PUNE VIDYARTHI GRIHA'S

COLLEGE OF ENGINEERING AND TECHNOLOGY, PUNE-9

(AFFILIATED TO SAVITRIBAI PHULE PUNE UNIVERSIT, PUNE)

DEPARTMENT OF ELECTRONICS & TELECOMMUNICATION ENGINEERING

(Accredited By National Board of Accreditation (NBA), New Delhi)

CURRICULUM BOOK

ACADEMIC YEAR: 2019-20

FOR THE PROGRAMME

B. E. (ELECTRONICS & TELECOMMUNICATION ENGINEERING)

PUNE VIDYARTHI GRIHA'S

COLLEGE OF ENGINEERING AND TECHNOLOGY

VISION

TO ACHIEVE EXCELLENCE IN ENGINEERING EDUCATION

MISSION

- **To satisfy all stakeholders**
- **To develop ethical, highly motivated engineering professionals with good human values, requisite skills and competencies**
- **To adopt innovative teaching mechanisms**
- **To promote research culture**
- **To contribute to country's economic development**
- **To be responsive to changes in technology, socio-economic and environmental conditions**

DEPARTMENT OF ELECTRONICS & TELECOMMUNICATION ENGINEERING

VISION

To achieve academic excellence in Electronics and Telecommunication Engineering and Technology

MISSION

To impart quality education in Electronics and Telecommunication engineering (IM4, IM5) (DPEO1)

To facilitate techno-social and economic growth (IM5, IM6) (DPEO3) (DPEO1)

To develop active learners and competitive engineers for sustainable technical growth through lifelong learning and ICT based education (IM3, IM6) (DPEO1)

To provide skill and value-based education to address societal issues (IM1, IM2) (DPEO2, DPEO3)

PROGRAM EDUCATIONAL OBJECTIVES

PEO1 To provide engineering solutions by applying domain knowledge

PEO2 To instill professionalism and ethical values among engineers towards cultured and developed society

PEO3 To develop interpersonal skills to meet the aspirations of the stakeholders

PROGRAMME SPECIFIC OUTCOMES

PSO1 Demonstrate reasonable amount of proficiency to understand the engineering problems to design and develop the electronic and communication systems through collaborative efforts

PSO2 Utilize modern simulation and hardware tools to analyze the performance of electronic and communication systems.

PROGRAMME OUTCOMES

The Program Outcomes of the Department of Electronics and Telecommunication are:

PO1. Ability to apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Ability to conduct experiments, analyze and interpret data.

PO3. Ability to gather broad education necessary to recognize the impact of engineering solutions in global and societal context

PO4. Ability to exercise professional and ethical responsibility in multicultural environment

PO5. Ability to communicate effectively with engineers and community at large

PO6. Ability to identify, formulate and solve Electronic Engineering problems

PO7. Ability to recognize the need and engage life-long learning

PO8. Ability to comprehend management and entrepreneurship skills

PO9. Ability to design process, components and system to meet specified needs in Electronic Engineering

PO10. Understanding the principle of sustainable development for Electronic Engineering Design

PO11. Ability to use the techniques, skills and modern engineering tools necessary for Electronics Engineering practice

PO12. Ability to work in multi-disciplinary teams within Electronic Engineering discipline

INDEX

Final year

Curriculum Book

Syllabus Structure of Savitribai Phule Pune University, Pune

Course Structure for B. E. (Electronics & Telecommunication Engineering)
2015 Course

Course Code	Course	Teaching Scheme Hrs/Week			Examination Scheme					Marks Total	Credit	
					Theory							
		L	T	P	InSem	Theory	TW	P	O		TH/TUT	PR+OR
Legends:												
L: Lectures T: Tutorial P: Practical TW: Term Work O: Oral												
Semester –VII												
404181	VLSI Design &Technology	3	--	--	30	70	--	--	--	100	3	--
404182	Computer Networks &Security	4	--	--	30	70	--	--	--	100	4	--
404183	Radiation & Microwave Techniques	3	--	--	30	70	--	--	--	100	3	--
404184	ElectiveI	3	--	--	30	70	--	--	--	100	3	--
404185	ElectiveII	3			30	70	--	--	--	100	3	--
404186	Lab Practice - I(CNS+ RMT)	--	--	4	--	--	50	--	50	100	--	2
404187	Lab Practice-II (VLSI+ElectiveI)	--	--	4	--	--	50	50		100	--	2
404188	ProjectStageI	-	2	--	--	--	-	--	50	50	--	2
	Audit Course 5	--	--	--	--	--	--	--	--	--	----	
	Total		2	8	150	350	100	50	100	750	16	6
Total Credits											**22**	

Elective I	**Elective II**	**Audit Course 5**
1. Digital Image and Video Processing	1. Wavelets	1. Green Energy
2. Industrial Drives and Control	2. Electronics Product Design	2. Human Behaviour
3. Embedded Systems& RTOS	3. Optimization Techniques	
4. Internet of Things	4. Artificial Intelligence	
	5. Electronics in agriculture	

Syllabus Structure of Savitribai Phule Pune University, Pune

Course Structure for B. E. (Electronics & Telecommunication Engineering)

2015 Course

Course Code	Course	Teaching Scheme Hrs/Week			Examination Scheme					Marks Total	Credit	
					Theory							
		L	T	P	In-Sem	Theory	TW	P	O		TH/ TUT	PR+ OR
Legends:												
L: Lectures T: Tutorial P: Practical TW: Term Work O: Oral												
Semester –VIII												
404189	Mobile Communication	3	--	--	30	70	--	--	--	100	3	--
404190	Broadband Communication Systems	4	--	--	30	70	--	--	--	100	4	--
404191	Elective III	3	--	--	30	70	--	--	--	100	3	--
404192	Elective IV	3	--	--	30	70	--	--	--	100	3	--
404193	Lab Practice – III(MC+BCS)	--	--	4	--	--	50	50	--	100	--	2
404194	Lab Practice –IV(Elective III)	--	--	2	--	--	--	--	50	50	--	1
404195	Project Stage II	--	6	-	--	--	150	--	50	200	--	6
	Audit Course 6	--	--	--	--	--	--	--	--	--		
	Total	13	6	6	120	280	200	50	100	750	13	9
Total Credits											**22**	

Elective III	**Elective-IV**	**Audit Course 6**
1. Machine Learning	1. Robotics	1. Team Building, Leadership and Fitness
2. PLC s and Automation	2. Biomedical Electronics	2. Environmental issues and Disaster Management
3. Audio and Speech Processing	3. Wireless Sensor Networks	
4. Software Defined Radio	4. Renewable Energy Systems	
5. Audio Video Engineering	5. Open Elective*	

BE (E&TC)

Semester I

VLSI Design and Technology

Course Title: VLSI Design and Technology		**Course Number:** 404181	**Course Name** :C401
Year: BE		**Semester: I**	
Designation of Course	Professional Core		
Teaching Scheme: 3 Hrs/Week		**Laboratories:** 2 Hrs/Week	
Course Assessment Methods	**Direct methods**	In-sem Examination: 30 Marks	Theory/End Semester Examination: 70 Marks
		Term-work	Practical
	Indirect Methods	Assignments, Presentations	Seminars, Quiz, Q&A session, Group Discussion
Prerequisites	Combinational and Sequential Digital circuits, MOSFET		

Course Objectives	
1	To understand the programming concepts of Hardware Description Language VHDL for modeling a digital circuit
2	To understand FSM using VHDL and the design aspects and optimization methods in design of System on Chip (SoC).
3	To get insight into architecture of different programmable logic devices like CPLD and FPGAs.
4	To understand characteristics of MOSFET and CMOS.
5	To understand the semicustom design flow of an ASIC and SPICE simulation.
6	To realize importance of testability in logic circuit design

Course Outcomes	
At the end of this course students will demonstrate the ability:	
CO1	To apply the understanding of Hardware description language to model, simulate and synthesize digital circuits.
CO2	To model Moore and Mealy FSM in VHDL and explain SoC design issues
CO3	To Classify and compare CPLD and FPGA architectures and implement digital circuits on an FPGA prototype board.
CO4	To design CMOS circuits for specified applications.
CO5	To implement a SPICE program for CMOS digital circuits and list the steps involved in design of an ASIC.
CO6	To classify the Fault Models and explain the testability methods at chip level design.

Course Contents	
Unit-I	**HDL Design**
	Design Flow, Language constructs, Data objects, Data types, Entity, Architecture & types of modeling, Sequential statements, Concurrent statements, Packages, Sub programs, Attributes, HDL modeling of Combinational, Sequential circuits and FSM. Simulations, Synthesis, Efficient coding styles, Hierarchical and flat designs, Partitioning for synthesis, Pipelining, Resource sharing.
	Practical **To write VHDL code, simulate with test bench, synthesize** 1.4 bit ALU for add, subtract, AND, NAND, XOR, XNOR, OR, & ALU pass. 2. Universal shift register with mode selection input for SISO, SIPO, PISO, &

	PIPO modes. 3. FIFO memory. 4. LCD interface. 5. Keypad interface.
Unit-II	**Digital Design and Issues**
	Sequential synchronous machine design, Moore and Mealy machines, HDL code for Machines, FIFO. Metastability and solutions, Noise margin, Fan-out, Skew, Timing considerations, Hazards, Clock distribution, Clock jitter, Supply and ground bounce, Power distribution techniques, Power optimization, Interconnect routing techniques; Wire parasitic, Signal integrity issues. I/O architecture.
Unit-III	**PLD Architectures and applications**
	Design Flow. CPLD Architecture, Features, Specifications, Applications. FPGA Architecture, Features, Specifications, Applications. The Simulation and Synthesis Tools, FPGA synthesis and implementation.
	Practical
	To write VHDL code and implement on PLD 1.4 bit ALU for add, subtract, AND, NAND, XOR, XNOR, OR, & ALU pass. 2. Universal shift register with mode selection input for SISO, SIPO, PISO, & PIPO modes. 3. FIFO memory. 4. LCD interface. 5. Keypad interface.
Unit-IV	**Digital CMOS circuits (7 Hrs)**
	N-MOS, P-MOS and CMOS, MOSFET parasitic, Technology scaling, Channel length modulation, Hot electron effect, Velocity saturation, CMOS Inverter, Device sizing, CMOS combinational logic design, Power dissipations, Power delay product, Body Effect, Rise and fall times, Latch Up effect, transmission gates.
	Practical
	To prepare CMOS layout in selected technology, simulate with and without capacitive load, comment on rise, and fall times. 1.Inverter, NAND, NOR gates, Half Adder 2. 2:1 Multiplexer using logic gates and transmission gates. **3.** Single bit SRAM cell
Unit- V	**Application Specific Integrated Circuit (7 Hrs)**
	Current sink and source, Current mirror. Active load, Current source and Push-pull inverters. Common source, Common drain, Common gate amplifiers. Cascode amplifier, Differential amplifier, Operational amplifier
Unit-VI	**VLSI Testing and Analysis (7Hrs)**
	Types of fault, Need of Design for Testability (DFT), DFT Guideline, Testability, Fault models, Path sensitizing, Test pattern generation,Sequential circuit test, Built-in Self Test, JTAG & Boundary scan, TAP Controller.

Text Books	**Author**	**Title of Book**	**Publication**
T1	Charles H. Roth	Digital systems design using VHDL	PWS

T2	Wyane Wolf	Modern VLSI Design (System on Chip)	PHI
T3	Steve Kilts	Advanced FPGA Design Architecture, Implementation and Optimization	Wiley
Reference Books			
R1	Neil H. E. Weste, David Money Harris	CMOS VLSI Design: A Circuit & System Perspective	Pearson Publication
R2	R. Jacob Baker	CMOS Circuit Design, Layout, and Simulation	3E, Wiley-IEEE Press
R3	John F. Wakerly	Digital Design Principles and Practices	3E, Prentice Hall
R4	M. Morris Mano	Digital Design	3E , Pearson
R5	CemUnsalan, Bora Tar	Digital System Design with FPGA: Implementation Using Verilog and VHDL	McGraw-Hill
Self-Learning Facilities, Web Resources, Research papers for reference	NPTEL Lecture Series for Unit IV and Unit VI		
	www.xilinx.com for Unit III		
Contents beyond Syllabus	Nil		
Additional Experiments			
Bridging Courses	Nil		
Assignments			
1	VHDL Data objects and data types, attributes, subprograms and packages and Hierarchical and flat designs, Partitioning for synthesis, Pipelining, Resource sharing		
2	Digital Design Issues		
3.	PLD Architectures		
4.	Application Specific Integrated Circuits		
5.	VLSI Testing: Boundary scan and JTAG		
Tutorials			
1.	VHDL code for Combinational and Sequential circuits		
2.	Combinational logic design using CMOS.		
Presentations	Based on each unit		
Videos	JTAG and Boundary Sacn		

Computer Networks and Security

Course Title:	Computer Networks and Security	**Course Number:** 404182	**Course Name:C402**
Designation of Course	Professional Core		
Teaching Scheme: 4Hrs/Week		**Laboratories:** 2 Hrs/Week	
Course Assessment Methods	**Direct methods**	In-sem. Examination: 30 Marks	End Semester Examination: 70 Marks
		Term-work	Oral
	Indirect Methods	Assignments, Presentations	Q&A session
Prerequisites	Analog Communication, Digital Communication		

Introduction of Course

Computer Networks is the fastest growing technology in our culture today. Data communication and networking have found their way not only through business and personal communication; they have found many applications in political and social issues. People have found how to communicate with other people in the world to express their social and political opinions and problems. We need to know how networks operate, what types of technologies are available, and which design best fills which set of needs. One of the ramification of that growth is a dramatic increase in the number of professions where an understanding of these technologies essential for success-and proportionate increase in the number and types of students taking course to learn about them.

Course Objectives

1	Understand state-of-the-art in network protocols, architectures, and applications
2	To provide students with a theoretical and practical base in computer networks issues
3	To outline the basic network configurations
4	To understand the transmission methods underlying LAN and WAN technologies.
5	To understand security issues involved in LAN and Internet.

Course Outcomes

CO1	Understand underlying principles of computer networking and learn network security.
CO2	Describe and analyze the hardware, software, components of a network and the interrelations
CO3	Analyse the requirements for a given organizational structure and select the most appropriate networking architecture and technologies
CO4	Have a basic knowledge of installing and configuring networking applications.
CO5	Specify and identify deficiencies in existing protocols, and then go onto select new and better protocols
CO6	Have a basic knowledge of the use of cryptography and network security.

Course Contents

Unit-I	**Introduction to Local Area Networks**
	TCP/IP Protocol Suit, Media Access Control: Random Access, Controlled Access- Reservation, Channelization. Wired LAN: Ethernet Protocol, Standard Ethernet, Fast Ethernet (100 MBPS), Gigabit Ethernet, 10 Gigabit Ethernet. Wireless LAN : Introduction, IEEE 802.11 Project, Bluetooth
	Experiments
	1. Implementation of LAN using suitable multiuser Windows operating System and demonstrating client-server and peer to peer mode of configuration
	2. Simulating LAN or WAN using suitable network simulator
	3. To Prepare the LAN cable

Unit-II	**Network Layer Part I**
	Introduction to Network Layer: Network-Layer Services, Packet Switching, Network-Layer Performance, IPv4 Addresses, Forwarding Of IPPackets,Network Layer Protocols: Internet Protocol (IP), ICMPv4, Mobile IP
	Experiments
	1. Study of different network components
Unit-III	**Network Layer Part II**
	Unicast and Multicast Routing: Introduction, Routing Algorithms, Unicast Routing Protocols, Introduction, Multicasting Basics, Intra-domain Multicast Protocols, Inter-domain Multicast Protocols, IGMP. Next Generation IP:IPv6 Addressing, The Ipv6 Protocol, TheICMPv6 Protocol, Transition From IPv4 toIPv6.
	Experiments
	1. Study of wireless LANs (Demonstrating Wi-Fi.)
	2. Configuration of router & study of routing between LAN's
	3. Study of IP Address subnetting and CIDR
	4. Write a program for implementation of Shortest Path algorithm
Unit-IV	**Transport Layer**
	Introduction to Transport Layer:Introduction, Transport-Layer Protocols,Transport Layer Protocols:Introduction, User Datagram Protocol, Transmission Control Protocol, SCTP.
	Experiments
	1. Socket Programming for client/Server application using Linux OS
Unit- V	**Application Layer**
	Introduction to Application Layer, Standard Client Server Protocols:World Wide Web and HTTP , FTP, Electronic Mail, Telenet, SSH, DNS.Network Management: Introduction, SNMP.
	Experiments
	1. Installation and configuration of Telnet server for Telnet communication
	2. Installation and configuration of FTP Server
Unit-VI	**Network Security**
	Cryptography & Network Security: Introduction Confidentiality, Other Aspects Of Security. Internet Security:N etwork-Layer Security, Transport-Layer Security, Application-Layer Security, Firewalls.
	Experiments
	1. To develop an algorithm for Encryption and Decryption (RSA Algorithm)
	2. Implementation of Security Algorithm : Substitution Cipher and Transposition Cipher

Text Books	**Author**	**Title of Book**	**Publication**
T1	Behrouz A. Foruzan	Data communication and Networking	Tata McGraw-Hill,5th Edition
T2	James F. Kurouse& W. Rouse	Computer Networking: A Top down Approach	6th Edition, Pearson Education
Reference Books			

R1	Andrew S. Tannenbaum	Computer Networks	Pearson Education, Fourth Edition,2003
R2	Wayne Tomasi	Introduction to Data Communication and Networking	1/e, Pearson Education
R3	Natalia Olifer, Victor Olifer	Computer Networks	Wiley Student Edition
Self-Learning Facilities	NPTELLecture Series on Computer Networksby Prof. Sujoy Ghosh and Prof A. Pal, Department of Computer Science & Engineering, IIT Kharagpur.		
Web Resources	www.Youtube.com (Lectures series by CCNA)		
Research papers for reference	**Author**	**Title of Paper**	**Journal/Transaction**
1			
2			
Contents beyond Syllabus	Practical: Study of different network components		
	Practical: Preparation of LAN cable		
	Practical: Remote desktop access and sharing of printer		
Additional Experiments	Simulation of LAN, WAN, VLAN using Cisco Packet Tracer		
Bridging Courses	NA		
Assignments	Assignment1 on unit 1 and 2		
	Assignment2 on unit 5 and 6		
Tutorials	NA		
Presentations	Self prepared presentations on different units.		

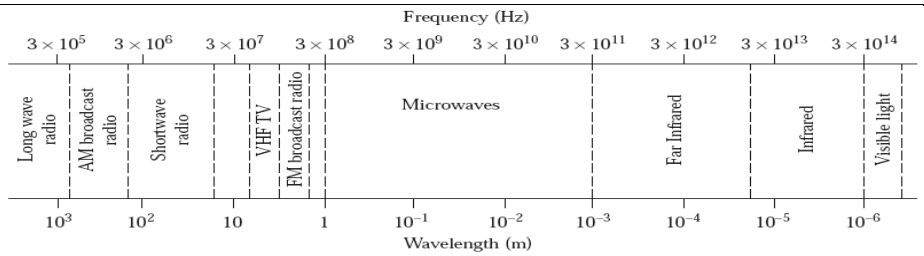
Radiation and Microwave Techniques

<table>
<tr><td>Course Title</td><td colspan="2">Radiation and Microwave Techniques</td><td>University Course Code:</td><td>404183</td></tr>
<tr><td colspan="2">Designation of Course</td><td>Professional Core</td><td>Course Number:</td><td>C403</td></tr>
<tr><td colspan="2">Teaching Scheme</td><td>Theory : 3 Hrs /Week</td><td colspan="2">Laboratories: 2 Hrs / Week</td></tr>
<tr><td rowspan="5">Course Outcome Assessment Tools</td><td rowspan="2">External Assessment (University Level)</td><td rowspan="4">Direct Tools</td><td>In-Semester Theory Examination: 30 Marks</td></tr>
<tr><td>End-Semester Theory Examination: 70 Marks</td></tr>
<tr><td rowspan="3">Internal Assessment (Department Level)</td><td>Term-work : 50 Mark</td></tr>
<tr><td>Oral : 50 Marks</td></tr>
<tr><td>Assignments, Presentations, Seminars, Quiz, Q&A session, Group Discussion, Tutorials etc</td></tr>
<tr><td>Indirect Tools</td><td>Course Exit Survey</td></tr>
<tr><td>Prerequisites</td><td colspan="4">Fundamentals in analog and digital communication, electromagnetic, network analysis etc</td></tr>
</table>

Introduction of the Course

The field of radio frequency (RF) and microwave engineering generally covers the behavior of alternating current signals with frequencies in the range of 100 MHz to 1000 GHz. RF frequencies range from very high frequency (VHF) (30–300 MHz) to ultra high frequency (UHF) (300–3000 MHz), while the term microwave is typically used for frequencies between 3 and 300 GHz, with a corresponding electrical wavelength between $\lambda = c/f = 10$ cm and $\lambda = 1$ mm, respectively. Signals with wavelengths on the order of millimeters are often referred to as millimeter waves.

Fig.1, below shows the location of the RF and microwave frequency bands in the electromagnetic spectrum. Because of the high frequencies (and short wavelengths), standard circuit theory often cannot be used directly to solve microwave network problems. In a sense, standard circuit theory is an approximation, or special case, of the broader theory of electromagnetic as described by Maxwell's equations. This is due to the fact that, in general, the lumped circuit element approximations of circuit theory may not be valid at high RF and microwave frequencies. Microwave components often act as distributed elements, where the phase of the voltage or current changes significantly over the physical extent of the device because the device dimensions are on the order of the electrical wavelength. At much lower frequencies the wavelength is large enough that there is insignificant phase variation across the dimensions of a component. The other extreme of frequency can be identified as optical engineering, in which the wavelength is much shorter than the dimensions of the component. In this case Maxwell's equations can be simplified to the geometrical optics regime, and optical systems can be designed with the theory of geometrical optics. Such techniques are sometimes applicable to millimeter wave systems, where they are referred to as quasi-optical.



Typical Frequencies		Approximate Band Designations	
AM broadcast band	535–1605 kHz	Medium frequency	300 kHz–3 MHz
Short wave radio band	3–30 MHz	High frequency (HF)	3 MHz–30 MHz
FM broadcast band	88–108 MHz	Very high frequency (VHF)	30 MHz–300 MHz
VHF TV (2–4)	54–72 MHz	Ultra high frequency (UHF)	300 MHz–3 GHz
VHF TV (5–6)	76–88 MHz	L band	1–2 GHz
UHF TV (7–13)	174–216 MHz	S band	2–4 GHz
UHF TV (14–83)	470–890 MHz	C band	4–8 GHz
US cellular telephone	824–849 MHz	X band	8–12 GHz
	869–894 MHz	Ku band	12–18 GHz
European GSM cellular	880–915 MHz	K band	18–26 GHz
	925–960 MHz	Ka band	26–40 GHz
GPS	1575.42 MHz	U band	40–60 GHz
	1227.60 MHz	V band	50–75 GHz
Microwave ovens	2.45 GHz	E band	60–90 GHz
US DBS	11.7–12.5 GHz	W band	75–110 GHz
US ISM bands	902–928 MHz	F band	90–140 GHz
	2.400–2.484 GHz		
	5.725–5.850 GHz		
US UWB radio	3.1–10.6 GHz		

Fig. 1. RF and microwave frequency bands in the electromagnetic spectrum

In RF and microwave engineering, then, one must often work with Maxwell's equations and their solutions. It is in the nature of these equations that mathematical complexity arises since Maxwell's equations involve vector differential or integral operations on vector field quantities, and these fields are functions of spatial coordinates. One of the goals of this book is to try to reduce the complexity of a field theory solution to a result that can be expressed in terms of simpler circuit theory, perhaps extended to include distributed elements (such as transmission lines) and concepts (such as reflection coefficients and scattering parameters). A field theory solution generally provides a complete description of the electromagnetic field at every point in space, which is usually much more information than we need for most practical purposes. We are typically more interested in terminal quantities such as power, impedance, voltage, and current, which can often be expressed in terms of these extended circuit theory concepts. It is this complexity that adds to the challenge, as well as the rewards, of microwave engineering

Course Objectives	
1	To introduce fundamental theory of radiation and microwaves and know applications of microwave systems and their implications
2	To design simple dipole and array of simple dipole antenna
3	To distinguish and evaluate passive and active components of microwave systems
4	To apply microwave measurement techniques
Course Outcomes	
CO1	Understand and apply various performance parameters of radiating elements
CO2	Design and analyze simple dipole and array antenna (linear uniform amplitude uniformly spaced) of simple dipole elements
CO3	Select and analyze various passive and active microwave components
CO4	Apply the knowledge of active and passive microwave components to establish a microwave link
CO5	Apply microwave measurement techniques to evaluate important performance parameters of microwave system
CO6	Understand various applications of microwaves and their implications
Course Contents as per the University Syllabus	
Unit-I	**Fundamental Theory of Radiation and Radiating Elements**
	Fundamental equations for free space propagation, Friis transmission equation,

	Definition of antenna, radiation mechanism and types of antenna, performance parameters such as radiation pattern, directivity, gain, efficiency, half power beam width, bandwidth, polarization, input impedance, radiation efficiency, effective length, effective area, radiation sphere.
	Practical /Assignment
	Study of fundamental theory of radiation and various performance parameters of the antenna.
Unit-II	**Radiating elements and arrays**
	Comparison of various radiating elements such as infinitesimal dipole, small dipole, finite length dipole and half wave length dipole, analytical treatment of these elements. Planar, log periodic and Yagi-Uda antenna. Types of arrays, two element array, N-element array, uniform amplitude uniformly spaced linear broad side and end-fire array.
	Practical
	To design , simulate and compare the performance of microwave dipole antennas of length 2λ, λ, $\lambda/2$ and $\lambda/4$
	To design , simulate and compare the performance of two element broad side and endfire uniform amplitude and uniformly spaced array
Unit-III	**Transmission lines and Waveguides**
	General solution for TEM, TE and TM waves. Analysis of coaxial line and rectangular waveguides. Analysis of rectangular cavity resonators and their applications, Striplines: Structural details, types and applications.
	Practical (Assignment)
	Study of various microwave transmission lines
Unit-IV	**Passive Microwave Components**
	Construction, working principle and scattering analysis of passive microwave components such as E-plane, H-plane and magic tee. Ferrite composition, characteristics and Faraday rotation principle. Construction, working principle and scattering analysis of isolator, circulator and directional coupler. Construction and operation of gyrator.
	Practical (Assignment)
	Study of various microwave components and equipment.
	To measure and verify port characteristics of microwave tee junctions (E, H, E-H Planes).
	To measure and verify port characteristics of Directional Coupler and calculate coupling factor, insertion loss and directivity.
	To measure and verify port characteristics of Isolator and Circulator and calculate insertion loss and isolation in dB.
Unit- V	**Active Microwave Components**
	Limitations of conventional tubes, O and M type classification of microwave tubes, re-entrant cavity, velocity modulation. Construction, operation, performance analysis and applications of -Single cavity and two cavity klystron, Cylindrical wave magnetron and Helix traveling wave. Construction, working principle and applications of two terminal microwave devices such as tunnel diode, Gunn Diode, PIN Diode, Schottky Barrier Diode and Varactor.
	Practical
	To measure and plot mode characteristics of Reflex Klystron as Microwave

	source in laboratory.		
	To measure and plot VI characteristics of Gunn Diode as a Microwave source and & study PIN Modulator		
Unit-VI	**Microwave Systems and Microwave Measurement Techniques**		
	Microwave terrestrial and satellite communication system and industrial applications of microwaves such as microwave heating, thickness and moisture measurement, medical application such as microwave diathermy. Microwave measurement devices such as slotted line, tunable detector, VSWR meter, power meter, and their working principles. Microwave measurement techniques to measure S-parameters, frequency, power, attenuation, and phase shift, VSWR, impedance. Radiation hazards and protection.		
	Practical		
	To measure radiation pattern and gain of horn antenna at microwave frequency		
	To measure free space wavelength of the microwave (for TE 10 mode) with the help of the X-band microwave test bench and verify with its theoretical calculation.		
	To plot standing wave pattern and measure SWR for various terminating impedances (matched, open and short) using slotted section with probe carriage.		
Text Books	**Author**	**Title of Book**	**Publication**
T1	E.C. Jordon and E.G. Balman	Electromagnetic Waves and Radiation Systems	Prentice Hall India
T2	C.A. Balanis	Antenna Theory - Analysis and Design	John Wiley
T3	Annapurna Das and Sisir K. Das	Microwave Engineering	Second edition, Tata McGraw Hill
T4	Samuel Y. Liao	Microwave Devices and Circuits, 3rd edition, Pearson	Pearson
T5	David M. Pozar	Microwave Engineering, 4th Edition	Wiley
Reference Books	**Author**	**Title of Book**	**Publication**
R1	David M. Pozar,	Microwave Engineering	Fourth edition, Wiley
R2	Ahmad Shahid Khan	Microwave Engineering : Concepts and Fundamentals	CRC Press
R3	K. D. Prasad	Antenna & Wave Propagation	Satya Prakashan, New Delhi
R4	M. Kulkarni	Microwave and Radar engineering, 3rd edition	Umesh Publications
R5	ML Sisodia & GS Raghuvamshi	Microwave Circuits and Passive Devices	Wiley
R6	M L Sisodia & G S Raghuvanshi	Basic Microwave Techniques and Laboratory Manual	New Age Int. (P) Ltd, Publishers
Self-Learning Facilities			
	Preparation of presentations on recent advances in Microwave Technology and its applications. Facilities available are IEEExplore with subscription of IEEE journal Microwave Theory and Applications, Transaction on Antennas and Propagation, you tube, various books available in library		

Web Resources			
1	NPTEL Lecture Series		
2	ieeexplorer with journal microwave theory and applications and Transaction on Antennas and Propagation		
Research papers for reference	**Author**	**Title of Paper**	**Journal/Transaction**
1	T. S. Sarkar, R. J. Mailloux, A. A. Oliner, M. Salazar-Palma, and D. Sengupta	History of Wireless.	John Wiley & Sons, Hoboken, N.J., 2006.
2	A. A. Oliner	Historical Perspectives on Microwave Field Theory	IEEE Transactions on Microwave Theory and Techniques, vol. MTT-32, pp. 1022–1045, September 1984
3	K. S. Packard	The Origin of Waveguides: A Case of Multiple Rediscovery	IEEE Transactions on Microwave Theory and Techniques, vol. MTT-32, pp. 961–969, September 1984.
4	D. D. Grieg and H. F. Englemann	Microstrip—A New Transmission Technique for the Kilomegacycle Range	Proceedings of the IRE, vol. 40, pp. 1644–1650, December 1952.
5	I. J. Bahl and R. Garg	A Designer's Guide to Stripline Circuits	Microwaves, January 1978, pp. 90–96.

Contents beyond Syllabus	
	Lecture on recent advances in microwave theory and their applications
Additional Experiments	Syllabus suggest any 08 experiments, but we will conduct more than 08 experiments

Bridging Courses	
	No bridging course is required since all the prerequisite courses have been learnt by the students at SE and TE classes.

Assignments	
1.	Prepare a write up on Study of fundamental theory of radiation and various performance parameters of antenna
2.	Prepare a write up on Study of various microwave transmission lines and microwave components and equipment.
3.	Collect recent advances in microwave technologies and their application using ieeexplore facility available in library.
4.	If necessary additional assignment will be given for improving the understanding and self learning abilities of the student.

Tutorials	
1	Determine impedance of unknown load using 50Ω coaxial slotted line practically and using Smith chart. Reference: David M. Pozar, "Example 2.4: impedance measurement with a slotted line, Chapter 2-Transmission line theory", Microwave Engineering, 4th edition, 2012, page 70-71.
Presentations	

	One lecture will be given for presenting the recent literature collected by the student on advances in microwaves and their applications. The selected no. of students will be given a chance. All the students will compulsorily prepare the presentations but will be selected for oral presentation on random basis.

Digital Image & Video Processing

Course Title: Digital Image& Video Processing		**Course Number:**404184	**Course Name:C407 a**
Year: BE		**Semester: I**	
Designation of Course		Professional Core	
Teaching Scheme: 3 Hrs/Week		**Laboratories:** 2 Hrs/Week	
Course Assessment Methods	**Direct methods**	In-semester Examination: 30 Marks	Theory/End Semester Examination: 70 Marks
		Term-work:50 Marks	Practical/Oral:50 Marks
	Indirect Methods	Class Test, Assignments, Presentations	Seminars, Quiz, Q&A session,Group Discussion
Prerequisites	Digital Signal Processing ,Information theory and Compression techniques		
Course Objectives			
1	Understand the fundamental concepts of Digital Image Processing with basic relationship of pixels and mathematical operations on 2-D data.		
2	Learn design and integrate image enhancement and image restoration techniques		
3	Understand object segmentation and image analysis techniques		
4	Learn the need for effective use of resources such as storage and bandwidth and ways to provide effective use of them by data compression techniques		
5	Learn basic concepts of video processing		
Course Outcomes			
CO1	Implement basic mathematical operations on digital images.		
CO2	Analyze and solve image enhancement and image restoration problems.		
CO3	Identify and design image processing techniques for object segmentation and recognition.		
CO4	Represent objects and region of the image with appropriate method.		
CO5	Apply 2-D data compression techniques for digital images.		
CO6	Explore video signal representation and different algorithm for video processing.		
Course Contents			
Unit-I	**Fundamentals of Image Processing**		
	Steps in Image processing, Human visual system, Sampling & quantization, Representing digital images, spatial and gray level resolution, Image file formats, Basic relationships between pixels, Distance Measures, Basic operations on images – image addition, subtraction, logical operations, scaling translation, rotation. Color fundamentals and models – RGB, HIS, YIQ		
	Practical		
	To perform basic operations on images		
	To perform conversion between colour spaces.		
Unit-II	**Image Enhancement and Restoration**		
	Point – Log transformation, Power law transformation, Piecewise linear transformation, Image histogram, histogram equalization, Mask processing of images, filtering operations- Image smoothing, image sharpening, frequency domains image enhancement: 2D DFT, smoothing and sharpening in frequency domein, Pseudo		

	coloring. Image Restoration: Noise models, restoration using Inverse filtering and Wiener filtering		
	Practical		
	To perform histogram equalization.		
	To perform image filtering in spatial domain.		
	To perform image filtering in frequency domain.		
	To perform image restoration		
Unit-III	**Image Compression**		
	Types of redundancy, Fidelity criteria, Compression models - Information theoretic perspective – Fundamental coding theorem, Lossless Compression: Huffman Coding-Arithmetic coding. Introduction to DCT, Lossy compression: DCT based compression, Wavelet based compression, Image compression standards JPEG and JPEG 2000.		
	Practical		
	To perform image compression using DCT / Wavelet transform.		
Unit-IV	**Image Segmentation and Morphological Operations**		
	Pixel classification, Bi-level thresholding, Multi-level thresholding, Adaptive thresholding, Otsu's method, Edge detection – First order derivative Prewitt and Sobel, Second order derivative – LoG, DoG, Canny, Edge linking, Hough transform, Region growing and region merging. Morphological operators: Dilation, Erosion, Opening, Closing, Hit or Miss transform, Boundary detection, Thinning, Thicking, Skelton.		
	Practical		
	To perform edge detection using various masks.		
	To perform global and adaptive thresholding.		
	To apply morphological operators on an image.		
Unit- V	**Representation and Description**		
	Representation – Chain codes, Polygonal approximation, Signatures, Boundary descriptors, Shape numbers, Fourier descriptors, Stastical moments, Regional descriptors – Topological, texture, Principal components for description		
	Practical		
	To obtain boundary / regional descriptors of an image.		
Unit-VI	**Object Recognition and Applications**		
	Fundamental Concepts in Video – Types of video signals, Analog video, Digital video, Color models in video, Motion Estimation; Video Filtering; Video Compression, Video coding standards MPEG.		
	Practical		
	Extraction of frames from video, improve the quality and convert them back to compressed video.		
Text Books	**Author**	**Title of Book**	**Publication**
T1	Rafael C. Gonzalez and Richard E. Woods	Digital Image Processing	Third Edition, - Pearson Education
T2	Iain E. G. Richardson, ―H.264 and MPEG	―H.264 and MPEG	Wiley

Reference Book			
R1	A. K. Jain	Fundamentals of digital image processing	Prentice Hall of India, 1989
R2	Pratt William K.	Digital Image Processing	John Wiley & sons
R3	A Bovik	Handbook of Image & Video Processing	Academic Press, 2000
Self-Learning Facilities, Web Resources, Research Papers for Reference	Lecture Series on Digital Image Processing by Prof. P.K. Biswas , Department of Electronics & Electrical Communication Engineering, I.I.T, Kharagpur . For more details on NPTEL visit http://nptel.iitm.ac.in.		
Contents beyond Syllabus	Nil		
Additional Experiments	Nil		
Bridging Courses	Nil		
Assignments			
1	Image file formats & Mathematical operations on Image.		
2	Image enhancement & restoration.		
3	Segmentation techniques.		
4	Thresholding operations		
5	Image compression techniques.		
6	Video coding standards		
Tutorials	N/A		
Presentations	Digital Image Processing-Gonzalez & Woods		

Internet of Things

Course Title:	**Internet of Things (Elective-I)**	**Course Number: 404184**	**Course Code C407d**
Designation of Course	Professional Core		
Teaching Scheme: 3 Hrs/Week		**Laboratories:** 2 Hrs/Week	
Course Assessment Methods	**Direct methods**	In-sem Examination: 30 Marks	Theory/End Semester Examination: 70 Marks
		Term-work	Practical
	Indirect Methods	Assignments, Presentations Continuous assessment	Q&A session, Group Discussion
Prerequisites	Microcontrollers, Embedded 'C' programming		

Course Objectives	
1	To understand what Internet of Things is.
2	To study RFID Technology ,sensor technology & wireless technologies for IoT.
3	To get knowledge of IP based protocols and Data Handling and Analytics.
4	To identify Applications of IoT.
Course Outcomes After successfully completing the course, students will be able to	
CO1	Explain fundamentals of IoT.
CO2	Describe RFID ,sensor and wireless technologies for IoT.
CO3	Explain various IP based protocols and concept of data handling and Analytics.
CO4	Demonstrate some IoT based Applications using sensors and IoT platforms.
Course Contents	
Unit-I	**Fundamentals of IoT:** Introduction, Definitions & Characteristics of IoT, IoT Architectures, Physical & Logical Design of IoT, Enabling Technologies in IoT, History of IoT, About Things in IoT, The Identifiers in IoT, About the Internet in IoT, IoT frameworks, IoT and M2M.
	Practicals :
	Study& Survey of various development boards for IoT.
	Study & Survey of various IoT platforms.
Unit-II	**Sensors Networks:** Definition, Types of Sensors, Types of Actuators, Examples and Working, RFID Principles and components, Wireless Sensor Networks: History and Context, The node, Connecting nodes, Networking Nodes, WSN and IoT.
	Practical
	Interfacing sensors and actuators with Aurdino .
	Build a cloud-ready temperature sensor with the Arduino Uno and the anyIoT Platform
	Interfacing Sensors and actuators with Raspberry Pi 2.
	IoT based Stepper Motor Control with Raspberry Pi
Unit-III	**Wireless Technologies for IoT :** WPAN Technologies for IoT: IEEE 802.15.4, Zigbee, HART, NFC, Z-Wave, BLE, Bacnet, Modbus.

Unit-IV	**IP Based Protocols for IoT :** IPv6, 6LowPAN, RPL, REST, AMPQ, CoAP, MQTT.		
Unit- V	**Data Handling & Analytics:** Introduction, Bigdata, Types of data, Characteristics of Big data, Data handling Technologies, Flow of data, Data acquisition, Data Storage, Introduction to Hadoop. Introduction to data Analytics, Types of Data analytics, Statistical Models, Analysis of Variance, Data Dispersion, Contingence and Correlation, Regression Analysis, Precision and Error limits.		
Unit-VI	**Applications of IoT** Home Automation, Smart Cities, Energy, Retail Management, Logistics, Agriculture, Health and Lifestyle, Industrial IoT, IoT design Ethics, IoT in Environmental Protection.		
Text Books	**Author**	**Title of Book**	**Publication**
T1	Hakima Chaouchi	The Internet of Things Connecting Objects to the Web‖ ISBN : 978-1-84821-140-7	Wiley Publications
T2	Olivier Hersent, David Boswarthick, and Omar Elloumi	The Internet of Things: Key Applications and Protocols‖,	Wiley Publications
T3	Vijay Madisetti and Arshdeep Bahga	Internet of Things (A Hands-on-Approach	1st Edition, VPT, 2014
Reference Books	**Author**	**Title of Book**	**Publication**
R1	Daniel Minoli, 3. http://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html 4. https://onlinecourses.nptel.ac.in/noc17_cs22/course	Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications‖, ISBN: 978-1-118-47347-4	Willy Publications
R2	Pethuru Raj and Anupama C. Raman	"The Internet of Things: Enabling Technologies, Platforms, and Use Cases",	CRC Press
R3	3. http://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html		
R4	4. https://onlinecourses.nptel.ac.in/noc17_cs22/course		
Self-Learning Facilities	NPTEL Lecture Series		
Web Resources			
Research papers for	**Author**	**Title of Paper**	**Journal/Transaction**

reference			
Contents beyond Syllabus			
Additional Experiments			
Bridging Courses	Guest session on "Applications of IOT by Industry Expert .		
Assignments	1. Write and explain characteristics of IoT. 2. Explain with neat diagram Physical & Logical Design of IoT. 3. Name the Types of Sensors and explain their working with neat diagram. 4. Name the Types of Actuators and explain their working with neat diagram. 5. Write a short on RFID Principles and components. 6. Explain various Data handling Technologies. 7. Wtite and explain various types of Data analytics. 8. Write down applications of IoT. Explain any one with : • Neat Block diagram • Interfacing diagram • Flow chart/ Algorithm • Embedded 'C' code		
Tutorials	**Not Applicable**		
Presentations	WPAN Technologies for IoT • IEEE 802.15.4 • Zigbee • HART • NFC • Z-Wave • BLE • Bacnet • Modbus.		

Electronic Product Design

Course Title: Electronic Product Design		**Course Number: 404185**	**Course Name:C405 b**
Year: BE		**Semester: I**	
Designation of Course		Professional Core	
Teaching Scheme: 3 Hrs/Week		**Laboratories:**	
Course Assessment Methods	**Direct methods**	In-sem Examination: 30 Marks	End Semester Examination: 70 Marks
		Term-work	Practical/Oral
	Indirect Methods	Assignments, Quizzes	Seminars, Quiz, Q&A session, Group Discussion
Prerequisites	Analog, Digital Electronics, Microprocessors and Microcontrollers, Design related lab work.		
Course Objectives (University Defined)			
1	To understand the stages of product design (hardware/ software) and development.		
2	To learn different considerations of analog, digital and mixed signal design		
3	To be acquainted with methods of PCB design and different tools for PCB design		
4	To understand the importance of testing in product design cycle.		
5	To understand the processes and importance of documentation.		
Course Outcomes (University defined)			
CO1	Understand various stages of hardware, software and PCB Design		
CO2	Importance of product test & test specifications		
CO3	Special design considerations and importance of documentation		
Course Outcomes (Teacher defined)			
CO1	List various ergonomic considerations observable in any laboratory equipment		
CO2	Draft specifications of any indentified electronic product		
CO3	Compare different software development techniques		
CO4	Identify applicable EMI Tests for a given product based on its intended environment		
Course Contents			
Unit-I	**Introduction to Electronic Product Design**		
	Man machine dialog and industrial design, user-centric design, five elements of successful design, cognition, ergonomics, Packaging and factors, design for manufacture, assembly disassembly. Wiring, temperature, vibration and shock. Safety, noise, energy coupling, grounding, filtering, shielding.		
Unit-II	**Hardware Design and Testing Methods**		
	Design process. Identifying the requirements, formulating specifications, design specifications. Specifications versus requirements, System partitioning. Functional Design. Functional model versus architectural model. Prototyping, performance and efficiency measures. Formulating a test plan. Writing specifications. Test procedures and test cases. Egoless design, design reviews. Module debug and test: black box test, white box test, gray box test.		

Unit-III	**Software Design and Testing Method**		
	Types of software, waterfall model of software development. Models, metrics and software limitations. Risk abatement and failure preventions. Software bugs and testing. Good programming practices. User interface. Embedded, real-time software.		
Unit-IV	**PCB Design**		
	Fundamental definitions, Standards. Routing Topology Configurations, Layer stack-up assignment, Grounding Methodologies, Aspect ratio, Image planes, Functional partitioning, Critical frequencies, Bypassing and decoupling. Design techniques for ESD protection, Guard band implementation.		
Unit- V	**Product Debugging and Testing**		
	Steps for debugging, Techniques for troubleshooting, characterization, Electromechanical components, passive components, active components, active devices, operational amplifiers, Analog-Digital conversion. Digital Components, Inspection and testing of components. Simulation, Prototyping and testing, Integration, validation and verification. EMI/EMC issues.		
Unit-VI	**Documentation**		
	Definition, need, and types of documentation. Records, Accountability, and Liability. Audience. Preparation, Presentation, and Preservation of documents. Methods of documentation, Visual techniques, Layout of documentation. Bill of material.		
Text Books	**Author**	**Title of Book**	**Publication**
T1	Kim Fowler	Electronic Instrument Design	Oxford University Press
T2	Robert J Herrick	Printed Circuit Board Design Techniques for EMC Compliance	IEEE Press
Reference Books			
R1	James K Peckol	Embedded Systems, A Contemporary Design Tool	Wiley
R2	J C Whitakar	The Electronic Handbook	CRC Press
Self-Learning Facilities (OCW, Handouts, Web Recourses, Research papers etc.)	NPTEL Lecture Series		
	Application Notes		
	Application Notes by Analog Devices, Altera Corporation, Maxim, TI etc.		
Contents beyond Syllabus	Environmental Testing Methods, Reliability theory		
Additional Experiments	Nil		
Bridging Courses	Nil		

Assignments	For students
1	List advantages and disadvantages of different filtering techniques used to achieve EMC
2	Sketch front panel of an Analog Real time oscilloscope
3	Prepare a write-up on Spiral Model of software development
4	A write-up on Mixed signal design practices
5	Prepare detailed Bill of material for Mini project
Tutorials	Nil
Presentations	Technical specifications of a professionally designed product
	Black box, white box and gray box testing
	ESD and protection techniques

Artificial Intelligence

Course Title:	**Artificial Intelligence**	**Course Number: 404185**	**Course Code:C407d**
Designation of Course	Professional Core		
Teaching Scheme: 3 Hrs/Week		**Laboratories: --**	
Course Assessment Methods	**Direct methods**	In-sem Examination:30 Marks	Theory/End Semester Examination: 70 Marks
		Term-work	Practical/Oral
	Indirect Methods	Assignments, Presentations	Seminars, Quiz, Q&A session, Group Discussion
Prerequisites	Fundamental Algorithms of Programming language		
Introduction of Course			
Artificial Intelligence			
Course Objectives			
1	To learn various types of algorithms useful in Artificial Intelligence (AI)		
2	To convey the ideas in AI research and programming language related to emerging technology		
3	To understand the concepts of machine learning, pattern recognition, and natural language processing		
4	To understand the numerous applications and huge possibilities in the field of AI that go beyond the normal human imagination		
Course Outcomes			
CO1	Design and implement key components of intelligent agents and expert systems		
CO2	To apply knowledge representation techniques and problem solving strategies to common AI applications		
CO3	Apply and integrate various artificial intelligence techniques in intelligent system development as well as understand the importance of maintaining intelligent systems		
CO4	Build rule-based and other knowledge-intensive problem solvers		
Course Contents			
Unit-I	**Foundation**		
	Intelligent Agents, Agents and environments, Good behaviour, The nature of environments, structure of agents, Problem Solving, problem solving agents, example problems, Searching for solutions, uniformed search strategies, avoiding repeated states, searching with partial information		
Unit-II	**Searching**		
	Search and exploration, Informed search strategies, heuristic function, local search algorithms and optimistic problems, local search in continuous spaces, online search agents and unknown environments, Constraint satisfaction problems (CSP), Backtracking search and Local search for CSP, Structure of problems, Games: Optimal decisions in games, Alpha- Beta Pruning, imperfect real-time decision, games that include an element of chance		
Unit-III	**Knowledge Representation**		

	First order logic, representation revisited, Syntax and semantics for first order logic, Using first order logic, Knowledge engineering in first order logic, Inference in First order logic, prepositional versus first order logic, unification and lifting, forward chaining, backward chaining, Resolution, Knowledge representation, Uncertainty and methods, Bayesian Probability and Belief network, probabilistic Reasoning, Bayesian networks, inferences in Bayesian networks, Temporal models, Hidden Markov models		
Unit-IV	**Learning**		
	Learning from observations: forms of learning, Inductive learning, Learning decision trees, Ensemble learning, Knowledge in learning, Logical formulation of learning, Explanation based learning, Learning using relevant information, Inductive logic programming, Statistical learning methods, Learning with complete data, Learning with hidden variable, EM algorithm, Instance based learning, Neural networks - Reinforcement learning, Passive reinforcement learning, Active reinforcement learning, Generalization in reinforcement learning		
Unit- V	**Pattern Recognition and Expert System**		
	Basic steps of pattern recognition system, Feature Extraction- Principal Component Analysis, Linear Discriminant Analysis, Classification, Object Recognition- Template Matching theory, Prototype Matching Theory, Speech Recognition, Pattern Mining- Apriori Algorithm		
Unit-VI	**Natural Language Understanding**		
	Why NL, Formal grammar for a fragment of English, Syntactic analysis, Augmented grammars, Semantic interpretation, Ambiguity and disambiguation, Discourse understanding, Grammar induction, Probabilistic language processing, Probabilistic language models		
Text Books	**Author**	**Title of Book**	**Publication**
T1	Stuart Russell, Peter Norvig	Artificial Intelligence, a Modern Approach	Pearson Education/Prentice Hall of India
T2	Elaine Rich and Kevin Knight	Artificial Intelligence	Tata McGraw-Hill
Reference Books			
R1	Nils J. Nilsson	Artificial Intelligence: A new Synthesis	Harcourt Asia Pvt. Ltd.
R2	George F. Luger	Artificial Intelligence- Structures and Strategies for Complex Problem Solving	Pearson Education/ PHI
Self-Learning Facilities	NPTEL Lecture Series		
Web Resources	Online AI courses		

Technical Notes for reference	Author	Title of Paper	Journal/Transaction
	Nils J. Nilsson	A mobile automaton: an application of artificial intelligence techniques	Stanford Research Institute Menlo Park, California
Contents beyond Syllabus	Case Study: IBM watson		
Additional Experiments	NA		
Bridging Courses	Linear Algebra		
Assignments			
1	Problems based on Intelligent Agents		
2	LDA and PCA		
3	Min-Max Algorithm		
4	EM algorithm		
5	Decision Tree in NLP		
Tutorials	EM algorithm		
	PCA and LDA		
Presentations	Natural Language Processing : Syntactic Analysis		
	Grammar induction		
	Probabilistic Language Models		

BE (E&TC)

Semester II

Mobile Communication

Course Title: Mobile Communication		**Course Number:** 404189	**Course Name:C409**
Year: BE		**Semester: II**	
Designation of Course		Professional Core	
Teaching Scheme: 4Hrs/Week		**Laboratories:** 2 Hrs/Week	
Course Assessment Methods	**Direct methods**	In-sem. Examination: 30 Marks	End Semester Examination: 70 Marks
		Term-work	Oral
	Indirect Methods	Assignments, Presentations	Seminars, Quiz, Q&A session, Group Discussion
Prerequisites	Analog Communication, Digital Communication, Telecommunication Switching Systems, Computer Network		
Course Objectives			
1	To learn and understand the basic principles of Telecommunication switching, traffic and networks.		
2	To learn and understand basic concepts of cellular system, wireless propagation and the techniques used to maximize the capacity of cellular network.		
3	To learn and understand architecture of GSM and CDMA system.		
4	To understand mobile management, voice signal processing and coding in GSM and CDMA system.		
Course Outcomes			
CO1	Explain and apply the concepts telecommunication switching, traffic and networks.		
CO2	Analyze the telecommunication traffic.		
CO3	Analyze radio channel and cellular capacity.		
CO4	Explain and apply concepts of GSM and CDMA system.		
Course Contents			
Unit-I	**Telecommunication Switching & Traffic**		
	Telecommunication switching: Message switching, Circuit switching, Manual System, Electronic Switching. Digital switching: Switching functions, Telecommunication Traffic: Unit of Traffic, Traffic measurement, A mathematical model, Lost- call systems: Theory, traffic performance, loss systems in tandem, traffic tables. Queuing systems: Erlang Distribution, probability of delay, Finite queue capacity, Systems with a single server, Queues in tandem, delay tables and application of Delay formulae.		
	Practical		
	Set up and carry out experiment on analysis of telecommunication traffic.		
Unit-II	**Switching Networks and Signalling**		
	Single Stage Networks, Grading, Link Systems, and Grade of service of link systems. Time Division Switching: Space and time switching, Time division switching networks, Synchronization, Call processing Functions, Common Control, Reliability, Availability and Security. Signalling: Customer line signalling. FDM carrier systems, PCM signalling, Inter-register signalling, Common channel signalling principles, CCITT signalling No. 6, CCITT		

	signalling No.7, Digital customer line signalling.		
	Practical		
	Set up and carry out experiment on PSTN TST switch.		
Unit-III	**Cellular Concepts**		
	Evolution of Wireless systems, Introduction to cellular telephone system, Frequency reuse, Channel Assignment, Handoff strategies, Cell Splitting, Propagation Mechanism: Free space loss, Reflection, Diffraction, Scattering. Fading and Multipath: Small scale multipath propagation, Impulse response model of multipath channel. Multiple Access Techniques-TDMA,FDMA, CDMA		
	Practical		
	Simulation of a wireless channel model.		
Unit-IV	**First and Second Generation Mobile Systems**		
	First Generation Cellular Systems, AMPS, GSM Cellular Telephony: Introduction, Basic GSM Architecture, Basic radio transmission parameters in GSM system, Logical Channels, GSM time hierarchy, GSM burst structure, Description of call setup procedure, Handover, Modifications and derivatives of GSM.		
	Practical		
	Set up and carry out experiment on Mobile phone.		
	Set up and carry out experiment on GSM.		
	Set up and carry out experiment on AT commands.		
Unit- V	**GSM Services**		
	GSM Physical layer: Speech Coding and decoding, GMSK modulation, Data transmission in GSM: Data Services, SMS, HSCSD, GPRS, And EDGE.		
	Practical		
	Simulation of Speech coding and decoding.		
Unit-VI	**CDMA Based Mobile Systems**		
	Motivation for CDMA use, Spreading Sequences, Basic Transmitter and Receiver schemes, Rake Receiver, IS-95 system: Frequency Range, Downlink transmission, Uplink transmission, Power control, Introduction to 3G mobile systems: W-CDMA and cdma-2000.		
	Practical		
	Set up and carry out experiment on GMSK modulation.		
	Set up and carry out experiment on spreading Sequences.		
	Set up and carry out experiment on CDMA.		
	Set up and carry out experiment on3G Mobile.		
	Set up and carry out experiment on VOIP implementation		
Text Books	**Author**	**Title of Book**	**Publication**
T1	J. E. Flood	Telecommunications Switching, Traffic and Networks	Pearson Education
T2	Krzysztof Wesolowski	Mobile Communication Systems	Wiley Student Edition
Reference Books			
R1	Theodore S Rappaport	Wireless Communications Principles and Practice	Second Edition, Pearson Education

R2	John C. Bellamy	Digital Telephony	Third Edition; Wiley Publications
R3	ThiagarajanVishwanathan	Telecommunication Switching Systems and Networks	PHI Publications
R4	Wayne Tomasi	Electronic Communications Systems	5th Edition; Pearson Education
R5	Vijay K Garg, Joseph E Wilkes	Principles and Applications of GSM	Pearson Education
R6	Vijay K Garg, Joseph E Wilkes	IS-95CDMA and CDMA 2000 Cellular/PCS Systems Implementation	Pearson Education
R7	Mischa Schwartz	Mobile Wireless Communications	Cambridge University Press

Self-Learning Facilities (OCW, Handouts, Web Recourses, Research papers etc.)	NPTEL Lecture Series on Mobile Communication by Prof. Sujoy Ghosh and Prof A. Pal, Department of Computer Science & Engineering, IIT Kharagpur.
	www.Youtube.com (Lectures series by Experts)
Contents beyond Syllabus	Concept of Telegraphy
	Three stage network
	Grade of service of link system(Three stage network)
Additional Experiments	Simulation to set up and carry out experiment on CDMA
Bridging Courses	
Assignments	Simulation of a wireless channel model.
	Set up and carry out experiment on analysis of telecommunication traffic.
	Numerical on Traffic calculation
	Traffic Measurement
	Numerical on first erlang distribution
	Numerical on channel capacity
Tutorials	Nil
Presentations	Traffic performance
	Cellular concepts, Switching systems

Broadband Communication Systems

Course Title: Broadband Communication Systems		**Course Number: 404190**	**Course Name:C410**
Year: BE		**Semester: II**	
Designation of Course: Professional Core			
Teaching Scheme: 4 Hrs/Week		**Laboratories:** 2 Hrs/Week	
Course Assessment Methods	**Direct methods**	In-sem Examination: 30 Marks	Theory/End Semester Examination: 70 Marks
		Term-work:50*	Oral:50**Lab Practise III: BCS & MC
	Indirect Methods	Assignments, Presentations	Seminars, Quiz, Q&A session, Group Discussion
Prerequisites	Physics, Electromagnetic Fields and Communication theory		

Course Objectives	
1	To select appropriate lightwave components and establish a digital optical link..
2	To understand the orbital mechanics, satellite subsystems and design satellite uplink & downlink.
Course Outcomes:	
After successfully completing the course students will be able to:	
CO1	**Explain** the working of the components in a light wave system and **estimate** the parameters associated with them.
CO2	**Experiment with** optical key components - sources, detectors & fibers and **select** appropriate components and **establish** digital optical link.
CO3	**Analyze** the given fiber optic link on the basis of OPB & RTB and **evaluate** the system viability in point to point link using simulation software.
CO4	**Explain** the fundamentals associated with orbital mechanics, launch vehicles and **analyze** the satellite design in uplink and downlink configuration.
CO5	**Explain** the various satellite subsystems and the orbital effects in communication satellite.
CO6	**Establish** uplink & downlink satellite link for transmission of tone, audio, video and data using satellite emulator.
Course Contents	
Unit-I	Light wave System Components 6L
	Key Elements of Optical Fiber Systems, Optical Fibers as a Communication Channel: Optical Fiber Modes and Configurations , Mode Theory for Circular Waveguides , Single-mode Fibers, Graded-index Fiber Structure, Signal Degradation in Optical Fibers.Optical Sources: Basic Concepts and characteristics of LEDs and LASERs. Photodetectors: Basic Concepts, Common Photodetectors.
	Practical
	1.Estimation of Numerical aperture of fiber
	2. Plot the characteristics of various sources and detectors
	3. Measure attenuation of MMSI and SMSI fiber and comment on the result based on attenuation due to increase in length as well as loss due to bend
Unit-II	Light-wave Systems 6L

	System Architectures, Point-to-Point Links: System Considerations, Design Guidelines: Optical Power Budget, Rise Time Budget, Long-Haul Systems.		
	Practical		
	4. Set up a digital link and analyze.		
	5. Tutorial on Power budget and time budget analysis of optical fiber		
Unit-III	Multichannel Systems 6L		
	Overview of WDM, WDM Components: 2 x 2 Fiber Coupler, Optical Isolators and Circulators, Multiplexers and De-multiplexers, Fiber Bragg Grating, FBG applications for multiplexing and De-multiplexing function, Diffraction Gratings, Overview of Optical Amplifiers: SOA, EDFA and RFA in brief.		
Unit-IV	Orbital Mechanics and Launchers 6L		
	History of Satellite Communication, Orbital Mechanics, Look angle determination, Orbital perturbations, Orbital determination, Launchers and Launch Vehicles, Orbital effects in communication system performance.		
Unit- V	Satellites 6L		
	Satellite Subsystems, Attitude and control systems (AOCS), Telemetry, Tracking, Command and Monitoring, Power systems, Communication subsystems, Satellite antennas, Equipment Reliability and space qualification.		
Unit-VI	Satellite Communication Link Design 6L		
	Introduction, Basic transmission Theory, System Noise Temperature and G/T Ratio, Design of Downlinks, Satellite Systems using Small Earth Stations, Uplink Design, Design of Specified C/N : Combining C/N and C/I values in Satellite Links, System Design Examples.		
	Practical		
	6. Establishing a direct communication link between Uplink Transmitter and Downlink Receiver using tone signal.		
	7. To communicate VOICE signal through satellite link.		
	8. To establish an AUDIO-VIDEO satellite link between Transmitter and Receiver		
	9. To transmit and receive PC data through satellite link		
	10. Tutorial on satellite link design		
Text Books	**Author**	**Title of Book**	**Publication**
T1	Gerd Keiser	Optical fiber Communications	Tata McGraw Hill, 4th edition
T2	Timothy Pratt, Charles Bostian, Jeremy Allnutt	Satellite Communications	John Wiley & Sons.
Reference Books			
R1	Govind P. Agrawal	Fiber-Optic Communication Systems	Wiley, 3rd edition.
R2	Dennis Roody	Satellite Communications	McGraw Hill
Self-Learning Facilities (OCW, Handouts,	NPTEL Lecture Series on Optical Fiber Communication by Prof Shevgaonkar, IITB.		

Web Recourses, Research papers etc.)	
Contents beyond Syllabus	State of art – Optical Link Components, Google Fiber Standards
Additional Experiments	1. Characterizing optical fiber link using OTDR.
	2. Simulation based.
Bridging Courses	Nil
Assignments	
1	Light wave Components
2	Optical Power Budget
3	Optical Rise Time Budget
4	Orbital Mechanics & Launchers
5	Satellite Link Design
Tutorials	Tutorial on Power budget and time budget analysis of optical fiber
	Tutorial on satellite link design
Presentations	Dense Wavelength Division Multiplexing Scheme
	Satellite Systems
Videos	Fiber Fabrication & Installation Satellite Communication

Machine Learning

Course Title: Machine Learning (Elective-III)		**Course Number: 404191**	**Course Name: C411a**
Year: BE	**Semester: II**		
Teaching Scheme: 3 Hrs/Week		**Laboratories:** 2 Hrs/Week	
Course Assessment Methods	**Direct methods**	On-line/In-sem Examination: 50/30 Marks	Theory/End Semester Examination: 50/70 Marks
		Term-work	Practical/Oral
	Indirect Methods	Assignments, Presentations	Seminars, Quiz, Q&A session, Group Discussion
Prerequisites	Signals and Systems, Engineering Mathematics		
Course Objectives			
1	Explore supervised and unsupervised learning paradigms of machine learning used for regression and classification		
2	To design and analyze various machine learning algorithms using neural networks		
3	To explore Deep learning technique and various feature extraction strategies		
Course Outcomes			
CO1	To compare and contrast pros and cons of various machine learning techniques and to get an insight of when to apply a particular machine learning approach		
CO2	To mathematically analyze various machine learning approaches and paradigms		
CO3	To implement convolution neural networks in recognition applications		
Course Contents			
Unit-I	**Introduction to Machine Learning**		
	Why Machine learning. Types of machine learning, basic concepts in machine learning like parametric and non-parametric modelling, linear and nonlinear regression, over fitting and dimensionality reduction. Decision trees, Feature reduction.		
	Practical		
	1. Implement a simple linear regressor with a single neuron model		
Unit-II	**Models for Regression and Classification**		
	Linear Models for Regression :Least Squares and Nearest Neighbours ,Linear Basis Function Models, The Bias-Variance Decomposition, Bayesian Linear Regression Bayesian Model Comparison Linear Models for Classification : Discriminant Functions .Probabilistic Discriminative Models Multivariate Data,ParameterEstimation,MultivariateClassification,Multivariate Regression Kernel Methods : Support Vector machines and Relevance Vector Machines		
	Practical		
	1. Implement SVM classifier for classification of data into two classes. Student can use datasets such as flower classification etc.		
	2. Implement and test Multiclass SVM classifier		

Unit-III	**Clustering**
	Dimensionality Reduction : Principal Components Analysis, Factor Analysis, Multidimensional Scaling, Linear Discriminant Analysis Clustering : k-Means Clustering, Mixtures of Gaussians
	Practical
	1. K-means clustering
Unit-IV	**Artificial Neural Networks I**
	Biological neuron, Artificial neuron model, concept of bias and threshold, Activation functions, McCulloch-Pits Neuron Model, learning paradigms, concept of error energy, gradient descent algorithm and application of linear neuron for linear regression,: Learning mechanisms: Hebbian, Delta Rule, Perceptron and its limitations
	Practical
	1. AND/ OR logic implementation using Hebbian Rule
Unit- V	**Artificial Neural Networks II**
	Multilayer Perceptron (MLP) and back propagation algorithm, Application of MLP for classification, Self-Organizing Feature Maps, Learning vector quantization Radial Basis Function networks
	Practical
	1.Implement and test MLP trained with back-propagation algorithm 2. Implement and test RBF network 3. Implement SOFM for character recognition
Unit-VI	**Deep Learning and Convolution Neural Networks**
	Improvement of the Deep Neural Network:Vanishing Gradient, Overfitting, Computational Load, ReLU Function, Dropout Architecture of ConvNet, Convolution Layer, Pooling Layer, Applications of CNN's
	Practical
	1. Implement and test CNN for object recognition.

Text Books	**Author**	**Title of Book**	**Publication**
T1	Christopher Bishop	Pattern Recognition and Machine Learning	Springer, 2007
T2	Laurene Fausett	Fundamentals of Neural Networks: Architectures, Algorithms And Applications	Pearson Education, Inc, 2008
Reference Books			
R1	Kevin Murphy	Machine Learning: A Probabilistic Perspective,	MIT Press, 2012.
R2	Trevor Hastie,	The Elementsof Statistical	Springer 2009

	Robert Tibshirani, Jerome Friedman	Learning	
R3	Phil Kim	MATLAB Deep Learning: With Machine Learning, Neural Networks and Artificial Intelligence	A Press 2017.
R4	Ethem Alpaydın	Introduction to Machine Learning	Second Edition The MIT Press 2010
R5	Simon Haykin	Neural Networks : A comprehensive foundation	Prentice Hall International Inc. 1999
Self-Learning Facilities	Linear Regression: https://youtu.be/rVviNyIR-fI		
	PCA: http://biol09.biol.umontreal.ca/PLcourses/PCA_algebra.pdf Bias-variance trade-off https://www.youtube.com/watch?v=EuBBz3bI-aA		
Web Resources	**Backpropogation Algorithm:** https://mattmazur.com/2015/03/17/a-step-by-step-backpropagation-example/ **NN overview:** https://medium.com/machinevision/overview-of-neural-networks-b86ce02ea3d1 **CNN:** https://www.completegate.com/2017022864/blog/deep-machine-learning-images-lenet-alexnet-cnn/		
Technical Notes for reference	Author	Title of Paper	Journal/Transaction
1	Anil Jain, Jianchang Mao, K. M. Mohiuddin	Artificial neural Networks: A tutorial	Theme Feature, 1996, IEEE
2	Shireen Elhabian and Aly A. Farag	A Tutorial on Data Reduction	University of Louisville, CVIP Lab, September 2009
Contents beyond Syllabus	Applications of CNN on image classification		
Additional Experiments	AND, OR implementation using Hebbian Learning Rule		
	k-means clustering		
Bridging Courses	Linear Algebra		
Assignments			
1	Topologies of Neural Networks		
2	k-SOFM		

3	Learning Rules
4	LVQ
5	SVM
Tutorials	**CNN** by Chinmay Savadikar
	Sums on Neural Networks
Presentations	**PCA and LDA** by Pranali Kulkarni, Rushikesh deshmukh, Abhisha Daine and Amey Kulkarni
	Bias and Variance by Shridhar Kshirsagar
	Linear Regression and Cost function by Rohit Deshmukh

Audio Video Engineering

Course Title: Audio Video Engineering (Elective-III)		**Course Number:404191**	**Course Name: C411 c**
Year: BE		**Semester: II**	
Designation of Course	Professional Core		
Teaching Scheme: 3 Hrs/Week		**Laboratories:** 2 Hrs/Week	
Course Assessment Methods	**Direct methods**	In-sem Examination: 30 Marks	Theory/End Semester Examination: 70 Marks
		Term-work 50 Marks	Practical/Oral50 Marks
	Indirect Methods	Assignments, Presentations	Seminars, Quiz, Q&A session, Group Discussion
Prerequisites	Basics of analog communication and transmission Techniques Knowledge about the antennas In depth understanding of cathode ray tube		
Course Objectives			
1	After learning AVE course, students will understand the working of real life video system and the different elements of video system plus the encoding/decoding techniques.		
2	The learners will be groomed up to understand different channel allocations, difference between various systems present in this world, their transmission and reception techniques		
3	Students will get insight on functioning of individual blocks, different standards of compression and they will be acquainted with different types of analog, digital TV and HDTV systems.		
4	The students will get overview of fundamentals of audio systems and basics of Acoustics		
Course Outcomes			
CO1	The learners will be able to understand the transmission of video signals.		
CO2	The learners will also understand the importance of television standards to effectively work with broadcasting applications.		
CO3	They will gain knowledge in advanced digital video transmission standards.		
CO4	They will be conversant with the studio acoustics and related parameters like reverberation		
Course Contents			
Unit-I	**Fundamentals of Colour Television**		
	Color TV systems, fundamentals, mixing of colors, colour perception, chromaticity diagram. NTSC, PAL, SECAM systems, colour TV transmitter, (high level, low level), colour TV receivers, remote control. Fault finding and servicing equipments like Wobbuloscope, TV Pattern Generator, and Field Strength meter.		
	Practical		
	-Voltage and Waveform analysis for color TV receiver		
Unit-II	**Digital TV and Display Devices**		
	Introduction to Digital TV, Digital TV signals and parameters, Digital TV Transmitters, MAC signals, advanced MAC signal transmission, Digital TV receivers, Basic principles of Digital Video compression techniques, MPEG		

	Standards. Digital TV recording techniques, Display devices: LED, LCD, TFT, Plasma.		
	Practical		
	Study of Direct to home TV and set top box		
	Study of Digital TV Pattern Generator		
	Study of Digital TV		
Unit-III	**HDTV**		
	HDTV standards and systems, HDTV transmitter and receiver/encoder, Digital TV satellite Systems, video on demand, CCTV, CATV, direct to home TV, set top box with recording facility, conditional access system (CAS), 3D TV systems, Digital broadcasting, case study (Cricket match, Marathon, Football match).		
	Practical		
	Study of HDTV		
Unit-IV	**Advanced TV Systems**		
	IP Audio and Video, IPTV systems, Mobile TV, Video transmission in 3G mobile System, IPod(MPEG4 Video player), Digital Video Recorders, Personal Video Recorders, Wi-Fi Audio / Video Transmitter and Receivers. Video Projectors, HD Video projectors, Video Intercom systems/ Video door phones.		
	Practical		
	Study of Wi-Fi TV /IPTV system		
Unit- V	**Fundamentals of Audio-Video Recording**		
	Methods of sound recording & reproduction, optical recording, CD recording, , audio standards. Digital Sound Recording, CD/ DVD player, MP3 player, Blue Ray DVD Players, MPEG, MP3 Player.		
	Practical		
	Simulation of Video, Audio & Image Processing Techniques(Software Assignment)		
	Study of Audio system: CD Players and MP3 Players		
Unit-VI	**Fundamentals of Acoustics**		
	Studio acoustics & reverberation, P.A. system for auditorium, , acoustic chambers ,Cordless microphone system, special types of speakers & microphones, Digital Radio Receiver Satellite radio reception.		
	Practical		
	Study of PA system with cordless microphone		
	Directivity Pattern of microphones/ Loudspeakers		
Text Books	**Author**	**Title of Book**	**Publication**
T1	A. M. Dhake	Television and Video Engineering	TMH Publication.
T2	Keith jack	Video Demisified	Penram International Publication.
	R.G. Gupta,	Audio Video System	TMH Publication
Reference Books			
R1	S. P. Bali	"Color TV Theory and	

		Practice"	
R2	Bernard Grobb, Charles E	"Basic TV and Video Sytems	
R3	Gulathi	"Monochrome & Color TV	
Self-Learning Facilities, Web Resources, Research papers for reference	NPTEL Lecture Series		
	www.dvdforum.com		
	www.trai.gov.in		
Contents beyond Syllabus	Introduction to Advanced compression techniques like MPEG-4 and JPEG-2000. Latest technology like 3D along with the latest 3D camera devices and viewing technology. Introduction to the latest broadcasting and reception technologies as the World is moving towards Digitization.		
Additional Experiments	Troubleshooting of Colour TV receiver from Expert		
Bridging Courses	Expert lectures by Communication Faculties		
Assignments			
1	Color TV receiver and PAL decoder		
2	Comparison between NTSC, PAL and SECAM		
3	Comparison of CD,DVD and Blu-ray DVDs.		
Tutorials	Calculations of channel frequencies on VHF and UHF bands		
	All parameters of display technologies like CRT, LCDs, TFTs, Plasmas, LEDs. Their comparison and voltages required		
	Calculations of satellite TV channels and LNBC frequencies		
Presentations	Presentation on Display Device Technologies Introduction to New Broadcasting Antennas Discussion of latest Video Compression Techniques		

Wireless Sensor Networks

Course Title: Wireless Sensor Networks		**Course Number:** 404192	**Course Name: C412 d**
Year: BE		**Semester: II**	
Designation of Course		Professional Core	
Teaching Scheme: 3Hrs/Week		**Laboratories:** -Nil	
Course Assessment Methods	**Direct methods**	In-sem. Examination: 30 Marks	End Semester Examination: 70 Marks
	Indirect Methods	Assignments, Presentations	Seminars, Quiz, Q&A session, Group Discussion
Prerequisites	Mobile Communication, Telecommunication Switching System, Digital Communication, Analog Communication, Computer Network		
Course Objectives			
1	To study the evolving wireless technologies and standards		
2	To understand the architectures of various access technologies such as 3G, 4G, WiFi etc.		
3	To understand various protocols and services provided by next generation networks.		
Course Outcomes			
CO1	Keep himself updated on latest wireless technologies and trends in the communication field		
CO2	Understand the transmission of voice and data through various networks.		
CO3	Explain and apply concepts of GSM and CDMA system.		
Course Contents			
Unit-I	**Introduction to Wireless Networks**		
	Introduction, Technology and service trends of Emerging Wireless technologies, The Amazing Growth of Mobile Communications, A Little History, Mobile Communications Fundamentals, Mobile Data, WiFi, Bluetooth, Cable Systems, Wireless Migration Options, Harmonization Process.		
Unit-II	**WiFi and Next Generation WLAN**		
	WiFi (802.11), 802.11 Standards, WiFi Protocols, Frequency Allocation, Modulation and Coding Schemes, Network Architecture, Typical WiFi Configurations, Security, 802.11 Services, Hot Spots, Virtual Private Networks (VPNs), Mobile VPN, VPN Types, WiFi Integration with 3G/4G, Benefits of Convergence of WiFi and Wireless Mobile.		
Unit-III	**Third Generation Mobile Services**		
	Introduction, Universal Mobile Telecommunications Service (UMTS), UMTS Services, The UMTS Air Interface, Overview of the 3GPP Release 1999 Network Architecture, Overview of the 3GPP Release 4 Network Architecture, Overview of the 3GPP Release 5, All-IP Network Architecture, Overview CDMA2000, TD-CDMA, TD-SCDMA, Commonality among WCDMA, CDMA2000, TD-CDMA, and TD-SCDMA		
Unit-IV	**LTE**		
	LTE Ecosystem, Standards, Radio Spectrum, LTE Architecture, User Equipment		

	(UE), Enhanced Node B (eNodeB), Core Network (EPC), Radio Channel Components, TD-LTE, Multiple Input Multiple Output, LTE Scheduler, Carrier Aggregation, Cell Search, Cell Reselection, Attach and Default Bearer Activation, Handover (X2, S1, Inter-MME), Self- Organizing Networks (SONs), Relay Cells, Heterogeneous Network (HetNET), Remote Radio Heads (RRH), VoLTE, LTE Advanced		
Unit- V	**WiMAX**		
	Introduction, Standards, Generic WiMAX Architecture, Core Network, Radio Network, WiMAX Spectrum, Modulation, Channel Structure, Mixed Mode, Interference Mitigation Techniques, Frequency Planning, Features and Applications, Security, QoS, Profiles, Origination, Handover, Femto and SON		
Unit-VI	**VOIP**		
	Why VoIP?, The Basics of IP Transport, VoIP Challenges, H.323, The Session Initiation Protocol (SIP), Distributed Architecture and Media Gateway Control, VoIP and SS7, VoIP Quality of Service.		
Text Books	**Author**	**Title of Book**	**Publication**
T1	Clint Smith, P.E., Daniel Collins	Wireless Networks: Design and Integration for LTE, EVDO, HSPA, and WiMAX	McGrawHill Education, Third Edition
T2	EldadPerahia, Robert Stacey	Next Generation Wireless LANs	Cambridge University Press, Second Edition
Reference Books			
R1	Yi-Bang Lin, ImrichChlamtac	Wireless and Mobile Network Architecture	Wiley India Edition
R2	DipankarRaychaudhary, Maria Gerla	Emerging Wireless Technologies and the Future Mobile Internet	Cambridge University Press
Self-Learning Facilities(OCW, Handouts, Web Recourses, Research papers etc.)	NPTEL Lecture Series on Mobile Communication by Prof. Sujoy Ghosh and Prof A. Pal, Department of Computer Science & Engineering, IIT Kharagpur.		
	www.Youtube.com (Lectures series by Experts)		
Contents beyond Syllabus	Understanding PSTN ,Telecommunication Traffic analysis ,Speech coding and decoding		
Additional Experiments	Nil		
Bridging Courses	Nil		
Assignments	How to create hotspot on laptop?		
	VOIP Implementation		
	WiFi Implementation		
Tutorials	Nil		

Presentations	1. Cellular concepts
	2. Multiple access technique
	3. WiFi and next generation WLAN