GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRONICS AND COMMUNICATION ENGINEERING (11)
VLSI TECHNOLOGY & DESIGN
SUBJECT CODE: 2161101
B.E. 6th SEMESTER

Type of course: MOSFET Device and Circuit course

Prerequisite: Knowledge of Basic and Digital Electronics

Rationale: This course will provide an opportunity to the students to learn about various topics VLSI such as MOSFET fabrication, its physics, and analysis as well as design of digital circuits using MOSFET device. In laboratory part of this course, students will be given exposure to hardware description language such as VHDL/verilog for automated design of digital circuits. This subject is very important for the students who will be in future would like to pursue their career in VLSI domain.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
				Theory Marks			Practical Marks			
L	T	P	C	ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
4	0	2	6	70	20	10	20	10	20	100

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Introduction:** Overview of VLSI design methodology, VLSI design flow, Design hierarchy, Concept of regularity, Modularity, and Locality, VLSI design style, Design quality, package technology, introduction to FPGA and CPLD, computer aided design technology.	4	8
2	**Fabrication of MOSFET :** Introduction, Fabrication Process flow: Basic steps, C-MOS n-Well Process, Layout Design rules, full custom mask layout design.	4	8
3	**MOS Transistor:** The Metal Oxide Semiconductor (MOS) structure, The MOS System under external bias, Structure and Operation of MOS transistor, MOSFET Current-Voltage characteristics, MOSFET scaling and small-geometry effects, MOSFET capacitances	8	16
4	**MOS Inverters: Static Characteristics:** Introduction, Resistive load Inverter, Inverter with n-type MOSFET load (Enhancement and Depletion type MOSFET load), CMOS Inverter	7	13
5	**MOS Inverters Switching characteristics and Interconnect Effects :** Introduction, Delay-time definitions, Calculation of Delay times, Inverter design with delay constraints, Estimation of Interconnect Parasitic, Calculation of interconnect delay, Switching Power Dissipation of CMOS Inverters	8	16

6	**Combinational MOS Logic Circuits:** Introduction, MOS logic circuits with Depletion nMOS Loads, CMOS logic circuits, Complex logic circuits, CMOS Transmission Gates (TGs)	**5**	**9**
7	**Sequential MOS Logic Circuits :** Introduction, Behavior of Bistable elements, The SR latch circuit, Clocked latch and Flip-flop circuit, CMOS D-latch and Edge-triggered flip-flop	**4**	**8**
8	**Dynamic Logic Circuits :** Introduction, Basic Principles of pass transistor circuits, Voltage Bootstrapping, Synchronous Dynamic Circuit Techniques, CMOS Dynamic Circuit Techniques, High-performance Dynamic CMOS circuits	**7**	**12**
9	**Chip I/P and O/P Circuits :** On chip Clock Generation and Distribution, Latch –Up and its Prevention	**2**	**4**
10	**Design for testability :** Introduction, Fault types and models, Controllability and observability, Ad Hoc Testable design techniques, Scan –based techniques, built-in Self Test (BIST) techniques, current monitoring IDDQ test	**3**	**6**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	**15**	**10**	**20**	**10**	**5**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. CMOS Digital Integrated circuits – Analysis and Design by Sung – Mo Kang, Yusuf Leblebici, TATA McGraw-Hill Pub. Company Ltd.
2. Basic VLSI Design By Pucknell and Eshraghian, PHI,3rd ed.
3. Introduction to VLSI Systems by Mead C and Conway, Addison Wesley
4. Introduction to VLSI Circuits & Systems – John P. Uyemura
5. Fundamentals of Digital Logic Design with VHDL, Brown and Vranesic

Course Outcome:

After learning the course the students should be able to:

1. Explain fabrication of MOSFET based circuits
2. Describe working of MOSFET and its mathematical model
3. Prepare layout of MOSFET based circuits
4. Analyze, design, and simulate various MOSFET based inverter circuits
5. Realize and size given logic function using MOSFETs
6. Analyze, design, and simulate Dynamic CMOS circuits
7. Explain importance of interconnect parasitic

8. Explain importance of CMOS latch-up, clocking strategy, and testing principles
9. Explain architecture of FPGA and CPLD
10. Write programs in VHDL for digital circuits and realize them on FPGA/CPLD

List of Experiments:

1. Minimum 9 practicals Based on VHDL/Verilog
2. Minimum 3 Practicals Based on Pspice/spice of MOSFET Characteristics
3. Minimum 2 Practicals on Layout Tools

VLSI design methodologies should be covered during Laboratory sessions.
Suggested List of Experiments

1. Introduction to programmable devices (FPGA, CPLD), Hardware Description Language (VHDL), and the use programming tool.
1. Implementation of basic logic gates and its testing.
2. Implementation of adder circuits and its testing.
3. Implementation 4 to 1 multiplexer and its testing.
4. Implementation of 3 to 8 decoder and its testing.
5. Implementation of 8 to 3 priority encoder and its testing.
6. Implementation of J-K and D Flip Flops and its testing.
7. Implementation of sequential adder and its testing.
8. Implementation of BCD counter and its testing.
9. Implementation of two 8-bit multiplier circuit and its testing.
10. Simulation of CMOS Inverter using SPICE for transfer characteristic.
11. Simulation and verification of two input CMOS NOR gate using SPICE.
12. Implementation and simulation of given logic function using dynamic logic.
13. To generate layout for CMOS Inverter circuit and simulate it for verification.
14. To prepare layout for given logic function and verify it with simulations.
15. To measure $I_{DS} – V_{GS}$ and $I_{DS} – V_{DS}$ characteristics of given n-channel and p-channel MOSFETs.
16. To measure propagation delay of a given CMOS Inverter circuit.

Design based Problems (DP)/Open Ended Problem:

1. Design and verify CMOS Inverter circuit.
2. Write and verify VHDL/Verilog program for practical applications of your choice (e. g. lift controller).
3. Design and verify dynamic CMOS circuit.
4. Design and verify MOSFET based voltage bootstrapping circuit.

Major Equipment/software:

Circuit simulator, FPGA/CPLD programming tool, Multimeter, Power supply, function generator, oscilloscope

List of Open Source Software/learning website: NPTEL, NGspice circuit simulator

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.

GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRONICS AND COMMUNICATION ENGINEERING (11)
ADVANCED MICROPROCESSOR
SUBJECT CODE: 2161102
B.E. 6thSEMESTER

Type of course: Advanced Microprocessor Architecture and Programming

Prerequisite: Knowledge of basic Microprocessor Architecture and Programming

Rationale: This course will provide an opportunity to the students to become familiar with ARM microprocessor architecture, instruction set and programming.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	2	5	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Introduction:** Need of advance microprocessors, Difference between RISC and CISC, RISC Design philosophy, ARM Design Philosophy, History of ARM microprocessor, ARM processor family, Development of ARM architecture	6	10
2	**The ARM Architecture and Programmers Model :** The Acorn RISC Machine, ARM Core data flow model, Architectural inheritance, The ARM7TDMI programmer's model: General purpose registers, CPSR, SPSR, ARM memory map, data format, load and store architecture, Core extensions, Architecture revisions, ARM development tools	10	20
3	**ARM Instruction set:** Data processing instructions**,** Arithmetic and logical instructions**,** Rotate and barrel shifter**,** Branch instructions, Load and store instructions, Software interrupt instructions, Program status register instructions, Conditional execution, Multiple register load and store instructions, Stack instructions, Thumb instruction set, advantage of thumb instructions, Assembler rules and directives, Assembly language programs for shifting of data, factorial calculation, swapping register contents, moving values between integer and floating point registers	10	20
4	**C Programming for ARM:** Overview of C compiler and optimization, Basic C data types, C Looping structures, Register allocations, function calls, pointer aliasing, structure arrangement, bit-fields, unaligned data and Endianness, Division, floating point, Inline functions and inline assembly, Portability issues. C programs for	10	20

	General purpose I/O, general purpose timer, PWM Modulator, UART, I2C Interface, SPI Interface, ADC, DAC		
5	**Memory management units:** Moving from memory protection unit (MPU) to memory management unit (MMU), Working of virtual memory, Multitasking, Memory organization in virtual memory system, Page tables, Translation look aside buffer, Caches and write buffer, Fast context switch extension,	8	15
6	Advanced Microprocessor Bus Architecture (AMBA) Bus System, User peripherals, Exception handling in ARM, ARM optimization techniques	8	15
Total		52	100

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	**15**	**20**	**10**	**10**	**5**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

[1] ARM Assembly Language Programming & Architecture By. Muhammad Ali Mazidi, Kindle edition
[2] Arm Assembly Language, Fundamentals and Techniques, 2nd edition, William Hohl, Christppher Hinds, CRC Press.
[3] Arm System Developer's Guide, Designing and Optimizing Software, Andrew N. Sloss, Dominic Symes, Chris Wwight, Elsevier
[4] Arm System-on-chip Architecture, 2nd Edition, Steve Furber, Pearson publication
[5] Embedded Systems By. Lyla Das, Pearson publication

Course Outcomes:

After learning the course the students should be able to:

[1] Become familiar with importance and applications of advance microprocessor
[2] Understand architecture of ARM processor
[3] Understand instruction set of ARM processor
[4] Be able to write hybrid (assembly & C) program for ARM microprocessor
[5] Analyze given program to find out program output
[6] Be able to interface input/output devices like Keyboard, LED, LCD, sensors with ARM7TDMI

List of Experiments:

1. To write and simulate ARM assembly language programs for data transfer, arithmetic and logical operations.
2. To write and simulate C Programs for ARM microprocessor in KEIL
3. To interface LED with ARM microprocessor and write program to blink LED at the interval of 1 second
4. To interface switch with ARM microprocessor and write program in C language to read status of the switch
5. To interface LCD with ARM microprocessor. Write and execute programs in C language for displaying text messages and numbers on LCD.
6. To interface DC motor with ARM microprocessor. Write program to rotate DC motor in clockwise and anticlockwise direction with different speed
7. To interface Stepper motor with ARM microprocessor. Write program to rotate motor in half step and full step mode
8. To write programs for ARM microprocessor using optimization techniques and compare execution time
9. To implement convolution of two sequences on ARM microprocessor using assembly or C language
10. To write and execute programs using ARM free mbed online developer tool using cloud computing https://developer.mbed.org/
11. Interfacing of temperature sensor with ARM freedom board (or any other ARM microprocessor board) and display temperature on LCD
12. To write programs for serial communication between PC and ARM microprocessor
13. Student mini project based on ARM microprocessor

Design based Problems (DP)/Open Ended Problem:

- To design ARM based wireless sensor network for temperature measurement
- To monitor and control industrial parameters with help of ARM processor
- To design ARM cortex based automatic number plate recognition system
- To design ARM based power saving system

Major Equipment/software:

[1] Freescale freedom development boards for ARM

[2] Add on Sensor board for ARM

[3] Open source ARM Mbed Development plateform

[4] KEIL IDE and Proteus for simulation

List of Open Source Software/learning website:

[1] GNU tool chain

[2] NPTEL Video lecturers : http://nptel.ac.in/syllabus/117106111/

Website:

[1] https://developer.mbed.org

[2] http://www.freescale.com/tools/software-and-tools/hardware-development-tools/freedom-development-boards:FREDEVPLA

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.

GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRONICS AND COMMUNICATION ENGINEERING (11)
TELECOMMUNICATION SWITCHING SYSTEMS AND NETWORKS
SUBJECT CODE: 2161103
B.E. 6th SEMESTER

Type of course: Departmental Elective-**I**

Prerequisite: Basic knowledge of microprocessor and microcontrollers. Fundamental knowledge of analog and digital circuits, Analog and digital communication. Analytical skills for communication systems and electronic circuits and mathematical knowledge.

Rationale: Students of EC Engineering need to have good understanding of the fundamentals and application of telecommunication networks i.e. PSTN, PDN and ISDN .Modern digital telecommunication switching and networks. They will be able to understand recent topics like switching systems,time division switching systems, data communication Networks. ISDN, voice data integration and importance of telephone traffic analysis and telephone networks**.**

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	2	5	70	20	10	20	10	20	100

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Introduction:**Evolution of Telecommunications, Simple Telephone Communication, Manual switching system, major telecommunication Networks, Strowger Switching System, Crossbar Switching.	05	10
2	**Electronic Space Division Switching:** Stored Program Control, Centralized SPC, Distributed SPC, Enhanced Services, Two stage networks, Three stage network n-stage networks.	06	12
3	**Time Division Switching:** Time multiplexed Space Switching, Time Multiplexed time switching, combination Switching, Three stage combination switching, n-stage combination switching.	05	14
4	**Traffic Engineering:** Network Traffic load and parameters, Grade of service and blocking probability, Modeling Switching Systems, Incoming Traffic and Service Time Characterization, Blocking Models and Loss Estimates, Delay systems.	06	14
5	**Telephone Networks:** Subscriber Loop Systems, Switching Hierarchy and Routing, Transmission Plan, Transmission Systems, Numbering Plan, Charging Plan, Signaling Techniques, In channel signaling, common channel signaling, Cellular mobile telephony.	7	16

6	**Data networks:** Block Diagram, features, working of EPABX Systems**,** Data transmission in PSTNs, Data Rates in PSTNs, Modems, Switching Techniques for data Transmission, Circuit Switching, Store and Forward Switching Data communication Architecture, ISO-OSI Reference Model, Link to Link Layers, Physical Layer, Data Link Layer, Network Layer, End to End layers, Transport Layer, Session Layer, Presentation Layer, Satellite based data networks, LAN, Metropolitan Area network, Fiber optic networks, and Data network standards.	**9**	**18**
7	**Integrated Services Digital Networks:** Motivation for ISDN, New services, Network and Protocol architecture, Transmission Channels, User Network Interface, signaling, Numbering and Addressing, Service characterization, Interworking ,ISDN standards, Broadband ISDN ,Voice data Integration.	**7**	**16**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	**15**	**10**	**15**	**10**	**10**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Thiagarajan Vishwanathan, "Telecommunication Switching Systems and Networks"; PHI Publications.
2. J. E. Flood, "Telecommunications Switching, Traffic and Networks", Pearson Education.
3. John C. Bellamy, "Digital Telephony", Third Edition; Wiley Publications.

Course Outcome:

After completing this course students shall able to:

1. Describe the need for switching systems and their evolution from analogue to digital.
2. Describe the Public Switched Telephone Network.
3. Describe private networks.
4. Describe integrated networks.
5. To compare telephone network, data network and integrated service digital network

List of Experiments:

This shall consist of about 10 Practical's based on the above syllabus using EPABX Trainer Kit, MATLAB AND SCILAB. Following are the list for example.

1. Study of EPABX System and its features.
2. Perform Basic Switching Systems using MATLAB/SCILAB.
3. Simulation of Time slot interchange algorithm.
4. Simulation of TDMA using MATLAB/SCILAB.
5. To perform digitization of speech signal by writing program in MATLAB/SCILAB.

6. To Perform PCM using MATLAB/SCILAB.
7. Study & Perform sound, speech, Dialer and Key board Matrix section of Telephone.
8. Study & Perform voltage dropper, Line in/Protector and Ringer Section of Telephone.
9. To study and perform TDM PCM.
10. To perform basic Traffic parameters by writing programs in MATLAB/SCILAB.

Design based Problems (DP)/Open Ended Problem:

1. MATLAB/SCILAB implementation to find blocking probability of a two stage and three stage network.

2. MATLAB/SCILAB implementation to find availability and non-availability of single processor and dual processor.

3. MATLAB/SCILAB implementation to find traffic carried per server and group of servers.

Major Equipment: MATLAB/SCILAB, EPABX Trainer.

List of Open Source Software/learning website:www.nptel.ac.in

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.

GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRONICS (10) &
ELECTRONICS AND COMMUNICATION ENGINEERING (11)
DIGITAL COMMUNICATION
SUBJECT CODE: 2161001
B.E. 6th SEMESTER

Type of course: Program Core

Prerequisite: Basic Electronics, Digital electronics, Electronics Communication

Rationale: The course provides the basic knowledge of various digital modulation and demodulation techniques used in digital communication system. Comparison of various techniques will enable the student to select most appropriate technique for the application. The course includes the statistical analysis like mean, variance etc. The error detection and error correction codes are also included.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
4	0	2	6	70	20	10	20	10	20	100

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	Base Band Modulation Base band system, sampling theorem, Sampling and signal reconstruction, Aliasing, Types of sampling, Quantization, PCM, Companding, DPCM, ADPCM, Delta modulation, Adaptive delta modulation, T1 carrier system	**10**	19
2	Digital Data Transmission Components of digital communication system, line coding, pulse shaping, Scrambling, Regenerative Repeater, Eye Diagram, Timing Extraction, Detection Error Probability, M-ary communication, Digital Carrier Systems	**6**	12
3	Digital Modulation Techniques Modulation techniques for ASK, QASK, FSK, M-ary FSK, BPSK, DPSK, DEPSK, QPSK, M-ary PSK, QAM, MSK, GMSK	**8**	15
4	Digital Carrier Demodulation Techniques Coherent and non coherent detection of ASK, QASK, FSK, PSK, QPSK, M-ary PSK, DPSK, Noise temperature, Noise bandwidth, Noise figure	**6**	12
5	Probability Theory and Random Variable Concept of probability, Conditional probability and independent event, random variable, types of random variable, CDF, PDF, Statistical Averages, Chebyshev's inequality, Central limit theorem, Concept of correlation,	**8**	15

6	Information Theory Measure of information, Entropy, Source encoding, Error free communication over noisy channel, channel capacity of discrete memory less channel, Channel capacity of continuous channel, Practical communication system in lights of Shannon theorem	**6**	12
7	Error Correcting Codes Introduction, Linear Block Code, Cyclic Code, Burst error detecting and correcting codes, Interlace codes for burst and random error correction, Convolution Code, Comparison of coded and un coded system	**8**	15

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	**20**	**25**	**25**	**10**	**10**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Modern Digital and Analog Communication Systems, B. P. Lathi, (3rd Edition), Oxford Publication
2. Principles of Communication Systems, Taub & Schilling, (2nd Edition), Tata McGraw Hill Publication
3. S.Haykin, Communication systems, John Wiley 2001
4. Bhattacharya Amitabh, "Digital Communication", Tata McGraw-Hill, 1st Ed., 2006.

Course Outcome:

After learning the course the students should be able to:

1. Convert analog signal into digital signal using different techniques like PCM, DM, ADM.
2. Understand the concept of ISI and reduction of ISI through nyquist criteria.
3. Compare various digital modulation techniques
4. Understand behavior of various modulation-demodulation techniques in presence of noise.
5. Know probability, random variable and various statistical analysis methods.
6. Derive channel capacity for discrete memory less channel and continuous channel.
7. Compare various error detection and correction codes.

List of Experiments:

1 To understand sampling theorem and sample speech and audio signal

2 To generate and observe Pulse Amplitude Modulation, Pulse Width Modulation and Pulse position modulation waveforms.

3 To observe effect of oversampling and under sampling in PCM systems

4 To transmit and receive digital signal using Amplitude shift keying

5 To transmit and receive digital signal using Frequency Shift Keying

6 To transmit and receive digital signal using Phase Shift Keying (BPSK and QPSK)

7 To understand Pulse Code Modulation to digitize speech signal

8 To understand time division multiplexing and de-multiplexing

9 To Implement Differential pulse code modulation and demodulation

10 To understand the concept of Delta Modulation and to achieve the Delta Modulation /De- Modulation.

11 To understand Error Detection and Correction codes

12 Simulation exercises on digital communication techniques

Design based Problems (DP)/Open Ended Problem:

1 Design Sampling circuit.

2 Design different component of analog to digital converter.

3 Simulation of various digital modulation and demodulation techniques

4 Simulation of various error detection and correction codes.

Major Equipment:

C.R.O., Function Generator, Power Supply, Multimeter, Digital Storage Oscilloscope, Spectrum Analyzer, Experimental Trainer Kits, Bread Board, General Purpose PCB

List of Open Source Software/learning website:

Video lecture from NPTEL

Learning material available on MIT open course ware

SCILAB

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.

GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRONICS (10) &
ELECTRONICS AND COMMUNICATION ENGINEERING (11)
ANTENNA & WAVE PROPAGATION
SUBJECT CODE: 2161003
B.E. 6th SEMESTER

Type of course: Compulsory

Prerequisite: Higher Engineering Mathematics, Fundamental knowledge of Engineering Electromagnetics (Maxwell's equations, three basic coordinate systems and polarization).

Rationale:
UG Students of EC Engineering need to possess good understanding of the fundamentals and applications of Antenna and wave propagation, including radiation from point sources as applied to antenna, antenna types and their radiation patterns. They are expected to be able to design different antennas for specific given frequency and application. They should be acquainted with concept of arrays and antenna measurement methods. They will be practiced in study of antenna radiation patterns and in measurement of different antenna parameters. They will be able to design and analyze some basic antennas in hardware and application specific antenna in HFSS or CST.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
				Theory Marks			Practical Marks			
L	T	P	C	ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
4	0	2	6	70	20	10	20	10	20	100

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Basic antenna concepts**: Definition and functions of an antenna, comparison between an antenna & transmission line, radio communication link with transmitting antenna and a receiving antenna, radiation patterns of antennas-field and power patterns, all antenna types.	3	9%
2	**Radiation of Electric dipole:** Potential functions and the electromagnetic field, Oscillating electric dipole-derivations for E and H field components in spherical coordinate systems, Power Radiated by a current element, Application to antennas, Radiation from quarter wave monopole and half wave dipoles, Derivation for radiation resistance, application of reciprocity theorem to antennas, equality of directional patterns and effective lengths of transmitting and receiving antennas, directional properties of dipole antennas, antenna feeding methods.	5	10%
3	**Antenna parameters and definitions:** beam area, beam width- Half-Power Beam width (HPBW)and First Null Beam width(FNBW) ,Polarisation, Radiation Intensity ,Beam Efficiency, Directivity and directive gain, radiation resistance, radiation efficiency, resolution, Antenna	5	10%

	aperture-physical and effective apertures, effective height, transmission formula, antenna field zones, Transmission loss as a function of frequency. Antenna temperature and signal to noise ratio.		
4	**Arrays of point sources :** Expression for electric fields from two, three and N element arrays- linear arrays: Broad-side array and End-Fire array- Method of pattern multiplication- Binomial array-Horizontal and Vertical Antennas above the ground plane, Effect of ground on ungrounded antenna, Schelkunoff theorems for linear arrays, Dolph-Tchebysheff distribution for linear arrays.	**6**	11%
5	**Loop Antenna:** Small loop short magnetic dipole, comparison of far field of small loop and short dipole loop antennas, field pattern of circular loop antenna & radiation resistance of loop antenna, directivity of circular loop antennas with uniform current.	**2**	3%
6	**Helical antenna:** Helical geometry, transmission radiation modes, practical design considerations, wide band characteristics of helical antenna.	**2**	3%
7	**Arrays of dipoles & apertures**: 3 element dipole Array with parasitic elements, Yagi-Uda array-function and its design, Phased arrays, frequency scanning arrays, smart antennas, long wire antennas, location methods of feeding antennas, folded dipole antennas, matching arrangements.	**4**	7%
8.	**Reflector antennas**: Parabolic reflector, paraboloidal reflector, aperture Pattern of large circular apertures with uniform illumination, off axis operation of paraboloidal reflectors, Cassegrain feed system.	4	7%
9.	**Slot patch & Horn antennas**: Slot antenna, its pattern, Babinet's principle and complementary antennas, impedance of slot antennas, and horn antenna-function and types.	3	9%
10.	**Microstrip (patch) antennas :** Rectangular and circular types-function, features analysis ,design considerations and applications	4	7%
11.	**Lens antennas**: Non-metallic Dielectric lens and artificial dielectric lens antennas, reflector lens antennas.	2	3%
12.	**Broadband & Freq. Independent antennas**: Broadband antenna, Frequency independent antenna, log periodic antennas.	2	3%
13.	**Antennas for special applications:** Antennas design consideration for satellite communication, antenna for terrestrial mobile communication systems, GPR, Embedded antennas, UWB, Plasma antenna.	2	3%
14.	**Antennas measurements**: Experimental set ups for measurement of radiation patterns, gain, phase polarization, terminal impedance.	2	3%
15.	**Radio wave propagation** : Modes of propagation, Ground Wave Propagation, Structure of troposphere and ionosphere, Characteristic of Ionospheric layers, Sky wave propagation, Definitions for Virtual height, MUF and Skip distance, OWF, Fading, ionospheric absorptions, Multi-hop propagation, Space wave propagation and Super refraction.	6	11%

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
30 %	**20 %**	**20 %**	**10 %**	**10 %**	**10 %**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. "Antennas for all applications", J.D. Krauss 3RD Edition (TMH)
2. "Electromagnetic wave & radiating systems", Jordan & Balmain PHI Publication
3. "Antenna & Wave Propagation", K.D. Prasad Satyaprakash Publications
4. "Antenna Theory: Analysis and design", C. Balanis Wiley India

Course Outcome:

After learning the course the students should be able to:

1. Explain the radiation through antenna and identify different types of antennas.
2. Identify and measure the basic antenna parameters
3. Design and analyze wire and aperture antennas
4. Design and analyze matching and feeding networks for antennas
5. Design and analyze antenna arrays
6. Identify the characteristics of radio-wave propagation

List of Experiments:

Sr.No.	Experiment Title
1.	To study the variation of radiated field with distance from transmitting antenna.
2.	To demonstrate the reciprocity theorem for transmitting and receiving radiation patterns of an antenna.
3.	To plot the radiation pattern of an Omni directional antenna.
4.	To plot radiation pattern of directional antenna.
5.	To study Phenomena of Circular, Linear and Elliptical Polarization of antennas.
6.	To study and plot the radiation pattern of the dipole/Folded dipole antennas in Azimuth & Elevation planes.
7.	To study and plot the radiation pattern of the helical antenna.
8.	To study and plot the radiation pattern of the parabolic reflector.
9.	To study and plot the radiation pattern of the Log-Periodic antenna.
10.	To study and plot the radiation pattern of the Broadside antennas and Measure its Gain, Bandwidth and Beam width.
11.	To plot radiation pattern of $3\lambda/2$ dipole antenna and compare with $\lambda/2$ dipole antenna.

12.	To plot the radiation pattern of a Slot antenna.
13.	Design and simulate micro strip patch antenna in HFSS simulator.

Design based Problems (DP)/Open Ended Problem:

1. Design a Yagi-Uda six element antenna for operation at 500 MHz with a folded dipole feed. What are the lengths of a) reflectors b) driven element, c) four detector elements? What is the spacing d) between the reflector and driven element and e) between directors? What is the frequency bandwidth and gain?
2. Design a right circularly polarized axial mode helical antenna with 15 dBi gain for operation at 1600 MHz with turn spacing λ/π. Find a) the number of turns, b) turn diameter and c) axial ratio.
3. a) Calculate and plot the pattern of 90 degree corner reflector with a thin center-fed $\lambda/2$ driven antenna spaced 0.35λ from the corner. Assume that the corner reflector is of infinite extent. b) Calculate the radiation resistance of driven antenna. c) Calculate the gain of the antenna and corner reflector over the antenna alone.
4. Design an optimum log-periodic antenna to operate at frequencies from 100 to 500 MHz with 11 elements. Give a) length of longest element, b) length of shortest element, and c) gain.
5. A linear array consists of an in-line configuration of 24 $\lambda/2$ dipoles spaced $\lambda/2$. The dipoles are fed with equal currents but with arbitrary progressive phase shift δ between dipoles. What value of δ is required to put the main lobe maximum a) perpendicular to the line of the array, b) 25 degrees from broadside, and c) 50 degrees from broadside.

Major Equipment:

1. RF Synthesizer
2. RF Detector or spectrum analyzer
3. Antenna kit

List of Open Source Software/learning website:

1. **www.nptel.ac.in**
2. **www.antenna-theory.com**

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.

GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRONICS (10) &
ELECTRONICS AND COMMUNICATION ENGINEERING (11)
OPTICAL COMMUNICATION
SUBJECT CODE: 2161005
B.E. 6th SEMESTER

Type of course: NA

Prerequisite: Semiconductor Physics, Electromagnetic, Mode theory of waveguide

Rationale: To introduce the students to various optical fiber modes, configurations and various signal degradation factors associated with optical fiber and to study about various optical sources and optical detectors and their use in the optical communication system, optical amplifiers, fiber network elements, basic optical components, and techniques of fiber optic measurement.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
				Theory Marks			Practical Marks			
L	T	P	C	ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
4	0	2	6	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Overview of Optical fiber Communications :** Electromagnetic spectrum, Optical Spectral bands, Evolution of fiber optic system, Multiplexing Techniques, Elements of an optical fiber transmission link with the functional description of each block, WDM concepts, transmission widows, advantages of optical fiber link over conventional copper systems, applications of fiber optic transmission systems.	3	6
2	**Optical fibers : Structures, Waveguiding and Fabrication** : Optical laws and definitions, optical fiber modes and configurations, Mode theory, Step Index and Graded Index (GI) fibers ,single mode and graded index fibers, Derivation for numerical aperture, V number and modes supported by step index fiber, mode field ,Numerical aperture and modes supported by GI fibers, fiber materials, linearly Polarized modes fiber fabrication techniques, and mechanical properties of fibers, fiber optic cables.	7	13
3	**Signal Degradation in Optical Fibers :** Attenuation, signal distortion in optical waveguides, pulse broadening in graded index fiber, Characteristics of Single Mode Fibers, mode coupling,International Standards for optical transmission fibers.	5	10
4	**Optical Sources :** Semiconductor Physics background, Light emitting diode (LEDs)-structures, materials, Figure of merits, characteristics & Modulation.	6	12

	Laser Diodes -Modes & threshold conditions, Diode Rate equations, resonant frequencies, structures, characteristics and figure of merits, single mode lasers, Modulation of laser diodes, Spectral width , temperature effects, and Light source linearity.		
5	**Power Launching and Coupling :** Source to fiber power launching, Lensing schemes, fiber-to-fiber joints, LED coupling to single mode fibers, fiber splicing, Optical fiber connectors.	**4**	**8**
6	**Photodetectors :** Principles of operation, types, characteristics, figure of merits of detectors photodiode materials, photodetector noise, detector response time,temperature effects on gain, comparison of photodetectors.	**4**	**8**
7	**Optical Receiver Operation :** Receiver operation, Preamplifier types, receiver performance and sensitivity, Eye diagrams, Coherent detection, Specification of receivers.	**5**	**10**
8	**Transmission Systems :** Point –to-point link –system considerations, Link power budget and rise time budget methods for design of optical link, BER calculation	**3**	**6**
9	**Optical Amplifiers :** Semiconductor optical Amplifier, EDFA, Raman Amplifier, Wideband Optical Amplifiers	**3**	**6**
10	**Advances in Optical Fiber Systems :** Principles of WDM, DWDM, Telecommunications & broadband application, SONET/SDH, MUX, Analog & Digital broadband, optical switching.	**5**	**10**
11	**Overview of Optical Components :** Optical couplers, Tunable sources and Filters ,optical MUX/DEMUX, Arrayed waveguide grating, optical add drop multiplexer (OADM), optical cirulators, attenuators, optical cross connects, wavelength converter, Mach-Zender Interferometer	**3**	**6**
12	**Fiber Optical Measurements :** Test Equipments, OTDR , Set ups for Measurement of Attenuation, Dispersion, NA and EYE pattern .	**3**	**6**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	**15**	**10**	**15**	**10**	**10**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Optical Fiber Communications by Gerd Keiser, 4th Edition (Mc Graw Hill)
2. Optical Fiber Communication by John M. Senior (PHI/Pearson)
3. Fiber optical communication Technology by Djafar Mymbaev & Lowell L, Scheiner. (Pearson)
4. Fiber optic Communication Systems by G. Agrawal (John Wiley and sons)

Course Outcome: After learning the course the students will be able

1. To comprehend the basic elements of optical fiber transmission link, fiber modes and structure configurations.
2. To visualize the significance of the different kind of losses, signal distortion in optical wave guides , signal degradation factors and dispersion management techniques in optical system performance.
3. To compare the various optical source materials, LED structures, quantum efficiency as well as structures and figure of merit of Laser diodes.
4. To analyze the fiber optil receiver operation and configuration.
5. To analyze and integrate fiber optical network components in variety of networking schemes, SONET/ SDH and operational principles WDM.
6. To analyze the system performance of optical transmitters,,receivers and optical amplifiers.
7. To analyze and deign optical fiber link with encapsulation of different system components.
8. To be familiar with different optical Components like Optical couplers, Tunable sources and Filters ,optical MUX/DEMUX, Arrayed waveguide grating, optical add drop multiplexer (OADM), optical cirulators, attenuators, optical cross connects, wavelength converter, Mach-Zender Interferometer.
9. To understand various Fiber Optical Measurement instruments such as OTDR.

List of Experiments:

1. Setting -up of Analog/ Digital Optical communication Link
2. Measurement of attenuation characteristics of an optical fiber
3. Measurement of NA of a multimode fiber
4. Measurement of Mode field diameter of a single mode fiber.
5. Measurement of Dispersion of optical fiber
6. Performance of PAM on fiber optic link
7. Performance of PWM on fiber optic link
8. Performance of PPM on fiber optic link
9. Measurement of attenuation with OTDR
10. Measurement of emission wavelength of LED/LASER source
11. Measurement of Data quality with EYE PATTERN
12. Preparation of optical fiber end and practices on splicing/connectorization.
13. Performance of TDM on fiber optic link
14. Setting -up of voice link on Optical communication Link.
15. Performing Experiments on the VI characteristics of the optical Sources.
16. Performing Experiments on the characteristics of the optical detectors.

Design based Problems (DP)/Open Ended Problem:

Open ended Problem:

1) Calculation of G. I. fiber parameters like Normalized frequency, No. of Guided Modes based on given data.

2) Determining the S.I. fiber parameters based on given data.

3) Calculation and determination of fiber optical sources parameters like LED,LASER based on given data.

4) Analysis of power link budget and various parameters.

5) Determination and calculations of Various photo detectors (PIN,APD) parameters based on given data.

6) Analysis and calculations of various power launching Techniques parameters based on given data.

7) Analysis and calculations of various parameters of fiber optic passive network components.

Major Equipments: Fiber Optical Trainer Kit, Laser Source, Photo Detector, Optical Power Meter, OTDR,WDM trainer setup, splicing and connectorization kits.

List of Open Source Software/learning website:

- http://www.cdeep.iitb.ac.in/nptel/Electrical%20&%20Comm%20Engg/Optical%20Communication/Course%20Objective.htm

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics as well as posters for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three group task of students should be submitted to GTU.

Visit to BSNL/Reliance Telecommunication may be arranged and the best report with photographs should be uploaded on the department website.

GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRONICS (10) &
ELECTRONICS AND COMMUNICATION ENGINEERING (11)
POWER ELECTRONICS DEVICES AND CIRCUITS
SUBJECT CODE: 2161006
B.E. 6th SEMESTER

Type of course: Discipline Core course.

Prerequisite: Semiconductor physics, Analog electronics, Electronic devices and circuits, Electrical machines, Microprocessors.

Rationale: This course provides strong foundation for understanding and designing of domestic and industrial power electronics circuits. Students can understand the conversion of power from AC to variable DC, Fixed DC to Variable DC, DC to variable AC and Fixed AC to variable AC using power electronics circuits. This subject also helps to understand the speed control of DC and AC drives and design of UPS and SMPS.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
				Theory Marks			Practical Marks			
L	T	P	C	ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	2	5	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**INTRODUCTION TO THYRISTER FAMILY:** Construction, operation and characteristics of SCR, Diac, Triac, SUS, SBS, RCT, LASCR, SITS, SITH, GTOs, IGBT , MCT etc. Two transistor analogy of SCR. Turn On and Commutation methods of SCR. Triggering circuits of SCR. UJT relaxation oscillator and PUT. Series and parallel operation of Thyristor. Thyristor protection.	7	15
2	**PHASE CONTROLLED RECTIFIERS:** Single phase, half wave, Full wave, half controlled bridge and Full controlled bridge rectifiers with resistive and inductive loads. Effect of freewheeling diodes. Three phase controlled rectifiers.	6	15
3	**INVERTERS:** Thyristor inverter classification, Voltage and current source inverters, Series, Parallel and Bridge Inverters. The McMurray and McMurray-Bedford inverters. PWM inverters, Three phase inverters.	6	15
4	**CHOPPER:** Principle of chopper operation, control strategies, Step-Up, Step-down and Step-Up/Down chopper. Type-A, Type-B, Type-C, Type-D and Type-E chopper. Voltage and current commutated chopper. Jones, Morgan and AC choppers.	6	15

5	**CYCLOCONVERTERS:** Basic principle of operation. Single phase to single phase, Three phase to single phase Cycloconverter. Three phase to three phase cycloconverter.	4	10
6	**CONTROL OF DC DRIVES:** Introduction, Basic machine equations. Braking modes. Single phase separately excited drives. Single phase series DC motor drives. DC chopper drives. Closed loop control of DC drives. PLL control of DC drives. Microcomputer control of DC drives.	5	10
7	**CONTROL OF AC DRIVES:** Basic principle of operation. Torque-speed characteristic of induction motor. Speed control of induction motor. Stator voltage control. Variable frequency control. Rotor resistance control. Slip power recovery scheme	5	10
8	**APPLICATION OF THYRISTOR:** Over voltage protection, Zero voltage switch. SMPS, Online and Off line UPS, Induction heating, Dielectric heating, Switch mode welding, Battery charger, Static circuit breakers.	6	10

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
05	**20**	**10**	**20**	**10**	**05**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Power Electronics By M D Singh And K B Khanchandani (TMH)
2. Power Electronics Circuits Devices And Application By Muhammad Rashid (PHI)
3. Power Electronics And Controls By Samir K Datta (PHI)
4. Industrial And Power Electronics By Harish C Rai
5. Power Electronics By Elbs R. Ramshaw
6. Thyristor And Their Applications By Ramamourthy
7. Power Electronics By Dr. P S Bimbhra (Khanna Publisher)

Course Outcome:

After learning the course the students should be able to:

- Understand the power semiconductor devices
- Design and analyze various SCR firing and commutation methods.
- Explain the operation of phase controlled rectification.
- Understand the design and operation of various industrial based power electronics circuits like inverters, choppers and cycloconverters.
- Designing and repairing of SMPS, UPS , battery charger and circuit breakers.

List of Experiments:

1. To study & plot characteristics of SCR, DIAC and TRIAC
2. To study & plot of characteristics of IGBT.
3. To study the various forces commutation methods of SCRs.
4. Resistance and RC triggered circuits of SCRs.
5. UJT as a relaxation oscillator and SCR firing circuits using UJT.
6. To study & observe the waveform of single phase half and semi converter with resistive and reactive load.
7. To study & observe the waveform of single phase full converter with resistive and reactive load
8. To study and observer the waveforms of series and parallel inverters.
9. To study and observe the waveforms of single phase cycloconverter.
10. To study the step up and step down choppers.
11. To study the speed control of AC and DC drives.
12. To study and measurement of various parameters of UPS.

Design based Problems (DP)/Open Ended Problem:

Faculty teaching the subject shall provide an application oriented project. The students can work in a group to design SCR triggering circuits, Single phase controlled rectifier, Fan regulator, series inverter, chopper, battery charger, SMPS and flasher circuits.

Major Equipment:

Electronic work bench, AC & DC regulated Power Supplies, Earthed and Un Earthed Oscilloscopes, Power Electronics Trainer Kits, Digital multi meters, Clip on meters , Regular and 1:10 CRO probs.

List of Open Source Software/learning website:

Open Source Software:

- Fritzing (http://fritzing.org/home/)
- TINA-TI for circuit simulation (http://www.ti.com/tool/tina-ti)
- OSCAD for CAD application (http://www.oscad.in/downloads)
- Multisim for circuit simulation (http://www.ni.com/multisim)
- http://sourceforge.net/projects/ktechlab/
- http://www.cburch.com/logisim

Learning website:

- http://www.datasheetcatalog.com
- http://nptel.iitm.ac.in/courses.php
- http://ocw.mit.edu
- http://www.smpstech.com
- http://www.ni.com/white-paper/14676/en/
- http://www.irf.com/product/_/N~1nje1m
- http://www.allaboutcircuits.com/vol_3/chpt_3/4.html
- http://www.deltapowersolutions.com/en/tps/rectifiers.php
- http://www.electrical-engineering-portal.com

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.