power Design Approaches: Low-Power Design through Voltage Scaling – VTCMOS circuits, MTCMOS circuits, Architectural Level Approach –Pipelining and Parallel Processing Approaches. Switched Capacitance, Minimization Approaches: System Level Measures and Circuit Level Measures.

UNIT–III

Low-Voltage Low-Power Adders: Introduction, Standard Adder Cells, CMOS Adder

Architectures – Ripple Carry Adders, Carry Look-Ahead Adders, Carry Select Adders, Carry Save Adders, Low-Voltage Low-Power Design Techniques–Trends of Technology and Power Supply Voltage, Low-Voltage Low-Power Logic Styles.

UNIT-IV

Low-Voltage Low-Power Multipliers: Introduction, Overview of Multiplication, Types of Multiplier Architectures, Braun Multiplier, Baugh-Wooley Multiplier, Booth Multiplier and Introduction to Wallace Tree Multiplier.

UNIT – V

Low-Voltage Low-Power Memories: Basics of ROM, Low-Power ROM Technology, Future Trend and Development of ROMs, Basics of SRAM, Memory Cell, Pre-charge and Equalization Circuit, Low-Power SRAM Technologies, Basics of DRAM, Self-Refresh Circuit, Future Trend and Development of DRAM.

SUGGESTED READING:

1	Sung-Mo Kang, Yusuf Leblebici, *"CMOS Digital Integrated Circuits – Analysis and Design"*, TMH, 2011.
2	Ming-BO Lin, "*Introduction to VLSI Systems: A Logic, Circuit and System Perspective",* CRC Press, 2011
3	Anantha Chandrakasan, *"Low Power CMOS Design*", IEEE Press/Wiley International, 1998
4	Kaushik Roy, Sharat C. Prasad, *"Low Power CMOS VLSI Circuit Design*", John Wiley & Sons,2000.
5	Gary K. Yeap, "*Practical Low Power Digital VLSI Design*", Kluwer Academic Press, 2002.

Course Code	Course Title						Core//PE/OE
PE716EC	OPTICAL COMMUNICATIONS						PE-III
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
Analog and Digital Communications	3	-	-	-	40	60	3

Course Objectives : The course is taught with the objectives of enabling the student to:

1. To become familiar with the fundamental concepts of Light, Basic laws of light, various types of Optical fibers, modes and configurations
2. To acquaint with theoretical analysis of the Signal propagation and distortion during propagation of light in Optical Fibers
3. To become familiar with Optical sources, Optical detectors and Optical amplifiers
4. To understand the design principles of Digital and Analog links
5. To know the operating principles of WDM and components for its realization

Course Outcomes : On completion of this course, the student will be able to :

1. Able to apply Optical Laws to provide solutions to the problems of Optical Waveguides
2. Able to deal with the Optical Communication System designs
3. Able to carry out the calculations of various noise powers at Optical Receivers
4. Able to design the Optical Link Power Budget and Rise Time Budget for the given applications
5. Able to design the WDM systems with various system considerations

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO-1	2	-	-	1	-	-	-	-	-	-	-	-	-	-
CO-2	1	2	-	1	-	-	-	-	-	-	-	-	-	-
CO-3	1	2	-	1	-	-	-	-	-	-	-	-	1	-
CO-4	1	1	-	1	1	-	-	-	-	-	-	1	1	-
CO-5	1	-	-	1	1	-	-	-	-	-	-	1	1	-

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT – I

Overview of Optical Fiber Communications: The evolution of optical fiber systems, Elements of an Optical fiber transmission link, Optical fibers, Nature of light – basic optical laws and definitions – Modes and configurations, Mode of theory of circular waveguides, Single and multi- mode step index and graded index fibers.

UNIT – II

Signal degradation in Optical fibers: Attenuation, Signal distortion in optical waveguides, Mode coupling, and Design optimization of single mode fibers.

Optical sources: Semiconductors as optical sources and their fabrication, LED's and Laser diodes, Linearity of sources.

UNIT – III

Photo detectors: Physical principles of PIN and APD, Photo detector noise, Detector response time, Avalanche multiplication noise, Comparisons of Photo detectors.
Optical receiver operation: Fundamental receiver operation, Digital receiver performance calculation. Preamplifiers types, Analog receivers.

UNIT – IV

Point-to-Point Optical links: System considerations, Link power budget, Rise time budget, Noise effects on system performance. Overview of analog links, Carrier noise ratio in analog systems.

UNIT –V

Optical Amplifiers & WDM: Introduction to optical amplifiers, Basic applications and types of Optical amplifier, WDM concepts and Components, operational principles, passive components, Tunable sources and Tunable filters.

Suggested Reading:

1. Gerd Keiser, "Optical Fiber Communications", 3rd Edition, Tata McGraw- Hill publishing company Limited, New Delhi, 2000.
2. D.C.Agarwal, "Fiber Optic Communication", 2nd Edition, Wheeler publishing, New Delhi, 1993.
3. D. k. Mynbaev, L.L. Scheiner, "Fiber-Optic Communications Technology", Pearson education, New Delhi, 2006.

PC 761 EC	ANTENNA & MICROWAVE LABORATORY					
Prerequisites			**L**	**T**	**P**	**C**
					2	**1**
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	To define the range of frequencies for operation in microwave engineering.
2	To discover the functions of microwave components.
3	To verify the various characteristics of active passive microwave devices practically.
4	To Measure Different parameters of an antenna.
5	To find the Transmission Line characteristics practically.

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	Study the characteristics of microwave sources.
CO-2	Estimate the guide wave length and free space wave length of a wave.
CO-3	Analyze the characteristics of antenna and microwave devices.
CO-4	Plot the radiation characteristics of UHF and microwave antennas.
CO-5	Analyze the characteristics of Transmission Line.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	-	-	-	-	-	-	-	-		
CO2	3	3	1	2	-	-	-	-	-	-	-	-		
CO3	3	3	2	2	1	-	-	-	-	-	-	-		
CO4	2	3	2	3	1	1	-	-	-	-	-	-		
CO5	3	3	2	2	-	-	-	-	-	-	-	-		

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

Microwave Source Characteristics
Reflex Klystron characteristics, Gun diode characteristics.

Waveguide Component characteristics
Measurement of standing wave pattern, VSWR measurement, Low &High VSWR measurements .
Measurement of unknown load characteristics of windows.. .
Measurement of Frequency, Wavelength, group and phase velocity. .
Directional Coupler characteristics, Coupling, Directivity and Isolation Measurements. .
E plane, H plane and Magic Tee characteristics. .
Characteristics of Circulator, Isolator, Measurement of S-parameters through insertion loss and isolation. .

Antenna Measurements
Plot Radiation pattern of all Wired Antenna. .
Plot Radiation pattern of all Aperture Antenna. .
Plot Radiation pattern of all Reflector Antenna. .
Plot Radiation pattern of all Array Antenna. .
Measurement in co-polarization and cross polarization. .
Circularly polarized antenna. .

Transmission Line Measurements
Measure the characteristics of Standing Wave. .
Measure the characteristics of OPEN &SHORT LOAD. .
Measurement of S-parameters (S11, S12, S21, S22). .

SUGGESTED READING:

1	Samuel Y. Liao, "Microwave Device and Circuits",PH1,3rd Edition.1994.
2	Pozar D.M., "Microwave Engineering", John Wiley & Sons 3rd Edition,2005.

Course Code	Course Title						Core//PE/OE
PC762EC	IOT APPLICATIONS						Core
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives : The course is taught with the objectives of enabling the student to:

6. Discuss fundamentals of IoT and its applications and requisite infrastructure
7. Describe Internet principles and communication technologies relevant to IoT
8. Discuss hardware and software aspects of designing an IoT system
9. Describe concepts of cloud computing and Data Analytics
10. Discuss business models and manufacturing strategies of IoT products

Course Outcomes : On completion of this course, the student will be able to :

1. Understand the various applications of IoT and other enabling technologies.
2. Comprehend various protocols and communication technologies used in IoT
3. Design simple IoT systems with requisite hardware and C programming software
4. Understand the relevance of cloud computing and data analytics to IoT
5. Comprehend the business model of IoT from developing a prototype to launching a product

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

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

Introduction to Internet of Things IOT vision, Strategic research and innovation directions, Iot Applications, Related future technologies, Infrastructure, Networks and communications, Processes, Data Management, Security, Device level energy issues

UNIT–II

Internet Principles and communication technology Internet Communications: An Overview – IP, TCP, IP protocol Suite, UDP. IP addresses – DNS, Static and Dynamic IP addresses, MAC Addresses, TCP and UDP Ports, Application Layer Protocols – HTTP, HTTPS, Cost Vs Ease of Production, Prototypes and Production, Open-Source Vs Closed Source

UNIT–III

Prototyping and programming for IoT Prototyping Embedded Devices – Sensors, Actuators,

Microcontrollers, SoC, Choosing a platform, Prototyping Hardware platforms – Arduino, Raspberry Pi. Prototyping the physical design – Laser Cutting, 3D printing, CNC Milling. Techniques for writing embedded C code: Integer data types in C, Manipulating bits - AND, OR, XOR, NOT, Reading and writing from I/ O ports. Simple Embedded C programs for LED Blinking, Control of motor using switch and temperature sensor for arduino board

UNIT-IV

Cloud computing and Data analytics Introduction to Cloud storage models -SAAS, PAAS, and IAAS. Communication APIs, Amazon webservices for IoT, Skynet IoT Messaging Platform. Introduction to Data Analytics for IoT - Apache hadoop- Map reduce job execution workflow

UNIT – V

IoT Product Manufacturing - From prototype to reality Business model for IoT product manufacturing, Business models canvas, Funding an IoT Startup, Mass manufacturing - designing kits, designing PCB,3D printing, certification, Scaling up software, Ethical issues in IoT- Privacy, Control, Environment, solutions to ethical issues

SUGGESTED READING:

1 Adrian McEwen, Hakim Cassimally, “Designing the Internet of Things”, Wiley India Publishers, 2015

2 Daneil W lewies,”Fundamentals of embedded software: where C meets assembl”, Pearson, 200.

3 Arshdeep Bahga and Vijay Madisetti ,“Internet of Things: A Hands-on Approach”, Orient Blackswan Private publishers, First edition, 2015

COURSE CODE	COURSE TITLE				CORE/PE/OE	
PW 761 EC	MAJOR PROJECT PHASE –I				CORE	
Prerequisites	-		L	T	P	C
			-	-	8	8
Evaluation	SEE	400	CIE -300		50 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1.	To enhance practical and professional skills.
2.	To familiarize tools and techniques of systematic Literature survey and documentation
3.	To expose the students to industry practices and team work.
4.	To encourage students to work with innovative and entrepreneurial ideas

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to real-world problems
CO-2	Evaluate different solutions based on economic and technical feasibility
CO-3	Effectively plan a project and confidently perform all aspects of project management
CO-4	Demonstrate effective written, oral/ presentation and communications kills
CO-5	Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to real-world problems

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-	-	-	-	1	-	-	1		2
CO2	1	-	3	2	-	-	-	1		-	-	-		2
CO3	-	1	2	1	3	-	-	-	2	-	-	-	2	2
CO4	-	-	-	1	-	-	-	-	2	-	-	1	2	-
CO5	-	1	1	1	-	-	-	1	1	-	1	1	2	2

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

The department can initiate the project allotment procedure at the end of VI semester and finalize it in the first two weeks of VII semester**.**

The department will appoint a project coordinator who will coordinate the following:

1. Collection of project topics/ descriptions from faculty members (Problems can also be invited from the industries)
2. Grouping of students (max 3 in a group)
3. Allotment of project guides.
4. Preparation of seminar schedules and conducting the same

The aim of project work should be to develop solutions to realistic problems applying the knowledge and skills obtained in different courses, new technologies and current industry practices. This requires students to understand current problems in their domain and methodologies to solve these problems. To get awareness on current problems and solution techniques, the department may arrange special lectures by faculty members, research scholars, post graduate students of the department and invited lectures by engineers from industries and R&D institutions during first 4 weeks of VII semester. After completion of these seminars each group has to formalize the project proposal based on their own ideas or as suggested by the project guide

Seminar schedule will be prepared by the coordinator for all the students from the 6^{th} week to the last week of the semester which should be strictly adhered to.

Each group will be required to:

1. Submit a one page synopsis at least 1 week before the seminar for display on notice board.
2. Give a 30 minutes presentation followed by 10 minutes discussion.
3. Submit a technical write-up on the talk.

At least two teachers will be associated with the Project Seminar to evaluate students for the award of Sessional marks which will be on the basis of performance of the student in literature survey, presentation and technical write up preparation and knowledge in the chosen topic.

Thus the seminar presentation should include the following components related to the project:

1. Problem definition and specifications
2. Literature survey
3. Broad knowledge of available techniques to solve a particular problem.
4. Planning of the work, preparation of bar (activity)charts
5. Presentation-oral and written.

SCHEME OF INSTRUCTION AND EXAMINATION

B. E. (ECE)

VIII–Semester

S. No	Code	Course Title	Scheme of Instruction			Contact Hrs/Wk	Scheme of Evaluation			Credits
			L	T	P		Hrs	CIE	SEE	
Theory										
1	MC801	Mandatory Course – I (Environmental Science)	3	-	-	3	3	40	60	0
2	MC802	MOOCS Course	3	-	-	3	3	40	60	3
3	PC803	GRNSS and Augmentation System	3	-	-	3	3	40	60	3
4	PC804	Cellular and Mobile Communication	3	-	-	3	3	40	60	3
5	PC805	Radar Systems	3	-	-	3	3	40	60	3
6		**Professional Elective-IV**								
		PE811EC Testing and Testability								
		PE812EC Artificial Neural Networks								
		PE813EC Wireless Sensor Networks	3	-	-	**3**	3	40	60	3
Practicals										
7	PW861EC	Major Project Phase-II	-	-	16	**16**	-	50	100	8
Total			**18**	**-**	**16**	**34**	**18**	**290**	**460**	**23**

COURSE CODE	COURSE TITLE				CORE/PE/OE	
MC 801 HS	ENVIRONMENTAL SCIENCE				CORE	
Pre-requisites	--		L	T	P	C
			3	0	0	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	To know the Natural resources and their importance.
2	To understand and realize significance of Ecosystems and Biodiversity.
3	To understand the types of pollution, abatement practices and Disaster Management.
4	To sensitize the students, about the global issues, mitigation techniques.
5	To built the awareness regarding sustainable future.

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	Rational utilization of natural resource can be expected.
CO-2	Protection and conservation of ecosystems and biodiversity.
CO-3	Development of New technologies for the abatement of pollution.
CO-4	Mitigative techniques will come from the students.
CO-5	Sustainability can be achieved.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	3	3	2	2	-	-	-	-	1	-	-	1
CO-2	1	-	3	2	-	-	-	1		-	-	-
CO-3	-	1	2	1	3	-	-	-	2	-	-	-
CO-4	-	-	-	1	-	-	-	-	2	-	-	1
CO-5	-	1	1	1	-	-	-	1	1	-	1	1

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I
Environmental studies: Definition, scope and importance, need for public awareness. Natural resources: Water resources use and exploitation of Surface and Ground water. Floods, Drought,

Conflicts over water, Dams-merits and demerits. Land Resources: Land as a resource, Effects of modern Agriculture, Fertilizer-pesticide problems, Water logging and Salinity, land degradation, soil erosion and Desertification. Energy resources: Growing energy needs, renewable and non-renewable energy resources.

UNIT–II

Ecosystems and Biodiversity: Concept of Ecosystem, structure and function of an ecosystem, producers, consumers and decomposers, energy flow in ecosystem, food chains, food web, ecological pyramids, aquatic ecosystem (ponds, lakes, streams, rivers, oceans, estuaries) Biodiversity: Genetic species and ecosystem diversity, bio-geographical classification of India. Value of biodiversity, threats to biodiversity, endangered and endemic species of India, conservation of biodiversity.

UNIT–III

Environmental Pollution: Causes, effects and control measures of air pollution, water pollution, soil pollution, noise pollution, Thermal pollution. Solid waste management, Municipal solid waste management, Biomedical waste management and, hazardous waste management. Disaster management: Types of disasters, impact of disasters on environment, infrastructure, and development.

UNIT-IV

Environmental protection and Global issues: Environmental protection acts: Air, Water, Forest and wild life Acts, enforcement of Environmental legislation. Water conservation, watershed management, and Environmental ethics. Climate change, Global warming, acid rain, ozone layer depletion.

UNIT – V

Sustainable future: Concept of Sustainable Development, Sustainable development goals, Population and its explosion, Crazy Consumerism, Urban Sprawl, Environmental Education, Human health, Environmental Ethics, Concept of Green Building, Ecological Foot Print, Life Cycle assessment (LCA), Low carbon life style

SUGGESTED READING:

1	De A.K., "Environmental Chemistry", Wiley Eastern Ltd., 1989.
2	Odum E.P., "Fundamentals of Ecology", W.B. Sunders Co., USA,1975..
3	G.L. Karia and R.A. Christian, Waste Water Treatment, Concepts and Design Approach, Prentice Hall of India, 2005.
4	Benny Joseph, Environmental Studies, Tata McGraw Hill,2005.

5	V.K.Sharma, Disaster Management, National Centre for Disaster Management, IIPE, Delhi,1999. 6. Environmental Science: towards a sustainable future by Richard T. Wright. 2008 PHL Learning Private Ltd. New Delhi

PC 803 EC	GRNSS AND AUGMENTATION SYSTEM					
Pre-requisites			**L**	**T**	**P**	**C**
			3	**-**	**-**	**3**
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	To explain the basic principle of GPS and its operation
2	To make the students to understand signal structure, errors, coordinate systems
3	To make the students understand the GPS navigation and observation files.
4	Highlight the importance of integrating GPS with other systems.
5	To demonstrate the principle of DGPS and to facilitate the various augmentation systems.

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	Understand the principle and operation of GPS.
CO-2	Frame various coordinate systems for estimating position.
CO-3	Estimate the various errors and their effect on position estimation
CO-4	Use GPS in various fields such as navigation, GIS etc.
CO-5	Apply DGPS principle and can also analyze various augmentation systems.

Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO-1	2	-	1	-	-	-	-	-	-	-	-	-		
CO-2	2	-	1	-	-	-	-	-	-	-	-	-		
CO-3	2	3	3	3	-	-	-	-	-	-	-	-		
CO-4	2	3	3	3	2	-	-	-	-	-	-	-		
CO-5	2	3	3	3	2	-	-	-	-	-	-	-		

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

GPS fundamentals: Trilaiteration, Transit, GPS Principle of Operation, Architecture: Space, Control and User Segments, Operating frequencies, Orbits, Keplerian elements.

UNIT–II

GPS and UTC Time, Signal structure, SPS and PPS services, C/A and P-Codes, Geometry of ellipsoid, geodetic reference system, Geoid and Ellipsoid and Regional datum: Earth Centered Earth Fixed (ECEF) and Earth Centered Inertial (ECI) Coordinate systems and World Geodetic System (WGS 84) datum, Types of receivers, Spoofing and Anti-spoofing.

UNIT–III

GPS Error Models: Ionospheric error, Tropospheric error, Ephemeris error, Clock errors, Satellite and receiver instrumental biases, Multipath; GPS Navigation and Observation data formats, Various DOPS.

UNIT-IV

GPS Modernization: Future GPS satellites, New signals and their benefits, New Control Segment, Principle of operation of DGPS, architecture and limitations, GPS Applications: Surveying Mapping Marine, air and land Navigation, Military and Space Application. GPS Integration with Geographic Information System (GIS), Inertial Navigation System (INS), Pseudolite and Cellular.

UNIT – V

Other GRNSS: GLONASS, GALILEO, QZNSS, CNSS and IRNSS System. Relative advantages of SBAS, SBAS features and Principle of operation of Wide area augmentation system (WAAS), GPS Aided GEO Augmented Navigation (GAGAN) and Ground Based Augmentation System (GBAS), Local Area Augmentation System (LAAS).

SUGGESTED READING:

1	Ahmed El-Rabbany, "Introduction to GPS", Artech House Publishers, 2/e, Boston 2006.
2	Elliot D Kaplan and Christopher J Hegarty, "Understanding GPS principles and applications", Artech House Publishers, 2/e Boston & London 2005.
3	B.Hofmann-Wellenhof, H.Lichtenegger, and J.Collins, "GPS Theory and Practice, Springer Verlog, 5/e, 2008.

PC 804 EC	CELLULAR AND MOBILE COMMUNICATIONS					
Prerequisites	Communication Theory		**L**	**T**	**P**	**C**
			3	**-**	**-**	**3**
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	Understand basics of Cellular systems, their generations and Characteristics of Mobile Communications.
2	Understand the Frequency reuse mechanism for Mobile operations and Co-Channel interference concepts
3	Understand the Mobile signal Coverage in different terrains and Lee models
4	Understand the working of Antennas at Cell-site and at Mobile units.
5	Understand the various Handoff mechanisms and Concept of Dropped calls

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	Able to analyze the various operational features of Mobile Communication Systems
CO-2	Able to deal with the Mobile communication system designs of Frequency re-use and Interference Factors
CO-3	Able to carry out the Design aspects of Mobile signal coverage over different terrains
CO-4	Able to analyze the different Cell-site and Mobile antennas for different applications
CO-5	Able to characterize the Handoffs mechanisms

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO-1	2	2	3	2	3	2	-	-	-	-	-	-		
CO-2	3	2	3	3	3	2	-	-	-	-	-	-		
CO-3	3	3	3	3	3	2	-	-	-	-	-	-		
CO-4	3	3	2	2	3	2	-	-	-	-	-	-		
CO-5	3	3	3	2	3	2	-	-	-	-	-	-		

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

Introduction to Cellular Mobile Communications: History of Mobile cellular: AMPS system (First-generation systems), Second-generation System, 3G Systems, 4G Systems, 5G Systems, mm-wave mobile communications for 5G cellular, Pico-cells and micro-cells in mobile technology. Other Cellular-like Systems, Spectrum Efficiency Considerations. Basic Cellular systems, Circuit-Switched and Packet-Switched Systems, Performance criteria, Voice quality, Data quality, Picture quality, Service quality.

Uniqueness of Mobile Radio Environment, Description of Mobile Radio Transmission Medium, Model of Transmission Medium, Delay spread and Coherence Bandwidth..

UNIT–II

Frequency Reuse Concept and Cellular system Components: Concept of Frequency reuse channels, Frequency reuse schemes, Frequency reuse distance, Number of Customers in the System, Co-Channel Interference Reduction Factor, Desired C/I from a Normal case in an Omni-directional antenna System, Handoff mechanism, Cell splitting, Consideration of the Components of Cellular Systems, Antennas, Switching equipment and Data Links.

UNIT–III

Cell Coverage: General Introduction, Ground Incident angle and Ground Elevation angle, Ground Reflection angle and Reflection point, Obtaining the Mobile Point-to-Point Model (Lee Model), A standard condition, Obtain Area-to-Area Prediction model, The Phase difference between a direct path and ground-reflected path, A general formula for Mobile Radio Propagation, Propagation over water or Flat open area, Between Fixed stations, Landto-Mobile transmission over water, Obtain Path loss from a Point-to-Point Prediction Model in Non-obstructive condition and obstructive condition, Form of a Point-to-Point Model, General Formula and its Merit

UNIT-IV

Cell-Site and Mobile Antennas: Antennas at Cell-site, Omni-directional antennas, Directional antennas, Location antennas, Set-up Channel antennas, Space Diversity Antennas at cell site, Umbrella-Pattern Antennas, Interference reduction antennas, Smart antennas, types and applications, MIMO system, SDMA technology.

Mobile Antennas, Roof-mounted antenna, Glass-Mounted antenna, High-gain antenna, Horizontally and Vertically oriented Space-Diversity Antennas.

UNIT – V

Handoff and Dropped Calls: Value of Implementing Handoffs, Types of Handoff, Prioritizing handoff, Umbrella cell approach, Initiation of Hard Handoff, Delaying a Handoff, Forced Handoffs. Cell-site Handoff only, Intersystem Handoff.

Introduction to Dropped Call Rate and Soft Handoffs.

SUGGESTED READING:

1	William C.Y. Lee, "Wireless and Cellular Telecommunications", 3rd International edition, McGraw Hill, 2006

2	Theodere S. Rappaport, “Wireless Communications, Principles and Practice”, 2nd edition, Prentice Hall, 2003.
3	Gordon L. Stuber. “Principles of Mobile Communications”, 3rd edition, Springer Publications, 2011.

Course Code	Course Title						Core//PE/OE
PC805EC	RADAR SYSTEMS						Core
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives : The course is taught with the objectives of enabling the student to:

1. Familiarize with basic concepts of radar systems
2. Understand different Radar Systems
3. Know about Radar antennas
4. Know the propagation effects on a radar signal
5. Understand tracking radar principles

Course Outcomes : On completion of this course, the student will be able to :

1. Understand the components of a radar system
2. Understand the components of a radar system
3. Analyze the concept of MTI radar systems
4. Incorporate the effects of environment condition in a radar system
5. Apply appropriate mathematical and computer models relevant to radar systems to calculate system performance

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

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

Radar Systems: Radar Block diagram and operation, Applications of Radar. Radar frequencies, Radar Range Equation, Radar Cross Section of target, Prediction of range performance, Minimum detectable signal, Receiver noise figure, Effective noise temperature, Signal to noise ratio, System losses, False alarm time and probability of false alarm, Integration of radar pulses, Pulse-repetition frequency and range ambiguities. Swerling‘s Models.

UNIT–II

CW and FMCW Radars: Doppler effects, CW Radar, FMCW Radar, Multiple frequency CW radar, Low noise front-ends, A-scope, B-scope, PPI Displays, and Duplexers

UNIT–III

MTI and Pulse Doppler Radar: MTI radar, Delay line canceller, Multiple and staggered prf, Blind speeds, Limitations to MTI performance, MTI using range gated Doppler filters, Pulse Doppler radar, Non coherent radar. CFAR techniques in Radar Detection

UNIT-IV

Tracking Radar: Sequential Lobing, Conical scan, Monopulse - Amplitude comparison and Phase comparison methods, tracking in range and in Doppler, Acquisition, and Comparison of Trackers

UNIT – V

Search Radar: Track while scan radars, Search radar range equation, Search scans, Effect of surface reflection, Line of Sight (LOS), Propagation effects: Propagation over a plane earth, the round earth, Refraction, Anomalous propagation, Diffraction, Attenuation by atmospheric gases, Environmental noise

SUGGESTED READING:

1. Skolnik, Merrill I, ―*Introduction to Radar Systems*‖, MGH, third edn. 2001.
2. Barton. David K, ―*Modern Radar System Analysis*‖, Artech House, 1988.
3. Peebles PZ, ―*Radar Principles*‖, John – Willey, 2004

PE 811 EC	TESTING AND TESTABILITY (PE-IV)					
Prerequisites	Digital system Design, Integrated Circuits		**L**	**T**	**P**	**C**
			3			**3**
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	To represent physical faults with logical faults and understand fault modeling methods.
2	To understand the concept of fault detection in combinational and sequential circuits
3	To understand designing for testability and its standards.
4	To understand the requirements for a circuit to be self checking .
5	To understand BIST concepts and methods to improve fault coverage

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	Able to understand fault and their modeling in digital circuits thoroughly.
CO-2	Able to derive test vectors for given faults in combinational and sequential circuits.
CO-3	Apply testability techniques.
CO-4	Able to understand various self checking methods used in digital systems
CO-5	Understand various TPGs, ORAs and methods to enhance fault coverage in circuits

Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO-1	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-2	2	2	3	-	-	-	-	-	-	-	-	-	2	-
CO-3	2	-	2	-	-	-	-	-	-	-	-	-	2	1
CO-4	2	2	-	-	-	-	-	-	1	-	-	-	2	-
CO-5	2	1	1	-	-	-	-	-	1	-	-	-	2	1

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I
Basics Of Testing And Fault Modeling

Introduction to Testing - Faults in digital circuits - Modeling of faults - Logical Fault Models – Fault detection - Fault location - Fault dominance - Logic Simulation - Types of simulation - Delay models - Gate level Event-driven simulation.

UNIT–II

Fault Detection: Fault detection and redundancy in combinational and sequential circuits, Fault Simulation- Applications and general techniques. Testing for single stuck faults.

UNIT–III

Design For Testability

Design for Testability - Ad-hoc design – observability and controllability by use of Scan Registers, Generic scan based design - Classical scan based design – JTAG Boundary scan standard.

UNIT-IV

Self Checking Design: Basic concepts, application of error-Detecting and Error-correcting codes, checking circuits and self checking, self checking checkers- m/n code checkers and Berger code checkers, self checking combinational and sequential circuits.

UNIT – V

BIST and TPG: BIST concepts, Testing types and Test pattern generation for BIST, Output response analysis, Fault coverage enhancement with test point insertion, mixed mode BIST and Hybrid BIST.

SUGGESTED READING:

1	M. Abramovici, M. Breuer, A. Friedman, ―Digital *System Testing and testable design*‖, Jaico Publications
2	Samuel C Lee―*Digital Circuits and Logic Design*. PHI Pvt. Ltd, 2000
3	Zvi Kohavi―Switching*andFiniteAutomataTheory*‖,TMH.2ndedition
4	Laung-Terng Wang, Chen-Wen Wu, Xiaoqing Wen., "VLSI test principles and Architectures", Morgan Khauffmann publishers, 2006

PE 812 EC	ARTIFICIAL NEURAL NETWORKS (PE- IV)					
Prerequisites	-		**L**	**T**	**P**	**C**
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	Understand the biological neural network and to model equivalent neuron models.
2	Learn different training algorithms in training neural networks
3	Know the issues of various feed forward neural networks.
4	Understand the concepts of Back Propagation
5	Know the issues of various feedback neural networks

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	Understand the similarity of Biological networks and Neural networks.
CO-2	Identify different types of models of artificial neural networks.
CO-3	Understand and analyze the concepts of feed forward neural networks.
CO-4	Apply the concepts of backward propagation.
CO-5	Understand and analyze the concepts of feedback neural networks

Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	2	-	2		
CO2	2	-	-	-	-	-	-	-	-	2	-	-		
CO3	-	2	-	-	-	-	-	-	-	2	-	-		
CO4	-	3	-	-	-	-	-	-	-	3	-	-		
CO5	-	2	-	-	-	2	2	-	2	2	-	-		

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

Basics of Artificial Neural Networks: Characteristics of Neural Networks, Historical Development of Neural Network Principles, Artificial Neural Networks: Terminology, Models of Neuron: McCulloch-Pitts model, Perceptron and Adaline neuron, Topology, Basic Learning Laws: Hebb's law, Perceptron, Delta , Widrow and Hoff LMS, Correlation, Instar (winner-take-all) and outstar learning.

UNIT–II

Activation and Synaptic Dynamics: Introduction, Activation Dynamics Models: Additive, shunting and stochastic activation models, Synaptic Dynamics Models: Requirements of learning laws, Distinction between the activation and synaptic dynamics model, Learning Methods, Recall in Neural networks.

UNIT–III

Feed-forward Neural Network: Introduction, Analysis of Pattern Association Networks: Linear Associative Network, Analysis of Pattern Classification Networks: Perceptron, Pattern classification problem, Perceptron learning law, Perceptron convergence theorem, Perceptron representation problem.

UNIT-IV

Back Propagation: Back propagation learning rule, Features of Back propagation, and limitations of and extensions of Back Propagation rule.

UNIT – V

Feedback Neural networks: Linear auto associative feed forward and feedback networks. Hopfield network, capacity and energy analysis of Hopfield neural network. Stochastic neuron, Boltzmann machine, Boltzman learning law, Issues in Implementation of Boltzman learning law.

SUGGESTED READING:

1	B. Yegnanarayana, Artificial Neural Networks, Prentice Hall, New Delhi, 2007.
2	J. A. Freeman and D.M. Skapura, Neural Networks Algorithms, Applications and Programming Techniques, Addison Wesley, New York, 1999.
3	Simon Haykin, Neural Networks (A Comprehensive Foundation), McMillan College Publishing Company, New York, 1994.
4	Kevin L. Priddy, Paul E. Keller – Artificial neural networks: An Introduction - SPIE Press, 2005.

PE 813 EC	WIRELESS SENSOR NETWORKS (PE-IV)					
Prerequisites	-		**L**	**T**	**P**	**C**
			3	**-**	**-**	**3**
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	To understand the fundamentals of wireless sensor networks and its application to critical real time scenarios.
2	To study the protocols at various layers and its differences with traditional protocols.
3	To understand the issues pertaining to sensor networks and the challenges involved in managing a sensor network.

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	To understand the state-of-the-art in network protocols, architectures and applications
CO-2	To Explain the Fundamental Concepts and applications of ad hoc and wireless sensor Networks
CO-3	To Describe the MAC protocol issues of Adhoc and sensor networks
CO-4	To Discuss the WSN routing issues by considering QoS measurements
CO-5	To understand the state-of-the-art techniques and protocols in QoS and Energy management for wireless sensor networks.

Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	PO11	**PO12**	**PSO1**	**PSO2**
CO-1	3	3	2	2	1	1	1	-	-	-	-	1		
CO-2	3	3	2	2	1	1	1	-	-	-	-	1		
CO-3	3	3	2	2	3	1	1	-	-	-	-	1		
CO-4	3	3	2	2	3	1	1	-	-	-	-	1		
CO-5	3	3	2	2	3	1	1	-	-	-	-	1		

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

Introduction: Fundamentals of wireless communication technology, the electromagnetic spectrum radio propagation, characteristics of wireless channels, modulation techniques, multiple access techniques, wireless LANs, PANs, WANs, and MANs, Wireless Internet.

UNIT–II

Introduction to adhoc/sensor networks: Key definitions of adhoc/ sensor networks, unique constraints and challenges, advantages of ad-hoc/sensor network, driving applications, issues in adhoc wireless networks, issues in design of sensor network, sensor network architecture, data dissemination and gathering.

UNIT–III

MAC Protocols : Issues in designing MAC protocols for adhoc wireless networks, design goals, classification of MAC protocols, MAC protocols for sensor network, location discovery, quality, other issues, S-MAC, IEEE 802.15.4.

UNIT-IV

Routing Protocols: Issues in designing a routing protocol, classification of routing protocols, table driven, on-demand, hybrid, flooding, hierarchical, and power aware routing protocols.

UNIT – V

QoS and Energy Management : Issues and Challenges in providing QoS, classifications, MAC, network layer solutions, QoS frameworks, need for energy management, classification, battery, transmission power, and system power management schemes.

SUGGESTED READING:

1	C. Siva Ram Murthy, and B. S. Manoj, *"AdHoc Wireless networks* ", Pearson Education - 2008.
2	Feng Zhao and Leonides Guibas, *"Wireless sensor networks* ", Elsevier publication - 2004.
3	Jochen Schiller*, "Mobile Communications",* Pearson Education, 2nd Edition, 2003.
4	William Stallings, *"Wireless Communications and Networks ",* Pearson Education – 2004
5	Holger Karl and Andreas Willing, ―*Protocols and Architectures for Wireless Sensor Networks*‖*,* John Wiley and Sons, 2005.
6	Waltenegus Dargie and Christian Poellabauer, ―Fundamentals of Wireless Sensor Networks:Theory and Practice‖, First Edition, John Wiley and Sons, 2010.

PW 861 EC	MAJOR PROJECT PHASE-II					
Pre-requisites	--		**L**	**T**	**P**	**C**
					12	**6**
Evaluation	**SEE**	100 Marks	**CIE**		50 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	To enhance practical and professional skills.
2	To familiarize tools and techniques of systematic Literature survey and documentation
3	To expose the students to industry practices and team work.
4	To encourage students to work with innovative and entrepreneurial ideas

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to real-world problems
CO-2	Evaluate different solutions based on economic and technical feasibility
CO-3	Effectively plan a project and confidently perform all aspects of project management
CO-4	Demonstrate effective written and oral communications kills
CO-5	Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to real-world problems

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-	-	1	-	1	-	1	1		2
CO2	1	-	3	2	1	-	2	1		-	2	-		2
CO3	-	1	2	1	3	2	-	-	3	-	-	-	2	2
CO4	-	-	-	1	-	1	-	2	1	3	-	1	2	
CO5	-	1	1	1	-	-	-	1	1	-	1	1	2	2

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

The aim of project work –II is to implement and evaluate the proposal made as part of project – I. Students can also be encouraged to do full time internship as part of project work-II based on the common guidelines for all the departments. The students placed in internships need to write the new proposal in consultation with industry coordinator and project guide within two weeks from the commencement of instruction.

The department will appoint a project coordinator who will coordinate the following:

1. Re-grouping of students -deletion of inters hip candidates from groups made as part of project work-I
2. Re-Allotment of internship students to project guides
3. Project monitoring at regular intervals

All re-grouping/re-allotment has to be completed by the 1nd week of VIIIth semester so that students get sufficient time for completion of the project.

All projects (internship and departmental) will be monitored at least twice in a semester through student presentation for the award of Sessional marks. Sessional marks are awarded by a monitoring committee comprising of faculty members as well as by the supervisor. The first review of projects for 25 marks can be conducted after completion of five weeks. The second review for another 25 marks can be conducted after 12 weeks of instruction.

Common norms will be established for the final documentation of the project report by the respective departments. The students are required to submit draft copies of their project report within one week after completion of instruction.