GUJARAT TECHNOLOGICAL UNIVERSITY

POWER ELECTRONICS (24)

DIGITAL ELECTRONICS AND ITS APPLICATIONS

SUBJECT CODE: 2142406

B.E. 4th SEMESTER

Type of Course: Engineering Science (Electronics)

Prerequisite: 1) 2110016: Basic Electronics

Rationale: This subject focuses on the study of digital electronics and digital logic along with the basics of processor organization. It also briefs the students about different types of memories. It details the students about use of digital electronics in power electronics control applications.

Teaching and Examination Scheme:

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

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	**Number Systems and Boolean Algebra:** • Introduction – Decimal numbers – Binary numbers – Octal and Hexadecimal numbers – Number Base Conversion – Complements – Binary Codes – Binary storage and registers – Basic applications in electronics – Binary logic – Integrated circuits • Basic definitions – Axiomatic definition of Boolean Algebra – Basic theorems and properties – Canonical & Standard forms – Conversions between canonical forms – Logic operations – Digital logic gates, IC digital logic families.	8	20
2	**Simplification of Boolean Functions:** • Map method – Two, three, four, five and six variable maps – Product of Sums and Sum of Products – NAND and NOR implementation – Don't-Care conditions – The tabulation method	6	15
3	**Combinational Logic:** • Half and full Adder – Half and full Subtractor – BCD to excess-3 code conversion – Universal gates • Binary parallel adder – Decimal adder – Magnitude comparator – Encoders & Decoders – Multiplexers – Demultiplexer – ROM – Programmable Logic Arrays (PLA) • Applications of encoder, decoder, multiplexer and demultiplexer	6	15
4	**Sequential Logic and Circuits:** • Basic difference between Combinational logic and Sequential logic – Flip-Flops – Triggering of flip-flops - Analysis of clocked sequential circuits – State reduction and assignment – Excitation tables for flip-flops – State machine	8	20

	• Design of Sequential Circuits and Counters – Application of Flip-Flops in data Storage • Registers – Shift registers – Ripple and Synchronous counters – Generation of timing signals for control unit - Applications		
5	**Memory:** • Requirements – Classification – Organization and operation, Reading & Writing – ROM, PROM, EPROM, EEPROM, RAM, SDRAM, DRAM, Serial and Parallel memories – Various magnetic memories – Applications	4	15
6	**Processor Organization and Control Logic:** • Concept of register transfer level – Processor organization: Bus organization, Scratchpad memory, Accumulator Register – ALU Status register – Processor unit – Control organization – Microprogram control – Control of processor unit – PLA control	4	15

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks				
R Level	U Level	A Level	N Level	E Level
30%	25%	25%	10%	10%

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate 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. Digital Logic and Computer Design by M. Morris Mano, PHI
2. Digital Design by M. Morris Mano & Michael D. Ciletti, Pearson
3. Fundamentals of Digital Electronics by A. Anandkumar, PHI
4. Digital Electronics: Principles and Applications by Soumitra Kumar Mandal, TMH
5. Digital Computer Electronics by Malvino & Brown, Tata McGraw Hill

Course Outcomes:

After learning this course, the students should be able to:

1. Understand different number systems and its inter-conversions.
2. Understand the concept of Boolean algebra and its different theorems, properties etc.
3. Understand simplification of Boolean functions.
4. Understand the construction and working of different combinational circuits, their applications etc.
5. Understand different flip-flops and its applications.
6. Understand different sequential logic circuits and basic design of sequential circuits and counters.
7. Understand different types of memories and its applications.
8. Understand the fundamentals of processor and control logic.

List of Experiments (Laboratory Work):

Objectives: The laboratory work is aimed at putting the theory learnt in class in practice and to show that the results are matched with theory closely. In this context, following are the core objectives for laboratory work of this subject.

- Develop understanding of number systems and Boolean algebra.
- Understand the functioning of logic gates, their implementation and verification of truth tables.
- Develop the understanding of the working of different combinational logic circuits.
- Understand and verify the working of various sequential logic circuits.
- Understand simulation tools for digital logic circuits and simulation of digital logic circuits.
- Understand logic analyzer for testing the logic circuits.

Directions for Laboratory work:

- ✓ The list of experiments is given as a sample.
- ✓ Minimum 10 experiments should be carried out.
- ✓ At least one experiment should be selected from each group.
- ✓ Similar laboratory work fulfilling the objectives can also be considered.
- ✓ Each experiment should be simulated before verifying practically.
- ✓ As far as possible, printed manual should be preferred so that students can concentrate in laboratory experiments and related study.

The sample list of experiments is given below.

List of Experiments and Design Based (DP)/Open Ended Problems:

There are four experiment groups: A, B, C and D. Total 10 experiments from Group A, B & C should be carried out (At least two experiments from each group). Over and above 10 performance experiments, self-study work may be given to students from group D. This includes study of logic families, datasheets of logic ICs, memory chips, etc.

Group A (Logic Gates):

1. Verification of truth table of Logic gates.
2. Implementation of various Logic gates using only NAND gates.
3. Implementation of various Logic gates using only NOR gate.

Group B (Combinational Circuits):

4. Verification of function of Half/Full adder circuits.
5. Verification of function of Half/full subtractor circuits.
6. Verification of function of Binary to Grey code conversion.
7. Verification of function of Grey to Binary code conversion.
8. Verification of function of 2 line to 4 line decoder.
9. Verification of function of 4 line to 2 line encoder.
10. Verification of function of 4 to 1 multiplexer.
11. Verification of function of 1 to 4 demultiplexer.
12. Study of Parity Generator.

Group C (Sequential Logic Circuits):

13. Verification of function of Latch and flip-flop.
14. Verification of shift left/ right register.
15. Verification of counter circuit like binary up/down counter, decimal counter, ring counter, Johnson counter etc.
16. Verification of Sequential circuits other than counter and shift registers.

Group D (Study Experiments):

17. To study standard graphics symbols for digital logic.

18. To study the construction, working and application of any one memory IC from datasheet.
19. To study the processor organization of any one processor.
20. To study control organization of any one processor.

Major Equipments:

- Bread Board, Function Generator, Oscilloscope, Digital Logic Trainer Kits, Multimeter, Power Supply, Logic Analyzer, etc.
- Consumable Items: Various logic ICs for logic gates, flip-flops, latch, decoders, encoders, multiplexers, demultiplexer, etc., hook-up wires, Soldering iron, Desoldering pump, Electronics Toolkit, etc.

List of Open Source Software/learning website:

Open Source Software:

- TINA-TI for circuit simulation (http://www.ti.com/tool/tina-ti)
- OSCAD for CAD application (http://www.oscad.in/downloads)
- Fritzing for bread board/GP board wiring planning (http://fritzing.org/download)
- Multisim for circuit simulation (http://www.ni.com/multisim)
- Xilinx ISE/ Vivado (http://www.xilinx.com)
- http://sourceforge.net/projects/ktechlab/
- http://www.cburch.com/logisim/
- http://sourceforge.net/projects/digitalcircuitdesign/?source=directory

Web-based tools for design:

- https://www.circuitlab.com/editor/

Open source for Math Tools:

- http://maxima.sourceforge.net/
- http://www.sagemath.org/
- http://www.scilab.org/
- http://www.gnu.org/software/octave/

Learning website:

- http://www.datasheetcatalog.com/
- http://nptel.iitm.ac.in/courses.php
- http://ocw.mit.edu/
- 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.