



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3151106

POWER ELECTRONICS

Semester - 5

Type of course: DisciplineCore course.

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

Rationale: This course provides a 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 switching power supplies

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
			ESE (E)	PA (M)	ESE (V)	PA (I)		
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	Characteristics of Semiconductor Power Devices: Thyristor, power MOSFET and IGBT- Treatment should consist of structure, Characteristics, operation, ratings, protections and thermal considerations. Brief introduction to power devices viz. TRIAC, MOS controlled thyristor (MCT), Power Integrated Circuit (PIC) (Smart Power), Triggering/Driver, commutation and snubber circuits for thyristor, power MOSFETs and IGBTs (discrete and IC based). Concept of fast recovery and schottky diodes as freewheeling and feedback diode.	12
2	Controlled Rectifiers: Single phase: Study of semi and full bridge converters for R, RL, RLE and level loads. Analysis of load voltage and input current- Derivations of load form factor and ripple factor, Effect of source impedance, Input current Fourier series analysis of input current to derive input supply power factor, displacement factor and harmonic factor	10
3	Choppers: Principle of chopper operation, control strategies, Analysis of Step-Up, Step-down and Step-Up/Down chopper. Quadrant operations of Type A, Type B, Type C, Type D and type E choppers, Control techniques for choppers – TRC and CLC, Detailed analysis of Type A chopper. Step up chopper. Multiphase Choppers	10
4	Single-phase inverters: Principle of operation of full bridge square wave, quasi-square wave, PWM inverters and comparison of their performance. Driver circuits for above inverters and mathematical analysis of output (Fourier series) voltage and harmonic control at output of inverter (Fourier analysis of output voltage). Filters at the output of	10



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	inverters, Single phase current source inverter	
5	Switching Power Supplies: Analysis of fly back, forward converters for SMPS, Resonant converters - need, concept of soft switching, switching trajectory and SOAR, Load resonant converter - series loaded half bridge DC-DC converter.	09
6	Applications: Power line disturbances, EMI/EMC, power conditioners. Block diagram and configuration of UPS, salient features of UPS, selection of battery and charger ratings, sizing of UPS. Separately excited DC motor drive. P M Stepper motor Drive., DC Chopper drives, Speed control of Induction Motors .cooling and thermal	08

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
05	15	20	20	05	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 Book

1. Muhammad H. Rashid, "Power electronics" Prentice Hall of India.
2. Ned Mohan, Robbins, "Power electronics", edition III, John Wiley and sons.
3. Abraham I. Pressman, Keith Billings, Taylor Morey, "Switching Power Supply Design", edition III, McGraw Hill
4. M.D. Singh and K.B. Khanchandani, "Power Electronics", Tata McGraw Hill, New Delhi, Second Edition, 2008.
5. P.C. Sen., "Modern Power Electronics", edition II, Chand & Co.
6. V.R. Moorthi, "Power Electronics", Oxford University Press.
7. Cyril W., Lander, "Power Electronics", edition III, McGraw Hill.
8. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.
9. George Chryssis "High Frequency Switching Power Supplies : Theory And Design", McGraw Hill

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Understand the power semiconductor devices with terminologies, characteristics and ratings	
CO-2	Design and analyze SCR firing and commutation methods.	



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CO-3	Build and test circuits using power devices such as SCR	
CO-4	Analyse ,design and comprehend the operation of controlled rectifiers for possible configurations with different loads	
CO-5	Analyze the operation and performance characteristics of choppers and DC to AC inverters, switching power supplies for different topologies	
CO-6	To realize drive and control circuits for power converters used for the control of DC and AC drives	
CO-7	Evaluate the operation and applications such as power conditioners,UPS,battery chargers,drives	

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 observe 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.
13. Design of Different switching Power supplies
14. To analyse the characteristics and performance of power devices ,converters and inverters

Major Equipment:

Electronic work bench, AC & DC regulated Power Supplies, Earthed and Un Earthed Oscilloscopes, Power Electronics Trainer Kits, Digitalmultimeters, Clipon 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>



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- <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>

To realize drive and control circuits for power converters, •To develop power converters used for the control of DC and AC • To conceptualise and analyse the issues related to recent converter operation

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GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3151107

Semester – V

Subject Name: Advance Microcontroller

Type of course: Professional Elective Course

Prerequisite: Microprocessor & Microcontroller

Rationale: This course will provide an opportunity to the students to learn ARM architecture, instruction set and programming. ARM is very popular for portable applications because of its high performance with low power consumption. Students will learn architecture, assembly language and C programming for ARM microcontroller in this course.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
			ESE (E)	PA (M)	ESE (V)	PA (I)		
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs	% Weight age
1	ARM Introduction Types of computer Architectures, ISA's and ARM, Difference between RISC and CISC, RISC Design philosophy, ARM Design Philosophy, History of ARM microprocessor, ARM processor family, Embedded System Software and Hardware	6	10%
2	ARM Architecture and pipeline structure 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, ARM 3 stage Pipeline, ARM 5 stage Pipeline, Pipeline Hazards, Data forwarding - a hardware solution, Stack implementation in ARM, Endianness, condition codes. Processor core Vs CPU core, ARM7TDMI Interface signals	8	20%
3	ARM7TDMI assembly language instructions and programming Different Types of Instructions, ARM Instruction set, data processing instructions. Shift Operations, shift Operations using RS lower byte, Immediate value encoding. Data processing Instructions. Addressing modes with examples. Instruction Timing, Swap Instructions, Swap Register related Instructions, Loading Constants. Program Control Flow, Control Flow Instructions, B & BL instructions, BX instruction. Interrupts and Exceptions, Exception Handlers, Reset	10	25%



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	Handling. Aborts, software Interrupt Instruction, undefined instruction exception. Interrupt Latency, Multiply Instructions,. Thumb state, Thumb Programmers model, Thumb Implementation, Thumb Applications. Thumb Instructions, Interrupt processing. Interrupt Handling schemes, Examples of Interrupt Handlers, Co-processor instructions		
4	Embedded C Programming for ARM: ARM Development Environment Embedded Software, 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 General purpose I/O, general purpose timer, PWM Modulator, UART, I2C Interface, SPI Interface, ADC, DAC	10	20%
5	Cache and Memory Management and Protection Memory Technologies, Need for memory Hierarchy, Hierarchical Memory Organization, Virtual Memory. Cache Memory, Mapping Functions. Cache Design, Unified or split cache, multiple level of caches, ARM cache features, coprocessor 15 for system control. Processes, Memory Map, Protected Systems, ARM systems with MPU, memory Protection Unit (MPU). Physical Vs Virtual Memory, Paging, Segmentation. MMU Advantage, virtual memory translation, Multitasking with MMU, MMU organization, Tightly coupled Memory (TCM).	6	15%
6	ARM Peripherals and versions AMBA Overview, Typical AMBA Based Microcontroller, AHB bus features, AHB Bus transfers, APB bus transfers, APB bridge. Overview of ARM Versions: ARMv5, ARMv6, ARM v7 (Cortex family R: Real time A: Application and M: Microcontroller), ARM big.LITTLE® Technology, ARMv8.	5	10%

Suggested Specification table with Marks (Theory): (For BE only)

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



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Subject Code: 3151107

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, Christopher Hinds, CRC Press.
- [3] Arm System Developer's Guide, Designing and Optimizing Software, Andrew N. Sloss, Dominic Symes, Chris Wwright, Elsevier
- [4] Arm System-on-chip Architecture, 2nd Edition, Steve Furber, Pearson publication
- [5] Embedded Systems By. Lyla Das, Pearson publication
- [6] Manuals and Technical Documents from the ARM Inc, web site.

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Explain architecture and programming model of ARM 7TDMI	20
CO-2	Learn and analyse assembly language programs for ARM microcontroller	25
CO-3	Develop Embedded C language program for interfacing I/O devices with ARM microcontroller and use it	25
CO-4	Exemplify memory management system of ARM and different versions of ARM	15
CO-5	Design ARM based system to solve real life challenges	15

Suggested 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



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8. Programming NodeMCU with Arduino IDE or Micropython. Write and execute programs for device control using Android App and NodeMCU
9. Write program to control devices using webpage and NodeMCU.
10. Write program to read analog value from sensors (light, temperature, humidity etc.) using NodeMCU and upload data on cloud.
11. Student mini project based on ARM microprocessor/NodeMCU

List of Open Source Software/learning website:

- NPTEL Video lecture on <https://nptel.ac.in/courses/117106111/>
- Energia Software for Texas Tiva Board
- Micropython

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GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3151108

Semester – V

Subject Name: Python Programming

Type of course: Open Elective Subject

Prerequisite: Fundamental knowledge about computer systems and positive aptitude to learn programming, Basic knowledge of C Programming.

Rationale:

Python is general purpose programming language becomes very popular in last decade. In this age, every Electronics, Electrical and Computer engineers must learn Python Programming to build applications in their core domain. Python is becoming popular in artificial intelligence and machine learning. MicroPython is sub-set of Python Programming useful to port in hardware for embedded and IoT applications.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
2	0	2	3	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs	% Weight age
1	Introduction, Data Types and Operators: Installation and working with Python, Variables and data types in python, Perform computations and create logical statements using Python's operators: Arithmetic, Assignment, Comparison, Logical, Membership, Identity, Bitwise operators, list, tuple and string operations	6	20%
2	Python Decision making and Loops: Write conditional statements using If statement, if ...else statement, elif statement and Boolean expressions, While loop, For loop, Nested Loop, Infinite loop, Break statement, Continue statement, Pass statement, Use for and while loops along with useful built-in functions to iterate over and manipulate lists, sets, and dictionaries. Plotting data, Programs using decision making and loops.	8	20%
3	Python Functions and Modules: Defining custom functions, Organising Python codes using functions, Create and reference variables using the appropriate scope, Basic skills for working with lists, tuples, work with dates and times, get started with	6	20%



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	dictionaries, Importing own module as well as external modules, Programming using functions, modules and external packages		
4	Python File Operations: An introduction to file I/O, use text files, use CSV files, use binary files, Handle a single exception, handle multiple exceptions, Illustrative programs, Exercises	4	15%
5	MicroPython: Introduction, main difference between MicroPython and Python, Installation of MicroPython on Hardware, MicroPython libraries, GPIO programming on MicroPython Hardware, Sensor Programming using MicroPython	8	25%

Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	20	25	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. John V Guttag. "Introduction to Computation and Programming Using Python", Prentice Hall of India
2. Python Programming Fundamentals- A Beginner's Handbook by Nischay kumar Hegde
3. Kenneth A. Lambert, "Fundamentals of Python – First Programs", CENGAGE Publication
4. Introduction to Python for Engineers and Scientists, By. Sandeep Nagar, Apress
5. MicroPython for the Internet of Things (A Beginner's guide to programming with Python on microcontrollers) By. Charles Bell, Apress

Course Outcomes:

After completion of this course students will be able ...

Sr. No.	CO statement	Marks % weightage
CO-1	To test and debug code written in python	25



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Subject Code: 3151108

CO-2	To create applications using Python Programming	20
CO-3	To perform file operations to read and write data in files	25
CO-4	To write programs for general purpose I/O devices using MicroPython	30

List of Experiments:

- [1] Write Python programs to understand control structures
- [2] Write Python programs to understand list and tuples
- [3] Use conditional statements and loops in Python programs
- [4] Write python programs to create functions and use functions in the program
- [5] Import module and use it in Python programs
- [6] Write python program to plot data using PyPlot
- [7] To become familiar with MicroPython and NodeMCU. Configure NodeMCU for MicroPython.
- [8] Write program in MicroPython to send digital data on GPIO pins of NodeMCU and glow LED connected with NodeMCU or any other MicroPython supported board.
- [9] Connect Digital/Analog I/O module with NodeMCU and write program to display temperature in MicroPython.
- [10] Connect NodeMCU with with WiFi Access Point and transmit data from NodeMCU to Cloud. Connect Digital/Analog I/O module with NodeMCU and send temperature and light data on cloud (Thingspeak, Firebase or any other cloud service)

Major Equipment/software:

- NodeMCU boards or any other microcontroller board supporting MicroPython firmware
- Digital analog Input Output boards consisting LEDs, Switches, LDR, Temperature sensor, POT

List of Open Source Software/learning website:

- NPTEL Video lecture on Python Programming
- <https://www.coursera.org/learn/python-programming>
- Python Software



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- Turtle - <https://docs.python.org/2/library/turtle.html>
- PyLab - <https://scipy.github.io/old-wiki/pages/PyLab>
- Anaconda software

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GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3151109

Semester – V

Subject Name: Industrial Automation

Type of course: Open Elective Subject

Prerequisite: Knowledge of Basic Electrical Engineering, Basic Electronics, Digital Electronics, Electronics Measurement and Instruments

Rationale: Automation is playing a key role in Industries. Industries rely heavily on automation for economic viability and mass production. It is important for the students to learn basic of automation, how system works and importance of PLC, SCADA and robots in automation. This course will provide opportunity to learn industrial automation techniques.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
2	0	2	3	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	Introduction: Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Introduction of PLC and supervisory control and data acquisition (SCADA). Industrial bus systems: modbus & profibus. Role of computers in measurement and control.	4	15%
2	Automation components: Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement. Actuators, process control valves, power electronics devices DIAC, TRIAC, power MOSFET and IGBT. Introduction of DC and AC servo drives for motion control.	6	25%
3	Programmable logic controllers: Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC selection, PLC Installation, Advantage of using PLC for Industrial automation, Application of PLC to process control industries.	8	25%
4	Distributed Control System: Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of	8	20%



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	DCS.		
5	Overview of Industrial automation using robots: Basic construction and configuration of robot, Pick and place robot, Welding robot. Internet of things for plant automation and overview of Industry 4.0	6	15%

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
5	15	25	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] Industrial Instrumentation and Control By. S.K. Singh The McGraw Hill Companies
- [2] Process Control Instrumentation Technology By. C.D. Johnson, PHI
- [3] Industrial control handbook, Parr, Newnem
- [4] Programmable logic controller, Dunning, Delmar

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Explain automation components and systems application	25
CO-2	Identify suitable industrial automation hardware for given application	30
CO-3	Measure industrial parameters like temperature, pressure, force, displacement, speed, flow, level, humidity and pH.	25
CO-4	Integrate SCADA with PLC Systems	20



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List of Experiments:

(General guidelines.. Institute may change list of experiments based on laboratory set up available)

- Use industrial grade sensors and transducer introduction and characteristics like proximity detector, linear encoder, rotary encoder, touch sensor, force sensor, accelerometer, RTDs, loadcells and LVDT for measurement
- Use Various actuators such as relay, solenoid valve, process control valve and motors for control applications
- Simulate analog and digital function blocks
- Relay logic diagram and ladder logic diagram
- Understand and perform experiments on timers and counters
- Logic implementation for traffic Control Application
- Logic implementation for Bottle Filling Application
- Tune PID controller for heat exchanger using DCS
- FBD for autoclavable laboratory fermentor
- Develop graphical user interface for the plant visited by you
- Industrial visit report

There may be separate list of experiment where laboratory setup is developed by Siemens under Centre of Excellence.

Design based Problems (DP)/Open Ended Problem:

1. Design of low cost PLC Systems
2. Design of humanoid robots

Major Equipment:

1. ADC, DAC and Controller, Switches, LEDs, Solenoid valves
2. Relay, motor
3. PLC with software
4. MATLAB® or LABView®
5. AC Servo drives and DC Servo drives
6. Zigbee and Bluetooth based short range automation system.
7. IoT boards.
8. Robot for demonstration

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

Bachelor of Engineering
Subject Code: 3151110
Semester – V

Subject Name: Robotics and Automation

Type of course: Open Elective Subject

Prerequisite: Sensor/ Transducer, Fundamental of engineering mechanics, Control systems design

Rationale: In near future, robots will be used widely in the fields of manufacturing, medicine, search and rescue, service, and entertainment. So, it is very much important to teach robotics as the synergistic integration of mechanics, electronics, controls, and computer science. This subject is intended to make student aware with basics of robot sensors, controls and transformations along with essential kinematics and dynamics

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
2	0	2	3	70	30	30	20	150

Content:

Sr. No.	Contents	Total hrs	Weight age (%)
1	Introduction to Robotics: Definition and origin of robotics, different types of robotics, various generations of robots, degrees of freedom, Asimov's laws of robotics, dynamic stabilization of robots.	08	20
2	Robotic controllers and accessories: Microprocessors and Microcontrollers based robotic controllers, Peripheral Interfacing with microcontrollers and its programming in C, Arduino platform as robotic controller, Sensors & Actuators, Grippers interfacing with robotic controller, DC Motors, and Stepper Motors Interfacing and its programming.	10	30
3	Robot languages and Programming: Robot Languages, Classification of Robot Languages, Computer Control and Robot Software, Robot Operating Systems (ROS), Raspberry Pi based programming for robots. Inverse Kinematics and Path Planning Programming using ROS.	08	30
4	Case Study: Multiple robots, machine interface, robots in manufacturing and non- manufacturing applications, robot cell design, selection of robot.	04	20



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		Total	30	100
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Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
7	14	14	14	14	7

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:

Sr. No.	Title and Publications
1	S. K. Saha, "Introduction to Robotics", Tata McGraw Hill Education Pvt. Ltd., New Delhi.
2	S. R. Deb and S. Deb, "Robotics Technology and Flexible Automation", Second Edition, Tata McGraw Hill Education Pvt, Ltd., New Delhi
3	R. K. Mittal, I. J. Nagrath, "Robotics and Control", Tata McGraw-Hill Publishing Company Ltd.
4	Dhananjay Gadre, "Programming and Customizing the AVR Microcontroller", TMH, 1st Edition, 2001.
5	Beginning Arduino by McRoberts Michael, Publication: Technology in Action

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
	After successful completion the student will be able to	
CO-1	Summarise the fundamentals, history and components for designing robots.	20
CO-2	Design Electronics controller for robotics applications and actuators for robotic movements.	30
CO-3	Write programs for interfacing various sensors for robotics applications	30
CO-4	Compare and select between various programming languages and environments used for robot controller program development	20



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List of Experiments:

1. Introduction to Robotic controller card like Arduino UNO board.
2. Interfacing drivers for Arduino Controller for Robotic application
3. Various sensor interfacing with Robotic Controller like Arduino UNO board
4. To simulate simple robotic system using Matlab/ Msc Adam software
5. Matlab program for simple and inverse kinematics of simple robot configuration
6. To simulate joint torque control of manipulator
7. To study feedback control of robot manipulator
8. To study adaptive control of robot manipulator
9. To study different methods of speed control of dc Motor.
10. To study speed control of stepper motor using microcontroller.
11. To study robotic programming language like AL and AML.

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GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject code: 3150004

Subject Name: Contributor Personality Development Program

Semester V

Type of course: Work-Personality Development

Rationale: The Contributor Program aims to accomplish the following outcomes in the lives of students–

- Improve the employability of students by giving them the right work ethic and thinking that employers are looking for.
- Build their confidence with which they can go into any job and contribute meaningfully.
- Improve their ability to engage better in the workplace and to be able to handle the challenges that come up there.
- Build their career-worthiness and help them develop into future-ready contributors with ability to navigate a career in a volatile, changing world.
- Widen their choices of career and success, so that they are able to open up more opportunities for themselves and take up unconventional career pathways.
- Enable them to recognize how they, as technical professionals, can participate and make a positive contribution to their communities and to their state.

Towards this goal, the Contributor Program has been designed to awaken and strengthen students from within, in terms of building positive self-esteem, increasing their confidence level and I-can attitude, improving their aspirations, giving them new methods of thinking, building their cognitive capacities, exposing them to the skills and practices associated with being contributors in the workplace (not mere employees).

The Program content is also designed to expose students to real-world workplace scenarios and sensitize them to some of the challenges faced in society around them, especially in the local communities around them and in their own state of Gujarat.

The Contributor Program syllabus has been evolved and fine-tuned over several years, (a) to address the changing need and contemporary challenges being faced by industry and what employers of today are looking for in the people they hire and (b) by working extensively with universities and students building an appreciation of their challenges and concerns. At the core, the program is guided by the higher ideas and principles of practical Vedanta in work.

Teaching and Examination Scheme per semester:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
			ESE (E)	PA (M)	ESE (V)	PA (I)		
2	0	0	2	70	30	30	20	150

Note:

- Weekly 2 hours of Classroom facilitated sessions are planned which include Solutioning and Self-discovery sessions.



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- In addition, there will be individual/ team projects as part of Practicals. Students can do this on their own, with faculty as guide.

Note:

It is the responsibility of the institute heads that marks for PA of theory & ESE and PA of practical for each student are entered online into the GTU Portal at the end of each semester within the dates specified by GTU.

Content:

Sr. No.	Content	Total Hrs
1	The Contributor Work Ideal <i>In this topic, students explore what is their “ideal” of work - is the ideal to be a “worker” or to be a “contributor”? For example, an employee who has the ideal of a “worker” goes to work to pass time, earn a living, get benefits; in contrast to an employee with the ideal of a “contributor” who wants to make a difference, get things done well, create value for the company. This enables students to transform their expectation of themselves in work</i>	1.5 hrs Classroom engagement (including self-discovery/ solutioning sessions)
2	Identity & Self-esteem <i>In this topic, students engage with the question “who am I?” or on what basis do they define themselves. Is their identity defined by what others think of them (extrinsic self-esteem) or by what they think of themselves (intrinsic self-esteem)? Further, they discover positive identities that lead to intrinsic self-esteem, such as an I-can identity based on one’s capacity and inner strength. This enables them to build confidence and self-esteem.</i>	Same as above
3	Become a Creator of one’s destiny <i>In a “victim stance”, we see the career environment as full of difficulties and hurdles. We feel powerless or blame our circumstances for not having many opportunities. This makes us fearful of uncertainty and makes us settle for jobs where we remain mediocre. In this topic, students discover the “creator of destiny stance” to challenges and situations. This stance frees them to try out new things, open up new possibilities, take on responsibility, see the opportunity hidden in their environment.</i>	Same as above
4	Achieving Sustainable Success <i>In this topic, students discover how to achieve sustainable or lasting success, by building one’s “engine of success”, making them successful. Where their focus shifts to building one’s “engine of success” rather than being on chasing the “fruits of success”. This is important,</i>	Same as above



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	<i>because over a lifetime of work, all people go through ups and downs – where the fruits are not in their control. People who are focused on the fruits of success, fall prey to disappointment, loss in motivation, quitting too early, trying to find shortcuts – when fruits don't come. Whereas people focused on building their engine of success continue to contribute steadily, irrespective of whether fruits come or not. And with a strong engine of success, fruits come to them in time.</i>	
5	Career Development Models <i>In this topic, students explore a range of diverse “career development models” and the possibilities for contribution each opens up to them (e.g. start-up career model, change-maker career model, etc.). This opens their mind to different and even unconventional career models possible, beyond the usual (such as “stable large company career model” where one gets an engineering degree, then MBA, then get a job in a large company). This frees them from a herd mentality when making career choices.</i>	Same as above
6	Expanding contribution in every role <i>In this topic, students explore the many roles they can play in their life & discover the power they have to expand the contribution possible in any role. (E.g. role of student, role of manager, role of a project site engineer). So, the potential of a role is in the individual's hands. This opens their mind to an alternative way of career growth.</i>	Same as above

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks (for B.Pharma)					
R Level	U Level	A Level	N Level	E Level	C Level
-	15	20	-	25	20

Distribution of Theory Marks (for B.E., Diploma, MCA)					
R Level	U Level	A Level	N Level	E Level	C Level
-	15	15	-	20	20

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

Reference resources:

A. Basic reference for both students and teachers

- Contributor Personality Program textbook cum workbook developed by Illumine



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2. Web-based ActivGuide™ for self-exploration of rich media resources to vividly understand many of the ideas, watch role models, learn from industry people, get reference readings – that help them enrich the understanding they gained in the class published by Illumine Foundation

B. Advanced reference for teachers

1. On Contributors, Srinivas V.; Illumine Ideas, 2011
2. Enlightened Citizenship and Democracy; Swami Ranganathananda, Bharatiya Vidya Bhavan, 1989
3. Eternal Values for a Changing Society – Vol I-IV, Swami Ranganathananda; Bharatiya Vidya Bhavan
4. Karma Yoga, Swami Vivekananda; Advaita Ashrama
5. Vivekananda: His Call to the Nation, Swami Vivekananda; Advaita Ashrama
6. Six Pillars of Self Esteem, Nathaniel Branden; Bantam, 1995
7. Mindset: The New Psychology of Success, Carol S. Dweck; Random House Publishing Group, 2007
8. Lasting Contribution: How to Think, Plan, and Act to Accomplish Meaningful Work, Tad Waddington; Agate Publishing, 2007
9. Why not?: how to use everyday ingenuity to solve problems big and small, Barry Nalebuff, Ian Ayres; Harvard Business School Press, 2003
10. The value mindset: returning to the first principles of capitalist enterprise (Ch 8 & 9); Erik Stern, Mike Hutchinson; John Wiley and Sons, 2004
11. The Power of Full Engagement: Managing Energy, Not Time, is the Key to High Performance and Personal Renewal, Jim Loehr, Tony Schwartz; Simon and Schuster, 2003
12. Creating Shared Value, Michael E. Porter and Mark R. Kramer; Harvard Business Review; Jan/Feb2011, Vol. 89 Issue 1/2
13. The Speed of Trust: The One Thing That Changes Everything, Stephen M. R. Covey, Rebecca R. Merrill, Stephen R. Covey; Free Press, 2008
14. The Courage to Meet the Demands of Reality, Henry Cloud; HarperCollins, 2009
15. Responsibility at work: how leading professionals act (or don't act) responsibly, Howard Gardner; John Wiley & Sons, 2007

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
Outcome of theory sessions		
CO-1	Students will be able to recognize & appreciate two alternative ideals of work – ideal of a “worker” and ideal of a “contributor”. And why organizations of today expect people they employ to be contributors and not just workers.	10-12%
CO-2	Students will be able to recognize & appreciate alternative ways in which they could define themselves or “who am I” (their identity) – and which are positive identities that will lead to building intrinsic self-esteem and confidence in oneself; in contrast to identities that will lead to extrinsic self-esteem that makes them	10-12%



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	more dependent on their environment.	
CO-3	Students will be able to recognize & appreciate a “victim” stance as distinct from a “creator of destiny” stance in the way people approach challenges and situations; and how the latter frees individuals to take on challenges and open up opportunities.	10-12%
CO-4	Students will be able to differentiate between two alternative approaches to success - ‘building one’s engine of success’ and ‘chasing the fruits of success’; they also appreciate the payoffs/ consequences of both and which is more likely to lead to sustainable or lasting success in the long run.	10-12%
CO-5	Students will be able to recognize & appreciate different career models and their value; to help them make more informed career-related choices.	10-12%
CO-6	Students will be able to recognize & appreciate how one can expand the contribution possible in any role, thereby opening up an alternative way of career growth to them.	10-12%
Outcome of practical sessions		
CO-7	Students learn to re-interpret their life and college experiences to showcase their contribution affinities which are relevant for employers.	15%
CO-8	Students learn to apply contributor thinking to real-world or career relevant challenges.	15%



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Subject Code: 3150005

Semester – V

Subject Name: INTEGRATED PERSONALITY DEVELOPMENT COURSE

Type of Course –

Value-based holistic personality development course for university students.

Rationale -

This course aims to help a person understand and know his / her purpose in life, get a positive thought pattern, gain confidence, improve behaviour, learn better communication and develop a healthy physique with morality and ethics in its core.

Today youth lack the guidance to face insecurity about their health and career, premature relationships and family breakdown, addictions and substance abuse, negative impact of internet and social media etc. This course includes such topics that will cover all aspects and provide solution to the current challenges through creative and interactive activities.

This course will allow students to enjoy, understand and practice invaluable lessons preparing them for a successful future.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
			ESE (E)	PA (M)	ESE (V)	PA (I)		
2	0	0	70	30	30	20	150	

Content:

Lecture No.	Content	Hours
IPDC-1 (Semester-1)		
1	Remaking Yourself - Restructuring Yourself	2
2	Remaking Yourself - Power of Habit	2
3	Learning from Legends - Tendulkar & Tata	2
4	Mass Management - Project Management	2
5	From House to Home - Affectionate Relationships	2
6	Facing Failures - Factors Affecting Failures	2
7	Facing Failures - Failures are not Always Bad	2



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8	Remaking Yourself - Being Addiction-Free	2
9	Soft Skills - Teamwork & Harmony	2
10	Remaking Yourself - Handling the Devil - Social Media	2
11	From House to Home - Forgive & Forget	2
12	From House to Home - Listening & Understanding	2
13	Financial Wisdom - Basics of Financial Planning	2
14	Soft Skills - Networking - Decision Making - Leadership	2
15	Review Lecture - Student Voice-1	2

BASIC STUDY MATERIAL / MAIN COURSE WORK-BOOK -

1. IPDC Workbook-I
2. IPDC Workbook-II

IPDC REFERENCES –

- *These are the reference material for each lectures of IPDC.*

Module No.	Module/ Course Topics	Lectures	References
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1	Facing Failures	Factors Affecting Failures Failures are not Always Bad Insignificance of Failures Power of Faith Practicing Faith	<ol style="list-style-type: none">1. Thomas Edison's factory burns down, New York Times Archives, Page 1, 10/12/19142. Lincoln Financial Foundation, Abraham Lincoln's "Failures": Critiques, Forgotten Books, 20173. J.K. Rowling Harvard Commencement Speech Harvard University Commencement, 20084. Born Again on the Mountain: A Story of Losing Everything and Finding It Back, Arunima Sinha, Penguin, 20145. Failing Forward: Turning Mistakes Into Stepping Stones for Success, John C. Maxwell, Thomas Nelson, 20076. Steve Jobs: The Exclusive Biography Paperback, Walter Isaacson, Abacus, 2015
2	Learning from Legends	Tendulkar & Tata Leading Without Leading	<ol style="list-style-type: none">1. Chase Your Dreams: My Autobiography, Sachin Tendulkar, Hachette India, 20172. Playing It My Way: My Autobiography, Sachin Tendulkar, Hodder & Stoughton, 20143. The Wit and Wisdom of Ratan Tata, Ratan Tata, Hay House, 20184. The Tata Group: From Torchbearers to Trailblazers, Shashank Shah, Penguin Portfolio, 20185. The Leader Who Had No Title, Robin Sharma, Jaico Publishing House, 20106. In the Joy of Others: A Life Sketch of Pramukh Swami Maharaj, Mohanlal Patel and BAPS Sadhus, Swaminarayan Aksharpith, 2013
3	Mass Management	Project Management	<ol style="list-style-type: none">1. Project Management Absolute Beginner's Guide, Gregory Horine, Que Publishing, 20172. The Fast Forward MBA in Project Management, Eric Verzuh, Wiley, 20113. Guide to Project Management: Getting it right and achieving lasting benefit, Paul Roberts, Wiley, 2013



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4	My India My Pride	Glorious Past - Part 1 Glorious Past - Part 2 Present Scenario An Ideal Citizen - 1 An Ideal Citizen - 2 An Ideal Citizen - 3	<ol style="list-style-type: none">1. Hidden Horizons, Dr. David Frawley and Dr. Navaratna S. Rajaram, 20062. Rishis, Mystics and Heroes of India, Sadhu Mukundcharandas, Swaminarayan Aksharpath, 20113. Physics in Ancient India, Narayan Dongre, Shankar Nene, National Book Trust, 20164. The Rise of Civilization in India and Pakistan, Raymond Allchin, Bridget Allchin, Cambridge University Press, 19825. The Āryabhaṭīya of Āryabhaṭa: An Ancient Indian Work on Mathematics and Astronomy (1930), Walter Eugene Clark, University of Chicago Press, reprint, Kessinger Publishing, 2006
5	Remaking Yourself	Restructuring Yourself Power of Habit Being Addiction-Free Begin with the End in Mind Handling the Devil – Social Media	<ol style="list-style-type: none">1. Power of Habit, Charles Duhigg, Random House Trade Paperbacks, 20142. Change Your Habit, Change Your Life, Tom Corley, North Loop Books, 20163. The Seven Habits of Highly Effective People, Stephen Covey, Simon & Schuster, 20134. Seven Habits of Highly Effective Teens, Sean Covey, Simon & Schuster, 20125. Atomic Habits, James Clear, Random House, 20186. How a handful of tech companies control billions of minds every day, Tristan Harris, TED Talk, 2017
6	Financial Wisdom	Basics of Financial Planning Financial Planning Process	<ol style="list-style-type: none">1. Rich Dad Poor Dad, Robert Kiyosaki, Plata Publishing, 20172. The Warren Buffett Way, Robert Hagstrom, Wiley, 20133. The Intelligent Investor, Benjamin Graham, Harper Business, 20064. Yogic Wealth: The Wealth That Gives Bliss, Gaurav Mashruwala, TV18 Broadcast Ltd, 2016
7	From House to Home	Affectionate Relationships Forgive & Forget Listening & Understanding Bonding the Family	<ol style="list-style-type: none">1. “What Makes a Good Life? Lessons from the Longest Study on Happiness”, R. Waldinger, Ted Talks, 20152. Long Walk To Freedom, Nelson Mandela, Back Bay Books, 19953. Outliers, Malcolm Gladwell, Back Bay Books, 2011



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8	Soft Skills	Teamwork & Harmony Networking - Decision Making - Leadership	<ol style="list-style-type: none">1. The 17 Indisputable Laws of Teamwork, John Maxwell, HarperCollins, 20132. Team of Teams: New Rules of Engagement for a Complex World, Stanley McChrystal, Portfolio, 20153. Predictably Irrational, Revised and Expanded Edition: The Hidden Forces That Shape Our Decisions, Harper Perennial, Dan Ariely, 2010
9	Review	Student Voice – 1 Student Voice – 2 Words of Wim	

Course Outcomes:

- To provide students with a holistic education – focused on increasing their intelligence quotient, physical quotient, emotional quotient and spiritual quotient.
- To provide students with hard and soft skills, making them more marketable when entering the workforce.
- To educate students on their social responsibilities as citizens of India and have a greater sense of social responsibility.
- To provide students with a value-based education which will enable them to be successful in their family, professional, and social relationships by improving their moral and ethical values.
- To teach self-analysis and self-improvement exercises to enhance the potential of the participants.
- To have a broader sense of self-confidence and a defined identity.



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3151103

PRINCIPLES OF MANAGEMENT

Semester V

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	0	3	70	30	0	0	100

Content:

Sr. No	Topics	Hrs.
1.	Management – Definition, characteristics, Objectives, levels of Management. Difference between Management and Administration.	6
2	Management History: Schools of Management, Scientific Management, The Behavioural Approach, The systems approach and the contingency approach	6
3.	Motivation – definition, types, Maslow’s Hierarchy of needs theory, Leadership – definition and its importance for a manager	6
4.	Functions of Management: Planning, organizing, staffing, controlling and leading	6
5.	Organizational Structures; meaning, principles of organization, types-formal and informal, line, line & staff, matrix, hybrid (explanation with merits and demerits), span of control, departmentalization, chain of command, centralization and decentralisation	6
6.	Organisational culture of Environment concept of culture and its importance, attributes culture, How does culture affect managers and employees	5
7	Corporate Social Responsibility; meaning, importance Business Ethics; meaning, importance	5

Reference Books:

1. Fundamentals of Management: Essential Concepts and Applications, Pearson Education, Robbins S.P. and Decenzo David A.
2. Principles and Practices of Management by L.M.Prasad
3. Principles of Management by Tripathy and Reddy



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3151104

Subject Name: Analog and Digital Communication
Semester V

Type of course:

Prerequisite: Analog Electronics, Digital Electronics, Fourier Series, Fourier Transform.

This course explores the fundamentals of electronic communication systems. The course has two primary focuses:
(1) Understanding Analog communications systems with design and analysis of various basic modulation systems.
(2) Understanding Digital communications systems with design and analysis of various basic Digital modulation systems.

Rationale: The students need to learn basic concepts of analog and digital communication, components of Analog and Digital Communication systems, Advantages and disadvantages of Analog and Digital communication systems.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE Viva (V)	PA (I)	
4	0	2	5	70	30	30	20	150

Sr. No.	Content	Total hours	% Weightage
1	Introduction To Communication System. Analog and Digital Messages, Channel Effect, Signal-to Noise ration and capacity, Modulation and Detection, History of Communications. (Revision of Signal Transmission through a linear system, Signal distortion over a communication channel, Signal Energy and Energy spectra density, Signal power and power density).	7	20
2	Amplitude modulation And Demodulations Single and Double sideband Amplitude modulation, Amplitude modulation, Bandwidth-efficient Amplitude modulation, VSB, Local Carrier synchronization, FDM, PLL.	7	15
3	Angle Modulation and demodulation Nonlinear Modulation, Bandwidth of Angle-modulated Waves,, Generating FM waves, Demodulation of FM signals, Nonlinear distortion and interference, Superheterodyne Receivers, FM broadcasting System.	7	15
4	Sampling and Analog to digital Conversion Sampling theorem, Sampling and signal reconstruction, Aliasing, Types of sampling, Quantization, PCM, Companding, DPCM, ADPCM, Delta modulation, Adaptive delta modulation, T1 carrier system	9	20
5	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	9	20



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6	Introduction to Digital Modulation-Demodulation Techniques Modulation techniques for ASK,FSK, PSK, MSK, BPSK, QPSK, GMSK	6	10
Total		45	100

Suggested Specification table* with Marks (Theory):

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

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

**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 from above table.*

Reference Books:

1. Digital and analog communication system by B.P.Lathi .Zhi Ding 4th edition.
2. Communication Systems by Simon Haykins.
3. Electronic Communications Systems by Wayne Tomasi.

Suggested List of practicals:-

1. To understand and the concept of Pulse Code Modulation and To observe the Performance of PCM system.
2. To understand and the role of signal compression/Expansion on S/N ratio.
3. To understand the concept of Delta Modulation and to achieve the Delta Modulation / De- Modulation.
4. To study the performance of An-adaptive Delta modulator/De-modulator circuits
5. To Study and observe the performance of Digital carrier system—ASK.
6. To Study and observe the performance of Digital carrier system—FSK.
7. To Study and observe the performance of Digital carrier system—PSK.
8. To Study and observe the performance of Return to Zero (RZ) types of line codes.
9. To Study and observe the performance of Non- Return to Zero (NRZ) types of line Codes.
10. To establish a PCM based transmission-reception link.
11. To Study and observe the effect of signal Distortion using EYE-Diagram.
12. To Study and Perform sampling theorem and reconstruction.
13. To Study and perform Error Detection and Correction codes.
14. To perform TDM-PCM Transmission and Reception.
15. To study and perform Data Conditioning carrier modulation.
16. To study and perform Data Re-Conditioning carrier De-modulation.
17. To study and perform TDM pulse amplitude modulation/demodulation.
18. To study and perform PAM, PWM, PPM. 19 Few simulation exercises on digital communication techniques / basic systems.

Mini Project:

Mini project with emphasis on design and implementation is compulsory with the help of hardware and simulation tools.



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Useful Tools and LRs:-

1. NPTEL MOOC Courses
- 2.Swayam Portal AICTE
3. National Digital Library, IIT KGP.
4. Virtual Lab by IIT Bombay.
- 5.MATLAB
- 6.SCILAB
- 7.LABVIEW
- 8.Various Analog and Digital Communication Trainers.

Course Outcomes:

After learning the course, the students should be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Understand the Basics of Analog and Digital Communication Systems and Modulation as well as Transmission Techniques.	20
CO-2	Analyse the various Analog and Digital Modulation and Transmission Techniques	40
CO-3	Implement the Analog and Digital Communication Systems.	40



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3151105

Semester V

SUBJECT NAME:VLSI Design

Type of course: MOSFET Device and Circuitcourse

Prerequisite: Knowledge of Basic and Digital Electronics

Rationale: This course will provide an opportunity to the students to learn about various topics of 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 would like to pursue their career in VLSI domain.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
4	0	2	5	70	30	30	20	150

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.	3	8
2	Fabrication of MOSFET : Introduction, Fabrication Process flow: Basic steps, C-MOS n-WellProcess, Layout Design rules, full custom mask layout design.	4	8
3	MOS Transistor: The Metal Oxide Semiconductor (MOS) structure, The MOS System underexternal bias, Structure and Operation of MOS transistor, MOSFET Current-Voltage characteristics, MOSFET scaling and small-geometry effects, MOSFETcapacitances	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 designwith delay constraints, Estimation of Interconnect Parasitic, Calculation ofinterconnect delay, Switching Power Dissipation of CMOS Inverters	8	16



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6	Combinational MOS Logic Circuits: Introduction, MOS logic circuits with Depletion nMOS Loads, CMOS logic circuits, Complex logic circuits, CMOS Transmission Gates (TGs)	4	7
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	6
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	6	10
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, AdHoc Testable design techniques, Scan –based techniques, built-in SelfTest (BIST) techniques, current monitoring IDDQ test	3	6
11	FinFET Device: Introduction (Need of FinFET device), structure, Comparison between FinFET and Planar MOSFET (gm, gds, leakage current, DIBL, Subthreshold Slope)	3	6
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	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
6. FinFETs and Other Multigate Transistors. J. P. Colinge, Springer Publications

Course Outcomes:



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After learning the course the students should be able to:

1. Describe working of MOSFET and develop its mathematical model
2. Analyze, design, and simulate various static CMOS circuits
3. Analyze and simulate various dynamic CMOS circuits
4. Prepare layout of MOSFET based circuits
5. Understand CMOS latch-up, clocking strategy, and testing principles
6. Write programs in VHDL/Verilog 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 Practical 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.

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