KARAPAGAM ACADEMY OF HIGHER EDUCATION, COIMBATORE-21

SEMESTER IV

16PHU414A BASIC INSTRUMENTATION SKILL LAB (SEC 2 A) **L T P C**
- - 3 1

The test of lab skills will be of the following test items:

1. Use of an oscilloscope.
2. CRO as a versatile measuring device.
3. Circuit tracing of Laboratory electronic equipment,
4. Use of Digital multimeter/VTVM for measuring voltages
5. Circuit tracing of Laboratory electronic equipment,
6. Winding a coil / transformer.
7. Study the layout of receiver circuit.
8. Trouble shooting a circuit
9. Balancing of bridges

Laboratory Exercises:

1. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance.
2. To observe the limitations of a multimeter for measuring high frequency voltage and currents.
3. To measure Q of a coil and its dependence on frequency, using a Q- meter.
4. Measurement of voltage, frequency, time period and phase angle using CRO.
5. Measurement of time period, frequency, average period using universal counter/ frequency counter.
6. Measurement of rise, fall and delay times using a CRO.
7. Measurement of distortion of a RF signal generator using distortion factor meter.
8. Measurement of R, L and C using a LCR bridge/ universal bridge.

Open Ended Experiments:

1. Using a Dual Trace Oscilloscope
2. Converting the range of a given measuring instrument (voltmeter, ammeter)

Reference Books:

1. A text book in Electrical Technology - B L Theraja - S Chand and Co.
2. Performance and design of AC machines - M G Say ELBS Edn.
3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
4. Logic circuit design, Shimon P. Vingron, 2012, Springer.
5. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
6. Electronic Devices and circuits, S. Salivahanan & N. S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
7. Electronic circuits: Handbook of design and applications, U.Tietze, Ch.Schenk, 2008, Springer Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

LIST OF EXPERIMENTS

1. Full wave rectifiers
2. Half wave rectifier
3. Op-amp inverting & non- inverting circuits
4. Half and full subtrator
5. Half adder and full Adder
6. Logics gates (Discrete components)
7. Universal buliding block (NAND & NOR)
8. Basic Logic gates.

1. FULL WAVE RECTIFIER

AIM

To construct center tapped full wave rectifier circuit using pn junction diode and find the ripple factor

APPARATUS:

Zener diode, Resistance, Regulated power supply, Ammeter, Voltmeter, Bread board and connecting wires.

THEORY

A rectifier is an electrical device that converts alternating current (AC), to direct current (DC), which flows in only one direction. The process is called *rectification*.

In the center tapped full wave rectifier two diodes are used. These are connected to the center tapped secondary winding of the transformer. The positive terminal of two diodes is connected to the two ends of the transformer. Center tap divides the total secondary voltage into equal parts. For the positive half cycle of the input diode D1 is connected to the positive terminal and D2 is connected to the negative terminal. Thus diode D1 is in forward bias and the diode D2 is reverse biased. Only diode D1 starts conducting and thus current flows from diode and it appears across the load R_L. So positive cycle of the input is appeared at the load.

During the negative half cycle the diode D2 is applied with the positive cycle. D2 in forward bias condition. The diode D1 is in reverse bias and this does not conduct. Thus current flows from diode D2 and hence negative cycle is also rectified, it appears at the load resistor RL. By comparing the current flow through load resistance in Ripple Factor

Ripple Factor (r): It is the ratio of root mean square (rms) value of AC component to the DC component in the output

PROCEDURE

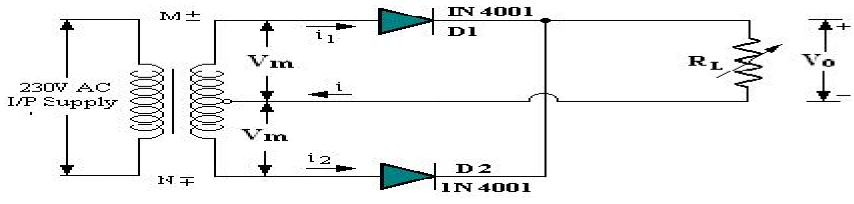
WITHOUT FILTER:

1. Connect the circuit as shown in the diagram (1).
2. Connect the primary of the transformer to main supply i.e. 230V, 50Hz
4. Switch on the power and measure the output across the load resistor RL and AC across secondary of the transformer.
5. Calculate ripple factor $\gamma = Vac/Vdc$

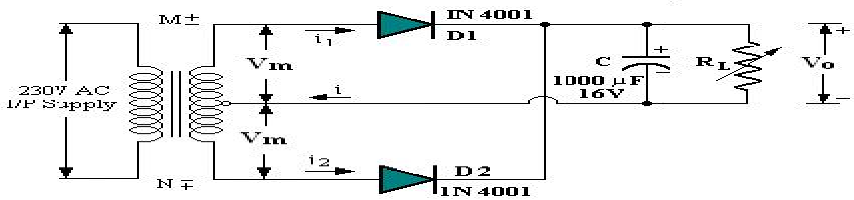
WITH CAPACITOR FILTER:

1. Connect the circuit as shown in the diagram (2).
2. Connect the primary of the transformer to main supply i.e. 230V, 50Hz
4. Switch on the power and measure the output across the load resistor RL and AC across secondary of the transformer.
5. Calculate ripple factor $\gamma = Vac/Vdc$

CIRCUIT DIAGRAM



Full-wave Rectifier without filter



Full-wave Rectifier with capacitor filter

TABULAR FORMS:

WITH OUT FILTER:

S No	Load Resistance R_L in Ω	Output Voltage Vo		Ripple factor Γ = Vac/Vdc
		V ac in Volt	V dc in Volt	

WITH FILTER

S No	Load Resistance R_L in Ω	Output Voltage Vo		Ripple factor Γ = Vac/Vdc
		V ac in Volt	V dc in Volt	

RESULT

Ripple factor of full wave rectifier with filter =

Ripple factor of full wave rectifier without filter =

VIVA –QUESTIONS

1. What is full wave rectifier?
2. Explain the working principle of full wave rectifier.
3. What is the efficiency of full wave rectifier?
4. Draw the output wave form of full wave rectifier.
5. What is the important of finding out the ripple factor of full wave rectifier?

2. FULL WAVE BRIDGE RECTIFIER

AIM

To construct full wave bridge rectifier circuit using pn junction diode and find the ripple factor

APPARATUS:

pn junction diode, Resistance, Regulated power supply, Ammeter, Voltmeter, Bread board and connecting wires.

THEORY

A rectifier is an electrical device that converts alternating current (AC), to direct current (DC), which flows in only one direction. The process is called *rectification*.

In full wave bridge rectifier circuit four diodes are arranged in the form of a bridge. This configuration provides same polarity output with either polarity. During first half cycle of the AC input, diodes D1 and D_4 are forward biased. Current flows through path 1-2, enter into the load R_L. It returns back flowing through path 4-3. During this half input cycle, the diodes D_2 and D_3 are reverse biased. During the next cycle lower portion of the transformer is positive with respect to the upper portion. Hence during this cycle diodes D2 and D3 are forward biased. Current flows through the path 3-2 and flows back through the path 4-1.The diodes D1 and D4 are reverse biased. So there is no current flow through the path 1-2 and 3-4.Thus negative cycle is rectified and it appears across the load.

Ripple Factor (r): It is the ratio of root mean square (rms) value of AC component to the DC component in the output

PROCEDURE

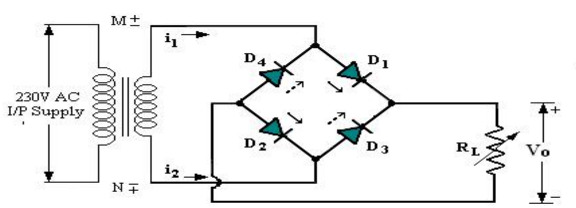
WITHOUT FILTER:

1. Connect the circuit as shown in the diagram (1).
2. Connect the primary of the transformer to main supply i.e. 230V, 50Hz
4. Switch on the power and measure the output across the load resistor RL and AC across secondary of the transformer.
5. Calculate ripple factor $\gamma = Vac/Vdc$

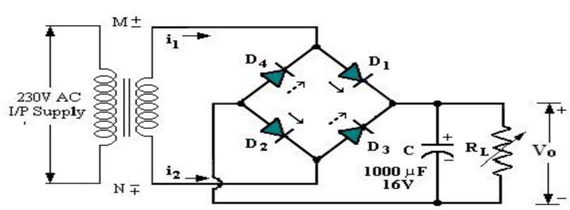
WITH CAPACITOR FILTER:

1. Connect the circuit as shown in the diagram (2).
2. Connect the primary of the transformer to main supply i.e. 230V, 50Hz
4. Switch on the power and measure the output across the load resistor RL and AC across secondary of the transformer.
5. Calculate ripple factor $\gamma = Vac/Vdc$

CIRCUIT DIAGRAM



Bridge Rectifier without filter



Bridge Rectifier with capacitor filter

TABULAR FORMS:

WITH OUT FILTER:

S No	Load Resistance	Output Voltage Vo	Ripple factor

	R_L in Ω	V ac in Volt	V dc in Volt	Γ = Vac/Vdc

WITH FILTER

S No	Load Resistance R_L in Ω	Output Voltage Vo		Ripple factor Γ = Vac/Vdc
		V ac in Volt	V dc in Volt	

RESULT

Ripple factor of bridge rectifier with filter =

Ripple factor of bridge rectifier without filter =

VIVA –QUESTIONS

1. What is full wave bridge rectifier?
2. Explain the working principle of full wave bridge rectifier.
3. What is the efficiency of full wave bridge rectifier?
4. What is the effect of capacitor in this circuit?
5. What are the advantages of full wave bridge rectifier?

3. INVERTING AMPLIFIER & NON - INVERTING AMPLIFIER\

INVERTING AMPLIFIER

AIM

To study the operation of Op-Amp as inverting amplifier.

APPARATUS

Op-amp(IC 741), resistors, Constant Dual power supply, multimeter, Decade resistance box (2), Bread board and connecting wires.

THEORY

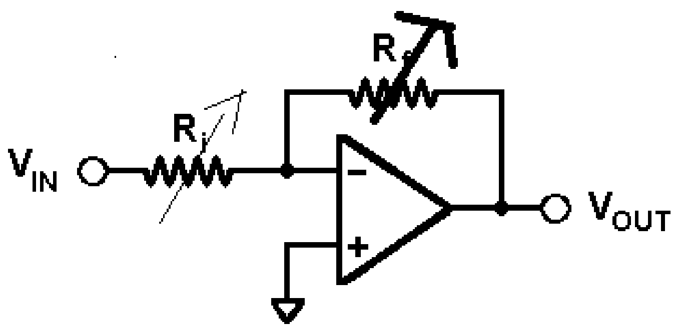
Inverting amplifier is one in which the output is exactly 180^0 out of phase with respect to input. Output is an inverted (in terms of phase) amplified version of input.

$$\text{Voltage gain } A_v = V_o / V_i = -R_f/R$$

PROCEDURE

1. Connections are made as shown in the diagram
2. Apply dc input voltage using variable regulated power supply.
3. Adjust input resistance and feedback resistance from DRB.
4. Measure the ouput voltage using digital multimeter.
5. Calculate the gain of the amplifier in terms of voltage and resistance.

CIRCUIT DIAGRAM



TABULAR FORMS

Input Voltage Vi in Volts	**Input resistance Ri in Ω**	**Feedback Resistance Rf in Ω**	**Output Voltage in volts**	**Gain= -Vo/Vi**	**Gain= -Rf/Ri**

RESULT

Inverting operation of Op-amp is studied and gain calculated.

Viva-Questions

1. What is inverting amplifier?
2. Draw the output waveform of inverting amplifier.
3. What is the phase of output signal of inverting amplifier?
4. What is the voltage gain of inverting amplifier?
5. What is inverting terminal?

NON-INVERTING AMPLIFIER

AIM

To study the operation of Op-Amp as non- inverting amplifier.

APPARATUS

Op-amp(IC 741), resistors, Constant Dual power supply, multimeter, Decade resistance box (2), Bread board and connecting wires.

THEORY

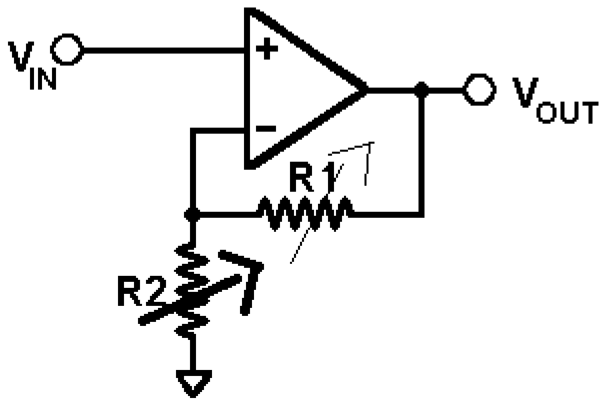
Non Inverting amplifier is one in which the output is in phase with respect to input (i.e. if you apply a positive voltage, output will be positive). Output is an Non inverted (in terms of phase) amplified version of input.

$$\text{Voltage gain } A_v = V_o / V_i = 1 + Rf/Ri$$

PROCEDURE

1. Connections are made as shown in the diagram
2. Apply dc input voltage using variable regulated power supply.
3. Adjust input resistance and feedback resistance from DRB.
4. Measure the ouput voltage using digital multimeter.
5. Calculate the gain of the amplifier in terms of voltage and resistance.

CIRCUIT DIAGRAM



TABULAR FORS

Input Voltage Vi in Volts	Input resistance R2 in Ω	Feedback Resistance R1 in Ω	Output Voltage in volts	Gain= Vo/Vi	Gain=1+R1/R2

RESULT

Non-inverting operation of Op-amp is studied and gain calculated.

Viva-Questions

1. What is non-inverting amplifier?
2. Draw the output waveform of non-inverting amplifier.
3. What is the phase of output signal of non-inverting amplifier?
4. What is the voltage gain of non-inverting amplifier?
5. What is unity gain?

4. BASIC LOGIC GATES

AIM:

To Verify Truth Table of Logic Gates (AND, OR, NOT, NAND & NOR Gates).

Apparatus

- Analog/Digital Training System

- IC Type 7400 Quadruple 2-input NAND gates
- IC Type 7402 Quadruple 2-input NOR gates
- IC Type 7404 Hex Inverters
- IC Type 7408 Quadruple 2-input AND gates
- IC Type 7432 Quadruple 2-input OR gates
- IC Type 7486 Quadruple 2-input XOR gate

THEORY: - There are different gates available in digital electronic filed. Which is used to perform the different tasks they are as follow:-

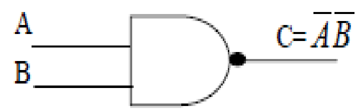
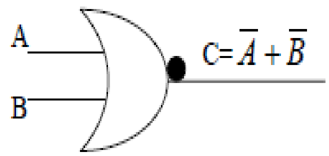
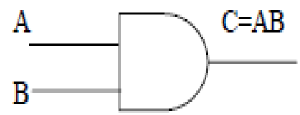
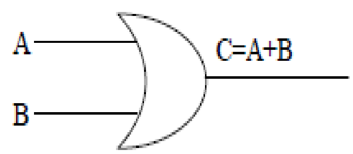
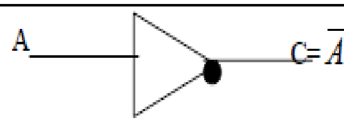
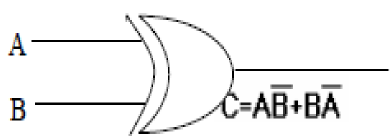
AND GATE: - This gate is used for the multiplication of two binary digits. OR GATE: - This gate is used for the addition of two binary digits.

NOT GATE: - This gate gives the compliment of given binary digit.

NAND GATE: - This gate is used for giving compliment of multiplication of two binary digits. NOR GATE: - This gate is used for giving compliment of the addition of two binary digits

PROCEDURE:

1. Check the components for their working.
2. Insert the appropriate IC into the IC base.
3. Make connections as shown in the circuit diagram.
4. Provide the input data via the input switches and observe the output on output LEDs

S.NO	GATE	SYMBOL	INPUTS		OUTPUT
			A	B	C
1.	NAND IC 7400		0	0	1
			0	1	1
			1	0	1
			1	1	0
2.	NOR IC 7402		0	0	1
			0	1	0
			1	0	0
			1	1	0
3.	AND IC 7408		0	0	0
			0	1	0
			1	0	0
			1	1	1
4.	OR IC 7432		0	0	0
			0	1	1
			1	0	1
			1	1	1
5.	NOT IC 7404		1	-	0
			0	-	1
6.	EX-OR IC 7486		0	0	0
			0	1	1
			1	0	1
			1	1	0

VIVA QUESTIONS:

1. Why NAND & NOR gates are called universal gates?
2. Realize the EX – OR gates using minimum number of NAND gates.

3. Give the truth table for EX-NOR and realize using NAND gates?
4. What are the logic low and High levels of TTL IC's and CMOS IC's?
5. Compare TTL logic family with CMOS family?
6. Which logic family is fastest and which has low power dissipation?

5. LOGIC GATES USING DISCRETE COMPONENTS

Aim:

To construct logic gates **OR, AND, NOT, NOR, NAND** gates using discrete components and verify their truth tables. To realize the logic gates using ICs and verify the truth tables.

Apparatus:

- Breadboard
- Resistors 10k, 1k, 220ohms
- Transistors 2N2222 (NPN)
- Diodes 1N 4001
- AND Gate IC 7408
- OR Gate IC 7432
- NOT Gate IC 7404
- NAND Gate IC 7400
- NOR Gate IC 7402
- Connecting wires
- DMM
- LEDs

Theory:

1. OR Gate:

The operation of these gates is to consider the diode as a simple switch, which is closed (on) when the voltage on one side (the anode) is higher than the other (the cathode). The current then flows in the direction of the arrow in the diode's circuit diagram symbol. The figure 1(a) shows the logic symbol, my discrete component implementation, and the truth table. In an OR gate, the output is "1" (high) if either of the inputs are "1". In this diagram, if either of the inputs has a "high" voltage, its diode will conduct and current will flow to the output. A "high" voltage will develop across the resistor, equivalent to the input voltage minus 0.7V drop, as is usual across silicon diode junctions. If both of the inputs are low voltage "0", then the diodes don't conduct. In this instance the gate's output is tied low by the 10K resistor.

AND Gate:

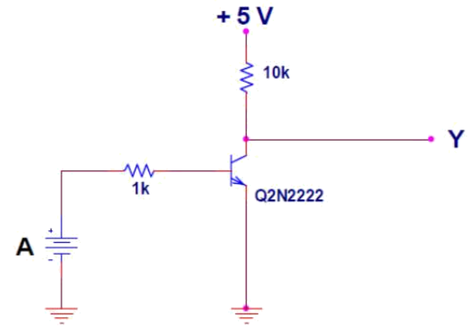
It's similar to the OR gate except that the diodes point in the other direction, and the resistor goes to +5V not ground. The output of an AND gate is "1" only if BOTH the inputs are "1". In diode-resistor implementation, if either input is "low" voltage (logic "0") then the diode will conduct and the output is effectively shorted to ground. If both of the input voltages are "high" (logic "1") then neither of the diodes will conduct, so the output is not shorted to ground: it remains at +5V (logic "1") via the 10K resistor. This gives the desired result. Note that again, due to the silicon junction voltage, the actual "low" output voltage is 0.7V higher than the "low" input voltage.

NOT Gate:

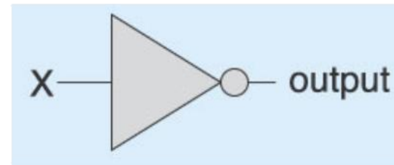
You cannot implement an inverting function with diodes and resistors alone. You also now need a transistor, to provide the inverting action. There's nothing particularly special about the transistor to be used, almost any small signal NPN transistor will suit, since it's driven into saturation (unbiased). If the voltage presented to the base of the transistor is above 0.7, the transistor will conduct which drags the output to logic "0", low voltage. If the input voltage is logic "0", then the transistor does not conduct, and the resistor will just tie the output to +5V. You always need that 10K current limiting resistor in the base, or excessive base-emitter current will destroy the transistor.

Circuit Diagrams:

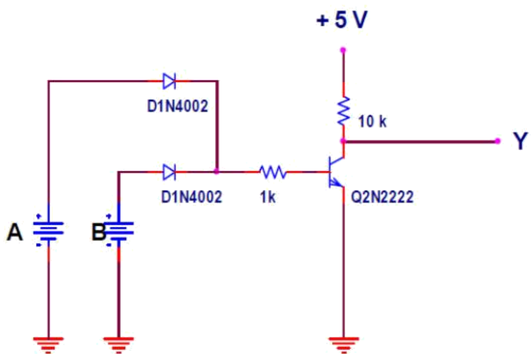
NOT Gate



A	Y
0v	5v
5v	0v

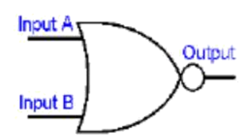


NOR Gate

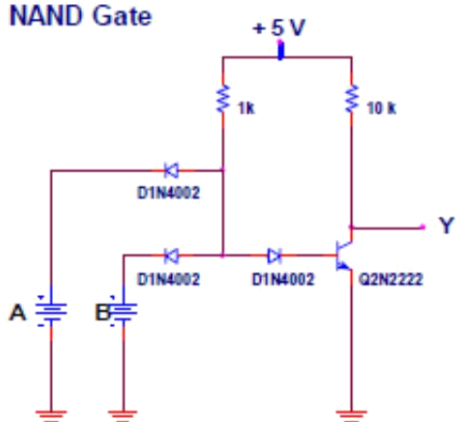


A	B	Y
0v	0v	5v
0v	5v	0v
5v	0v	0v
5v	5v	0v

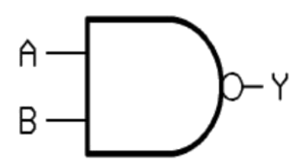
2-input NOR gate

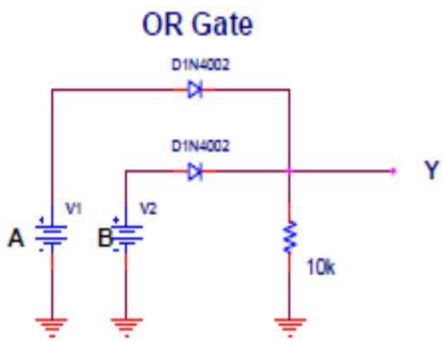


NAND Gate

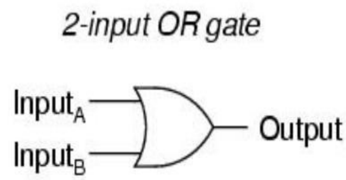


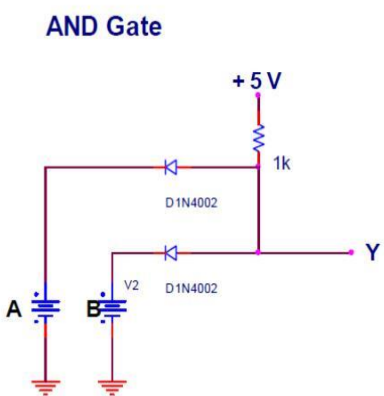
A	B	Y
0v	0v	5v
0v	5v	5v
5v	0v	5v
5v	5v	0v





A	B	Y
0v	0v	0v
0v	5v	5v
5v	0v	5v
5v	5v	5v





A	B	Y
0v	0v	0v
0v	5v	0v
5v	0v	0v
5v	5v	5v

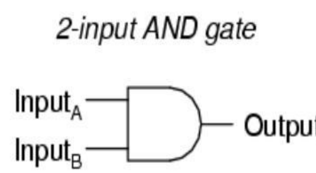


Fig: 1: logic gate symbol, discrete components implementation and truth table

Procedure:

1. Connections are made as per the circuit diagram.

2. Switch on the power supply.

3. Apply different combinations of inputs and observe the outputs; compare the outputs with the truth tables.

Result:

Different logic gates are constructed and their truth tables are verified.

6. NAND AND NOR AS UNIVERSAL BUILDING BLOCKS

Aim: To Implement Boolean expression using AOI logic. To design basic gates using NAND gate.

Apparatus:

- Breadboard
- NAND Gate IC 7400
- NOR Gate IC 7402
- Connecting wires
- DMM
- LEDs
- Power Supply

Theory:

A binary variable can take the value of 0 or 1. A Boolean function is an expression formed with binary variables, the two binary operators OR and AND, and unary operator NOT, parentheses, and an equal sign. For a given value of the variables, the function can be either 0 or 1. Boolean function represented as an algebraic expression may be transformed from an algebraic expression into a logic diagram composed of AND, OR, and NOT gates. . Every Boolean function can be realized by a And-Or-Not gates i.e. using AOI logic.

NAND GATE is a universal gate. It is so called as because by using of this gate we can make any gate like not, or, and etc. by help of this gate we can also make multiplexers and de mux

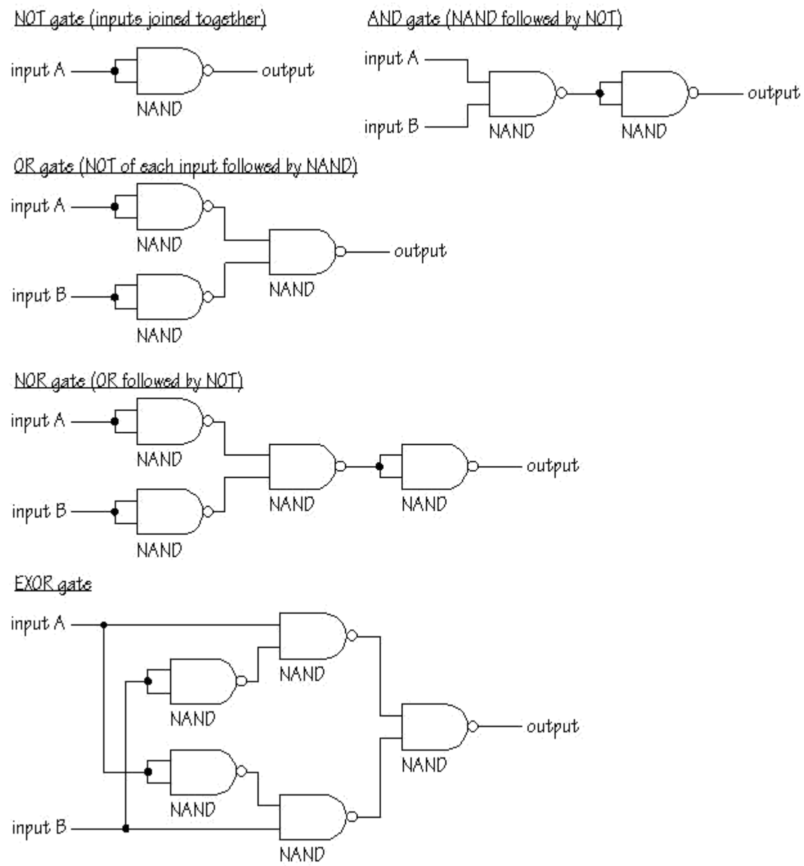


Fig: 1: Implementation of Basic Gates Using NAND Gate

Procedure:

i) Place the IC on breadboard.

ii) Connect Vcc and Gnd to the respective pins of IC Trainer Kit.

iii) Connect the inputs to the input switches/logical switches.

iv) Connect the output to the switches of O/p or LEDs.

v) Apply various combinations f inputs according to the truth table and observe condition of LEDs.

vi) Disconnect output from LEDs and note down the corresponding multimeter voltage readings for various combinations of inputs.

Precautions:

1. All the connections should be made properly.

2. Before the circuit connection it should be check out working condition of all the components and ICs.

Result:

Different logic gates are constructed and their truth tables are verified.

7. HALF ADDER AND FULL ADDER

Aim: To design and construct Half-adder, Full-adder.

Apparatus:

- Breadboard
- Resistors 10k, 1k, 220ohms
- IC's - 7486, 7432, 7408, 7400
- Connecting wires

Theory:

Half-Adder*:*

A combinational logic circuit that performs the addition of two data bits, A and B, is called a half-adder. Addition will result in two output bits; one of which is the sum bit, S, and the other is the carry bit, C. The Boolean functions describing the half-adder are:

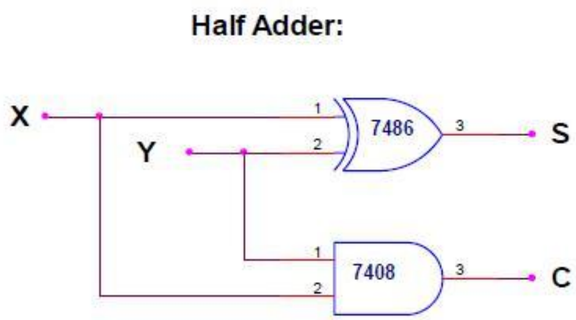
$S = A \oplus B$ $C = A B$

Full-Adder:

The half-adder does not take the carry bit from its previous stage into account. This carry bit from its previous stage is called carry-in bit. A combinational logic circuit that adds two data bits, A and B, and a carry-in bit, Cin , is called a full-adder. The Boolean functions describing the full-adder are:

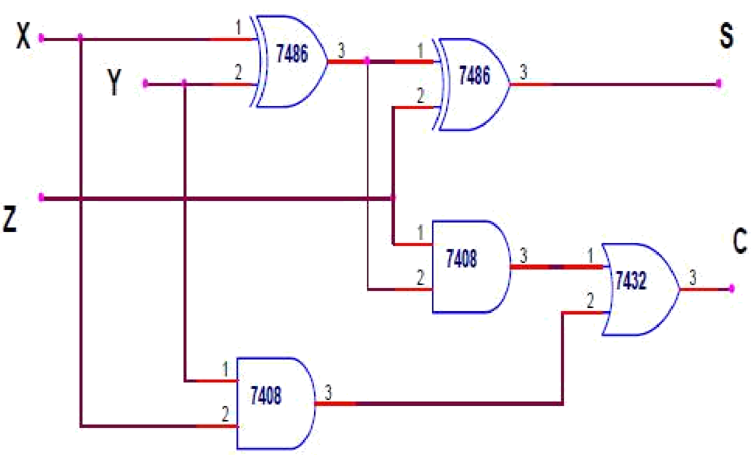
$S = (x \oplus y) \oplus Cin$ $C = xy + Cin\,(x \oplus y)$

Circuit Diagrams **Truth Table**



A	B	S	C
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

Full Adder:



A	B	C_{N-1}	S	C
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

Fig: 1: logic gate symbol, discrete components implementation and truth table

Procedure:

1. Verify the gates.
2. Make the connections as per the circuit diagram.
3. Switch on VCC and apply various combinations of input according to truth table.
4. Note down the output readings for half/full adder and half/full subtractor, Sum/difference and the carry/borrow bit for different combinations of inputs verify their truth tables.

Precautions:

1. All the connections should be made properly.
2. IC should not be reversed.

Result:

Combinational logic circuits like Half-adder, Full-adder are constructed and truth tables are verified.