Ahsanullah University of Science and Technology (AUST)

Department of Computer Science and Engineering

LABORATORY MANUAL

Course No. : CSE2210

Course Title: Digital Electronics and Pulse Techniques Lab

For the students of 2nd Year, 2nd Semester of

B.Sc. in Computer Science and Engineering program

TABLE OF CONTENTS

COURSE OBJECTIVES

1. Practical implementation of a complex digital system.
2. To handle substantial and challenging design problems.
3. To implement how signals are used to represent digital values in different logic families, including characterization of the noise margins.
4. To create the appropriate truth table from a description of a combinational logic function.
5. To create a gate-level implementation of a combinational logic function described by a truth table using AND/OR/Inverter gates.
6. To design and implement sequential circuits.

PREFFERED TOOL(S)

- DC Power Supply
- Breadboard
- Transistor
- Diode
- Pulse Generator
- Multimeter

TEXT/REFERENCE BOOK(S)

- Jacob Millman, ***Microelectronics: Digital and Analog Circuits and Systems***, International Student Edition, McGraw-Hill International Book Company, 1979.
- Jacob Millman and Herbert Taub, ***Millman's Pulse, Digital and Switching Waveforms***, 2nd edition.

ADMINISTRATIVE POLICY OF THE LABORATORY

- ✓ Students must perform class assessment tasks in a group of 2/3 members.
- ✓ Students must build and test the circuit within the allotted time.
- ✓ Viva for each experiment will be taken and considered as a performance.
- ✓ Students have to submit the lab report of the previous day experiment at the beginning of each lab.
- ✓ Plagiarism is strictly forbidden and will be dealt with punishment.

Session 1

Introduction to Digital Electronics and Pulse Techniques Lab

OBJECTIVES: To get basic and preliminary ideas of Transistors, Diodes, Multimeter, Trainer Board etc.

Trainer Board:

The Analog/Digital Training System consists of DC power supply, breadboard, pulse generator and a digital probe.

Useful features include:

1. DC Power Supply
   - Fixed DC Inputs: +5V & -5V
   - Variable DC Inputs: +1.5V to +15V, -1.5V to -15V
2. Breadboard
   - Terminal strips arranged for easy connection of standard ICs.
3. Pulse Generator
4. Digital Probe

Multimeter:

A Multimeter is a combination of Voltmeter, Ammeter and Ohmmeter. They provide an easy way to measure different parameters of an electronic circuit like current, voltage etc.

Multimeters can measure values in both AC and DC. Earlier Multimeters are Analog and consists of a pointing needle. Modern Multimeters are Digital and are often called as Digital Multimeters or DMMs.

Useful features include:

1. To measure voltage levels, current and resistance.
2. To check the transistors and diodes proper functioning.

Diodes:

A Diode is a non-linear semiconductor device that allows flow of current in one direction. A Diode is a two–terminal device and the two terminals are Anode and Cathode respectively.

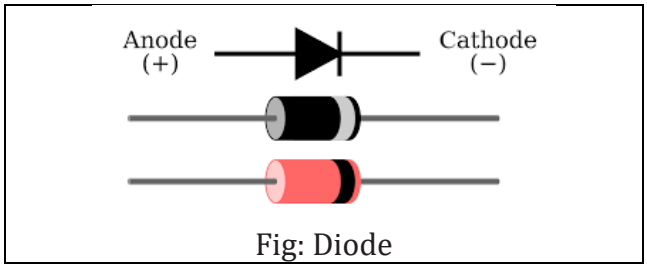


Fig: Diode

Transistors:

Transistor, the invention that changed the future of electronic circuits, is a semiconductor device that can be used to either switch electrical power or amplify electronic signals.

A Transistor is a 3 terminal device that can either a current controlled device or a voltage controlled device. Transistors are further classified in to Bipolar Junction Transistors (BJT) and Field Effect Transistors (FET).

A Bipolar Junction Transistor or BJT uses both the charge carriers i.e. electrons and holes and is often used as a current amplifier. Based on the construction, BJTs are further divided in to NPN and PNP Transistors.

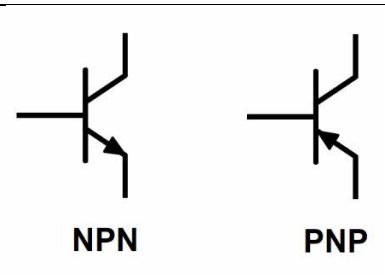


Fig: Two types of transistors

In the lab we will use NPN transistor (BD135). The transistor has three pins labeled as emitter, base and collector as shown in the following figure.

Fig: Pin Diagram of NPN transistor (BD135)

Session 2

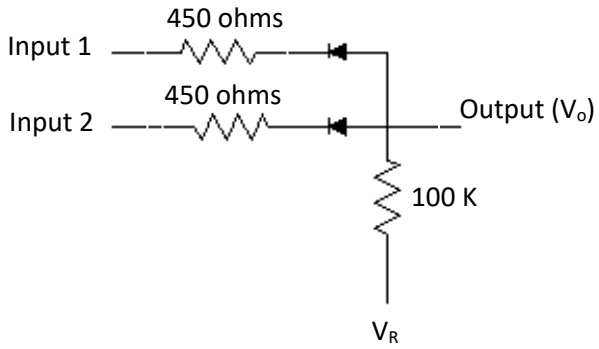
Experiment- 1

NAME OF THE EXPERIMENT: Study of DL and DTL gates.

OBJECTIVES: To analyze the circuits of different logic families especially DL and DTL.

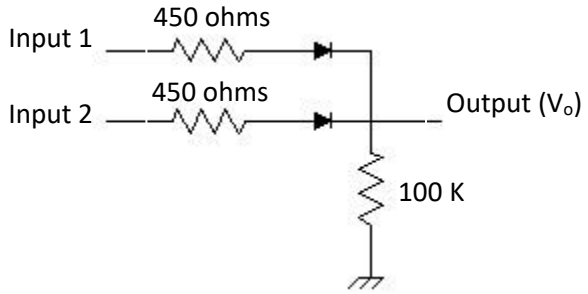
CIRCUIT DIAGRAM:

Circuit- 1:



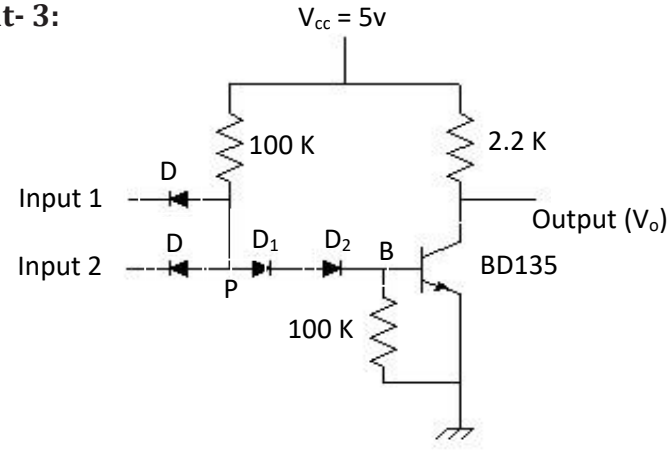
Input 1	Input 2	Output (V_o)
0	0	
0	1	
1	0	
1	1	

Circuit- 2:



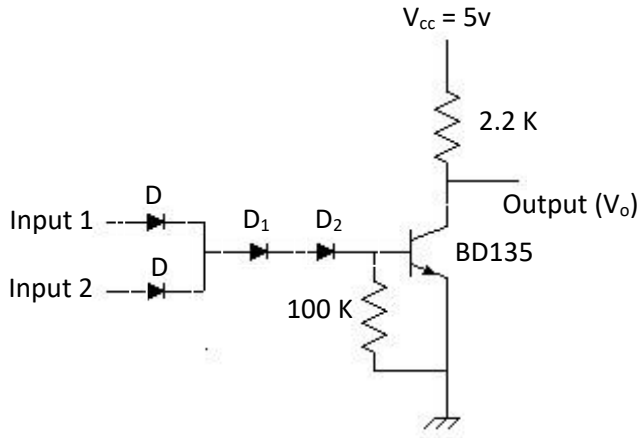
Input 1	Input 2	Output (V_o)
0	0	
0	1	
1	0	
1	1	

Circuit- 3:



Input 1	Input 2	Output (V_o)
0	0	
0	1	
1	0	
1	1	

Circuit- 4:



Input 1	Input 2	Output (V_o)
0	0	
0	1	
1	0	
1	1	

Procedure:

1. For circuit- 1 and circuit- 2, measure the output voltage V_o for all possible input combinations.
2. For circuit- 3 and circuit- 4, measure V_D, V_{D1}, V_{D2}, V_P, V_{CE} and V_o for all possible inputs. Calculate the $h_{FE(min)}$, NM(0) and NM(1).

Questions:

1. Analyze the circuit- 1 and circuit- 2 with the help of truth table for both positive and negative logic. [circuit- 1, circuit- 2]
2. What happens in V_R is more positive than V(1)? [circuit- 1]
3. What happens if not all inputs have the same upper level? [circuit- 1, circuit- 2]
4. Why diode D_2 is used? [circuit- 3, circuit- 4]
5. Can emitter and collector be interchanged? [circuit- 3, circuit- 4]
6. What is the significant of $h_{FE(min)}$? [circuit- 3, circuit- 4]

Report:

1. Objective.
2. Circuit diagram.
3. Answer to the questions.
4. Experimental data.
5. Calculations.
6. Discuss the findings.

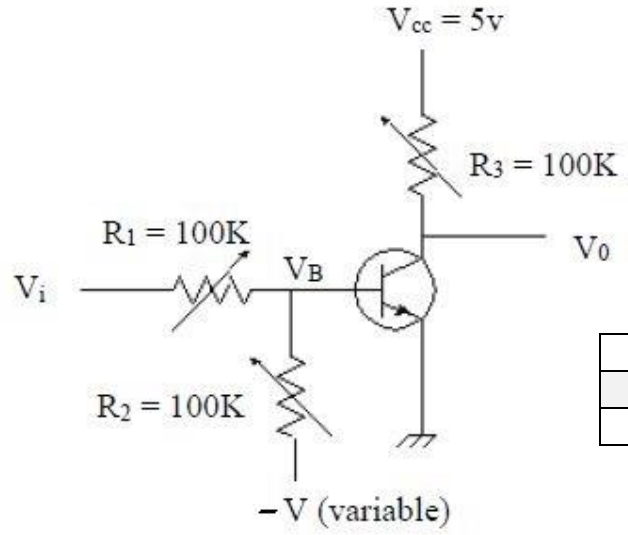
Session 3

Experiment- 2

NAME OF THE EXPERIMENT: Study of a transistorized NOT gate.

OBJECTIVES: To analyze the properties of a NOT gate.

CIRCUIT DIAGRAM:



V_i	Output (V_o)
0	
1	

Procedure:

1. Fix the value of R_1, R_2, V and vary R_3; measure V_0 and V_B.
2. Fix the value of R_1, R_3, V and vary R_2; measure V_0 and V_B.
3. Fix the value of R_2, R_3, V and vary R_1; measure V_0 and V_B.
4. Fix the value of R_1, R_2, R_3 and vary V; measure V_0 and V_B.

Questions:

1. Which factor affect the switching speed of a transistor and how?
2. What is the effect of R_1? Can it be very large?
3. Are there any effects of temperature on the circuit?

Report:

1. Objective.
2. Circuit diagram.
3. Answer to the questions.
4. Experimental data.
5. Calculations.
6. Discuss the findings.

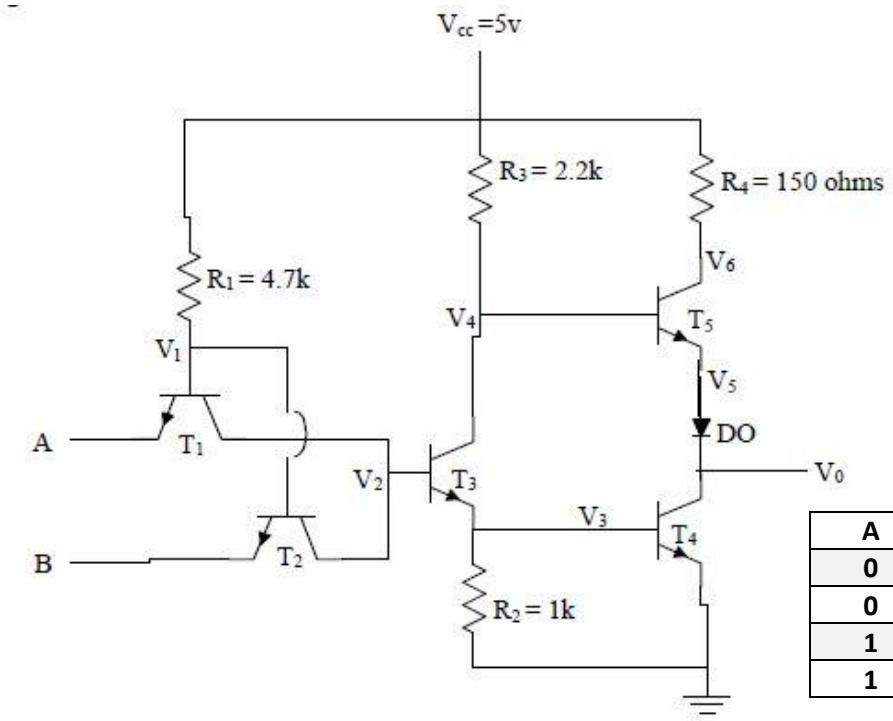
Session 4

Experiment- 3

NAME OF THE EXPERIMENT: Study of a TTL NAND gate with totem-pole output.

OBJECTIVES: To analyze the operation of a totem-pole stage TTL NAND gate.

CIRCUIT DIAGRAM:



A	B	Output (V_o)
0	0	
0	1	
1	0	
1	1	

Procedure:

1. Measure the V_0, V_1, V_2, V_3, V_4, V_5 & V_6 for all possible input combinations.
2. Calculate noise margins.

Questions:

1. Analyze the operation of TTL NAND gate with the experimental data.
2. What are the differences of transistors T_1 & T_2 with that of a multi-emitter transistor?
3. What is totem-pole stage? Why it is used in place of passive pull-up resistor?

4. What is the function of T_3?
5. Why resistor R_4 is used?
6. Why diode D_0 is used in the circuit? Can it be placed elsewhere?
7. Why two totem pole gates cannot be wire ANDed?
8. What are the features and advantages of TTL gates?

Report:

1. Objective.
2. Circuit diagram.
3. Answer to the questions.
4. Experimental data.
5. Calculations.
6. Discuss the findings.

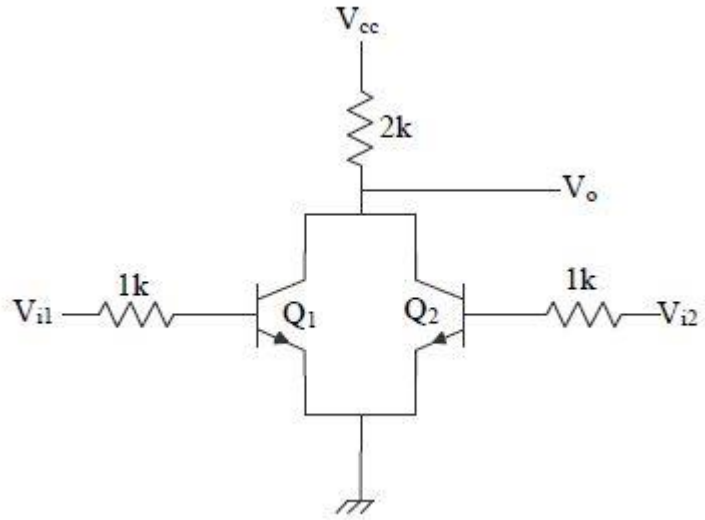
Session 5

Experiment- 4

NAME OF THE EXPERIMENT: Study of a RTL NOR gate.

OBJECTIVES: To analyze and understand the properties and operations of a NOR gate.

CIRCUIT DIAGRAM:



V_{i1}	V_{i2}	V_o
0	0	
0	1	
1	0	
1	1	

Procedure:

1. Measure the output voltage (V_0) for all possible input combinations.
2. Connect the V_{i1} input to ground, vary V_{i2} and measure V_0.
3. Connect the V_{i2} input to ground, vary V_{i1} and measure V_0.

Questions:

1. Analyze the operation of RTL NOR gate with the experimental data.
2. What is the importance of studying the RTL gate?
3. Draw the V_0 vs. V_{i1} and V_{i2} curves.

Report:

1. Objective.
2. Circuit diagram.
3. Answer to the questions.
4. Experimental data.
5. Calculations.
6. Discuss the findings.

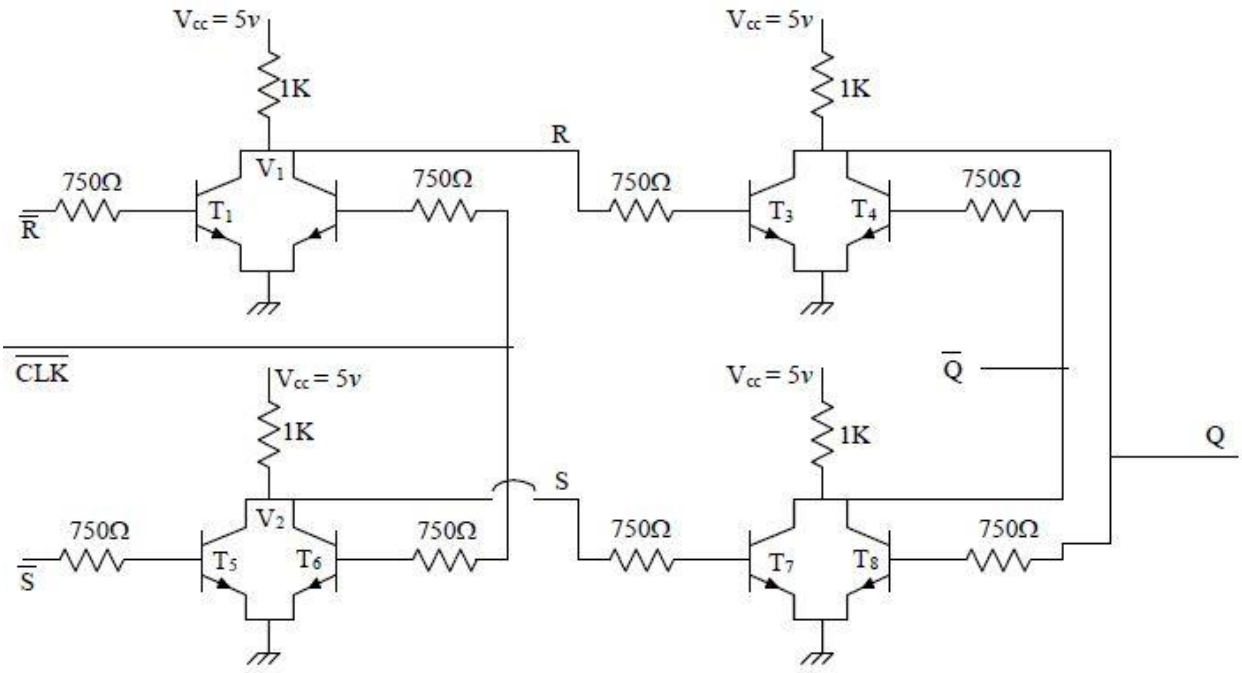
Session 6

Experiment- 5

NAME OF THE EXPERIMENT: Implementation of clocked SR Flip Flop using RTL NOR gates.

OBJECTIVES: To get acquainted with the properties and operations of clocked SR flip flop with RTL NOR gates.

CIRCUIT DIAGRAM:



Procedure:

1. Measure the output voltages at Q & $\overline{Q}$ and voltages V_1, V_2 for all possible input (S,R) combinations.

Questions:

1. Analyze the operation of SR FF with the experimental data.
2. What is the race around condition in SR FF? Discuss with respect to the internal circuit.

Report:

1. Objective.
2. Circuit diagram.
3. Answer to the questions.
4. Experimental data.
5. Calculations.
6. Discuss the findings.

FINAL TERM EXAMINATION

There will be a written examination. Different types of questions will be included such as MCQ, mathematics etc.