Digital Electronics and Logic Design

Unit I Combinational Logic Design

Logic minimization: Representation of truth-table, Sum of Product (SOP) form, Product of Sum(POS) form, Simplification of logical functions, Minimization of SOP and POS forms using KMaps up to 4 variables and Quine-McCluskey Technique, realization of logic gates.
Design of Combinational Logic: Code converter - BCD, Excess-3, Gray code, Binary Code. Half- Adder, Full Adder, Half Subtractor, Full Subtractor, Binary Adder (IC 7483), BCD adder,
Look ahead carry generator, Multiplexers (MUX): MUX (IC 74153, 74151), MUX tree, Demultiplexers (DEMUX)- Decoder. (IC 74138, IC 74154). DMUX Tree, Implementation of SOP and POS using MUX, DMUX, Comparators, Parity generators and Checker, Priority Encoders.

Unit II Sequential Logic Design

Flip- flop: SR, JK, D, T; Preset & Clear, Master and Slave Flip Flops, Truth Tables and Excitation tables, Conversion from one type to another type of Flip Flop. **Registers:** Buffer register, shift register, Applications of shift registers. **Counters:** Asynchronous counter. Synchronous counter,ring counters, BCD Counter, Johnson Counter, Modulus of the counter (IC 7490).
Synchronous Sequential Circuit Design: Models – Moore and Mealy, State diagram and State Tables, Design Procedure, Sequence generator and detector. **Asynchronous Sequential Circuit Design:** Difference with synchronous circuit design, design principles and procedure, applications

Unit III Algorithmic State Machines

Algorithmic State Machines: Finite State Machines (FSM) and ASM, ASM charts, notations,
construction of ASM chart and realization for sequential circuits, Sequence Generator, Types of Counters. **VHDL:** Introduction to HDL, Data Objects & Data Types, Attributes., VHDL-Library, Design Entity, Architecture, Modeling Styles, Concurrent and Sequential Statements,
Design Examples: VHDL for Combinational Circuits-Adder, MUX, VHDL for Sequential Circuits, Synchronous and Asynchronous Counter.

Unit IV Programmable Logic Devices

ROM as PLD, Programmable Logic Array (PLA), Programmable Array Logic (PAL), Designing combinational circuits using PLDs.

Unit V Logic Families

Classification of logic families: Unipolar and Bipolar Logic Families, Characteristics of Digital ICs: Speed, power dissipation, figure of merits, fan-out, Current and voltage parameters, Noise immunity, operating temperature range, power supply requirements.

Transistor-Transistor Logic: Operation of TTL, Current sink logic, TTL with active pull up, TTL with open collector output, Schottkey TTL, TTL characteristics, TTL 5400/7400 series, **CMOS:** CMOS Inverter,CMOS characteristics, CMOS configurations- Wired Logic, Open drain outputs, **Interfacing:** TTL to CMOS and CMOS to TTL. Tristate Logic and Tristate TTL inverter.

Unit VI Microcontrollers

Comparison of typical microprocessor and microcontroller. **16- bitMicrocontroller MSP430:** Features, architecture, Pin description, **Programming model**– Special Function Registers, addressing modes, instruction set, Timers and Counters, serial communication, interrupts, interfacing with ADC and DAC.

Text Books:

1. R.P. Jain, ―Modern Digital Electronics‖, TMH, 2012, ISBN–13: 978-0-07- 066911-6.
2. Stephen Brown, ZvonkoVranesic, ―Fundamentals of Digital Logic with VHDL Design‖, McGraw-Hill, ISBN–13:978-1-25-902597-6.
3. MuhammasMazidi, Janice Mazidi and RolinMcKinlay, ―The 8051 Microcontroller and Embedded Systems using Assembly and C‖, Pearson Education, ISBN-13: 9788131758991
4. MSP430 microcontroller basics 1st Edition by John H. Davies (Author), Newnes Publication ISBN- 13: 978-0750682763

References:

1. John Yarbrough, ―Digital Logic applications and Design‖, Cengage Learning, ISBN – 13: 978-81-315-0058-3
2. D. Leach, Malvino, Saha, ―Digital Principles and Applications‖, Tata McGraw Hill, ISBN – 13:978-0-07-014170-4.
3. Anil Maini, ―Digital Electronics: Principles and Integrated Circuits‖, Wiley India Ltd, ISBN:978-81-265-1466-3.
4. Norman B & Bradley, ―Digital Logic Design Principles, Wiley India Ltd, ISBN:978-81-265-1258-4.
5. Scott Mackenzie, ―The 8051 Microcontroller‖, Prentice Hall India, ISBN-13: 978-0130195623

Digital Electronics Lab

Suggested List of Laboratory Assignments

Group A

1. Realize Full Adder and Subtractor using a) Basic Gates and b) Universal Gates
2. Design and implement Code converters-Binary to Gray and BCD to Excess-3
3. Design of n-bit Carry Save Adder (CSA) and Carry Propagation Adder (CPA). Design and Realization of BCD Adder using 4-bit Binary Adder (IC 7483).
4. Realization of Boolean Expression for suitable combination logic using MUX 74151 / DMUX 74154
5. Verify the truth table of one bit and two bit comparators using logic gates and comparator IC
6. Design & Implement Parity Generator using EX-OR.

Group B

7. Flip Flop Conversion: Design and Realization
8. Design and implement a system using flip-flops, to monitor number of vehicles entering and exiting from a car parking area with maximum capacity of 15 and having separate entry and exit gates.
9. Design of Ripple Counter using suitable Flip Flops
10. a. Realization of 3 bit Up/Down Counter using MS JK Flip Flop / D Flip Flop
b. Realization of Mod -N counter using (7490 and 74193)
11. Assume a scenario of a hall where students are entering to attend seminar. Design and implement a system which will increment count if student is entering in the hall and will decrement count if student is exiting the hall. Assume seating capacity of a hall is 63.
12. Design and Realization of Ring Counter and Johnson Ring counter.
13. Design and implement Sequence generator using JK flip-flop.
14. Design and implement pseudo random sequence generator.
15. Design and implement Sequence detector using JK flip-flop
16. Design of ASM chart using MUX controller Method.

Group C

17. Design and Implementation of Combinational Logic using PLAs.
18. Design and simulation of - Full adder , Flip flop, MUX using VHDL (Any 2)
Use different modeling styles.
19. Design & simulate asynchronous 3- bit counter using VHDL.
20. Design and Implementation of Combinational Logic using PALs.

Group D (Study Assignments)

21. Study of Shift Registers (SISO,SIPO, PISO,PIPO)
22. Study of TTL Logic Family: Feature, Characteristics and Comparison with CMOS Family
23.Learn and understand how to configure MSP-EXP430G2 Launchpad digital I/O pins. Write a C program for configuration of GPIO ports for MSP430 (blinking LEDs, push buttons interface).

Exercises:

a) Modify the delay with which the LED blinks.
b) Modify the code to make the green LED blink.
c) Modify the code to make the green and red LEDs blink:
    i. Together
    ii. Alternately
d) Alter the code to turn the LED ON when the button is pressed and OFF when it is released.
e). Alter the code to make the green LED stay ON for around 1 second every time the button is pressed.
f). Alter the code to turn the red LED ON when the button is pressed and the green LED ON when the button is released.

24.Learn and understand GPIO based Interrupt programming. Write a C program and associated GPIO ISR using interrupt programming technique.

Exercises:

a) Write the code to enable a Timer interrupt for the pin P1.1.
b) Write the code to turn on interrupts globally

25.Implement Pulse Width Modulation to control the brightness of the on-board, green LED. This experiment will help you to learn and understand the configuration of PWM and Timer peripherals of the MSP430G2553.

Exercises:

a) Observe the PWM waveform on a particular pin using CRO.
b) What is the maximum resolution of PWM circuitry in MSP430G2 Launchpad?
c) Change the above code to create a PWM signal of 75% duty cycle on particular PWM pin.

26.The main objective of this experiment is to control the on-board, red LED by the analog input from a potentiometer. This experiment will help you to learn and understand how to configure an ADC to interface with a potentiometer.

Exercises:

a) Alter the threshold to 75% of Vcc for the LED to turn on.
b) Modify the code to change the Reference Voltage from Vcc to 2.5V.

27.Learn and understand how to configure the PWM and ADC modules of the MSP-EXP430G2 Launchpad to control the DC motor using external analog input.

Exercises:

a) What is the maximum resolution of PWM circuitry in MSP430G2 LaunchPad and how it can be achieved using program?
b) Create a PWM signal of 75% duty cycle on particular PWM pin.
c) Create Switch case code from the example code to run the DC Motor in 3 set of speeds.

28.Configure of Universal Serial Communication Interface (USCI) module of MSP430G2553 for UART based serial communication. The main objective of this experiment is to use UART of the MSP430G2553 to communicate with the computer.

Exercise:

Modify the above code to transmit the set of strings to the serial terminal via UART as shown below:

char str1[]="MSP430G2 launchpad"

char str2[]= "Ultra low power mixed signal processing applications"

Lab Manual:

1) www.ti.com/lab-maunals
   - Embedded System Design using MSP430 Launchpad Development Kit - Lab Manual