MODIFIED ELECTRONIC AND DIGITAL IC TRAINER

SUBMITTED TO:

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ABSTRACT

A modified electronic and Digital IC is a Trainer with a carrying case which shows industrial components and digital IC for providing a variety of experiments for the students. Among the industrial components included were Triac, SCR (Silicon Controlled Rectifier), Quadrac Relay, Light Dependent Resistors and Solenoid.

With the absence of a Trainer, students could hardly understand the function of Industrial Electronic Components and Digital IC, whose importance can be seen on the growth of our industries and development of computer which make it possible in the delivery of goods and services, business transactions faster in school , offices and community.

The methodology used in the construction of the Trainer includes planning – with subwork as circuit analysis and testing for its functionality and the availability of parts in the electronic stores. After planning was enclosure assembly – lay outing, working drawing and measuring ,cutting of aluminum for brace, boring boles, circuit designing and mounting of connectors and parts. The third was purchasing the parts and compute the estimated cost for the Bill of materials.

Circuits for industrial electronic components include gating effect of SCR and Triac, Light Dimmer , Night Switch, MOSFET motor controller, Relay circuit and LDR combination Circuit. Circuits for Digital IC includes experiment on AND , NAND, OR, NOR , XOR, Adder, Half Adder, Full Adder, Encoder, Flip Flop, Decoder, Clock Generator, Continuity Tester, Signal Injector,, Counter and Shift Registers. The Hands On Experiments is provided by the Trainer as it makes the Topic Interesting , as they follow circuit diagram, more easy in grasping the knowledge and developing skills.

Keywords:

- *Industrial Electronic Components , Sequential Logic Circuit , Combinational Logic Circuit*
- *Digital IC*
- *Trainer*

Introduction

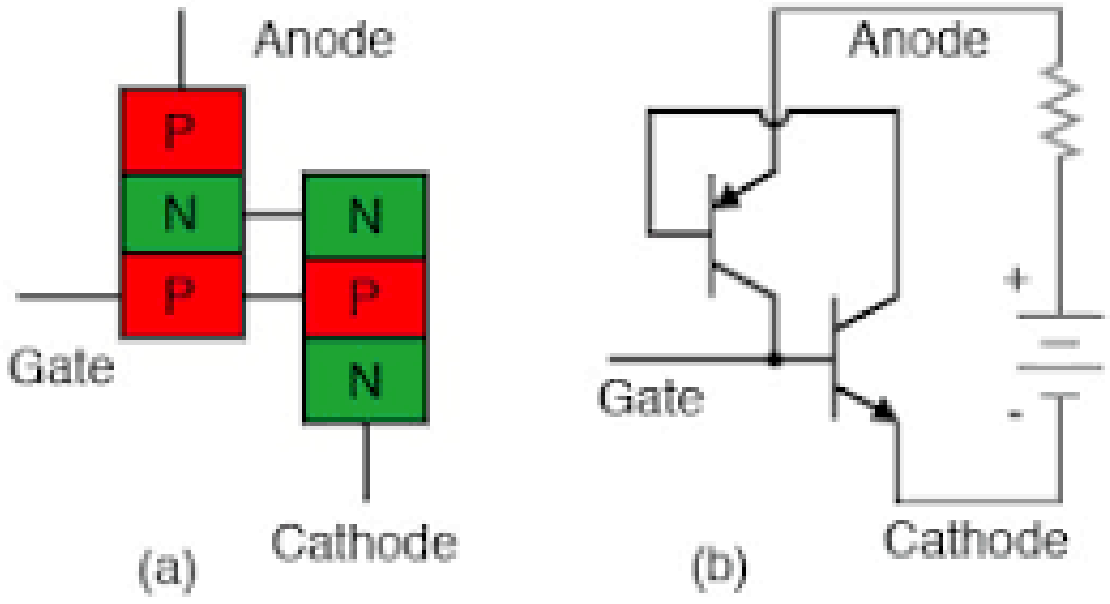
The Trainer entitled “Modified Electronic and Digital IC Traner” was conceive to aid in the teaching of Industrial Electronics Component purposely for First Year Bind Tech electronics students and Computer Technology Students. Components included are the Thyristors, MOSFET, Relay, Solenoid, Sensors like LDR, Photo Transistor IR Transmitter and Receiver , Thermistor and Thermostat and Digital IC.

Digital IC are responsible In the computer evolution. Digital IC accepts only binary numbers 0 and 1, 1 for High, 0 for low or 1 means On and 0 means Off. Digital perform mathematical operations as in calculator and computer devices. Digital IC are classified as combinational logic circuit and sequential logic circuit. The basic building block of combinational logic circuit are gates, while Flip Flop for sequential logic circuits. (Sabah, 2010)

The Trainer connections makes use of a breadboard single , solid wire connectors#22 and the input – output stage makes use of a modified bread board, cut and measured for mounting which makes the spaces of the Trainer wider and connections accuracy without the need of soldering. This provide cheap cost, compared to a binding post and banana plug connectors, where it consumes bigger space. A schematic diagram of the circuits involve is provided separately in the Trainer so as easy maintenance can be achieve once the Trainer failed.

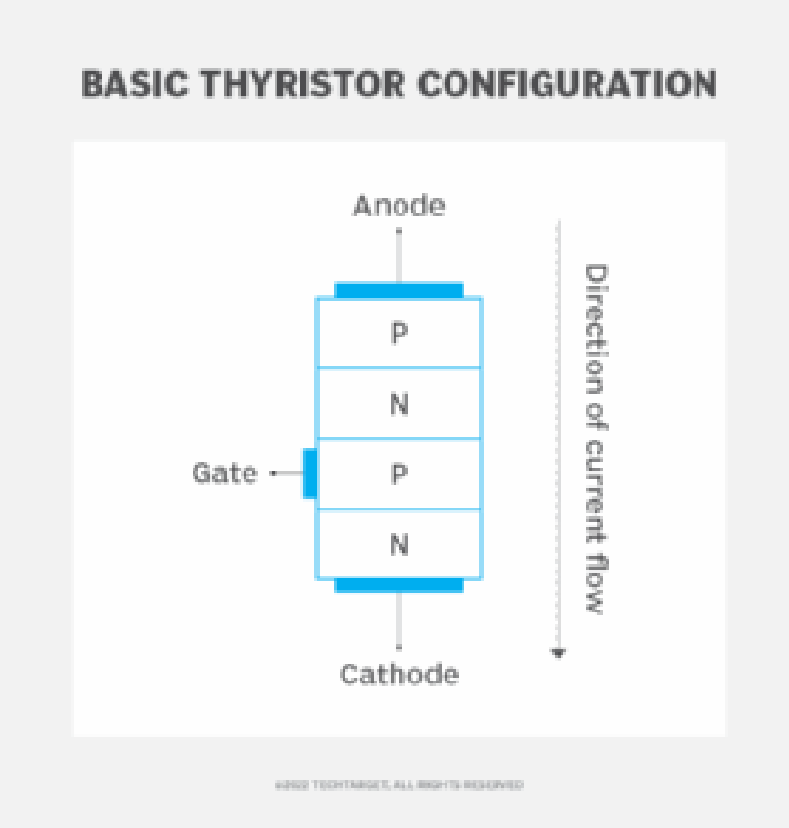
Related Literature

Thyristors are 4 layer devices usually equivalent circuit of a pnp and npn transistor. Ideally, these devices would not conduct, but when forward biased, if there is sufficient leakage current in the upper pnp device, it can act as base current to the lower npn device causing it to conduct and bringing both transistors into saturation. Diagram 1 shows the equivalent circuit of Thyristor.



Requirements as to conduction of SCR (Silicon Controlled Rectifier): Forward Breakover Voltage , ($V_{BR(F)}$. This is the voltage at which the SCR enters the forward conduction region. Holding Current I_H: This is the value of anode current below which the SCR switches from the forward conduction region to the forward – blocking region. Gate Trigger Current I_G : This is the value of the Gate current necessary to switch the SCR from the forward – blocking region to the forward – conduction region under specified conditions. Thyristors are a class of semiconductor devices

characterized by 4 layers of alternating p and n material. Four layer devices act as either open or closed switches, for this reason, they are most frequently used in control applications. (Thomas L. Floyd) Diagram 2 shows the 4 layer thyristor.



An SCR is a Thyristor device resembling a semiconductor diode in that it conducts current only when forward biased. The SCR , however, won't conduct a significant current even when it's forward biased unless the voltage across its anode and cathode exceeds the rated forward breakover voltage or a positive voltage is applied to gate terminal. (Project & Circuits. Vol 1)

Some Applications of SCR is an Over Voltage Protection (crowbar) circuits. Shown in. Diagram 3.

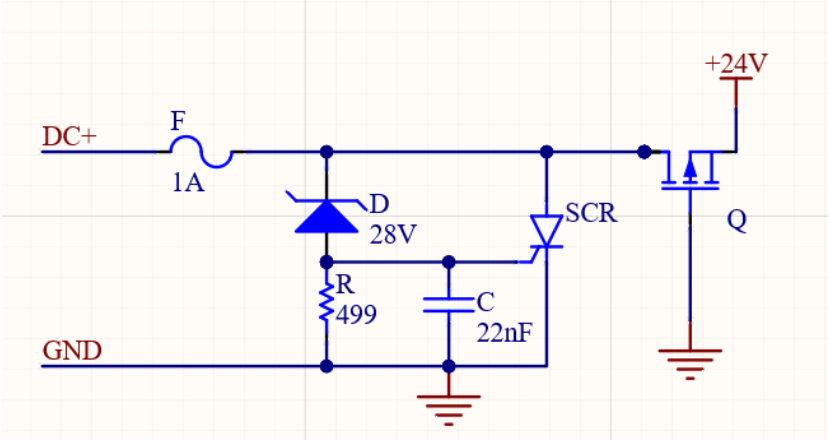


Diagram 3

If the DC output voltage is exceeds the Zener voltage, the zener conducts and the voltage divider produces an SCR trigger voltage. The trigger voltage turns on the SCR , causing the fuse to blow. Triacs or triode for alternating current are semiconductor devices that are used in a variety of applications, including : AC circuits Control, Lighting Controls, Motor Speed Control, Temperature control - temperature of electric furnaces, radio interference reduction, AC voltage regulators, Single phase motor starter and others

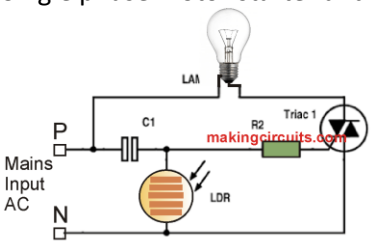


Diagram 4. Triac used as a night switch with LDR.

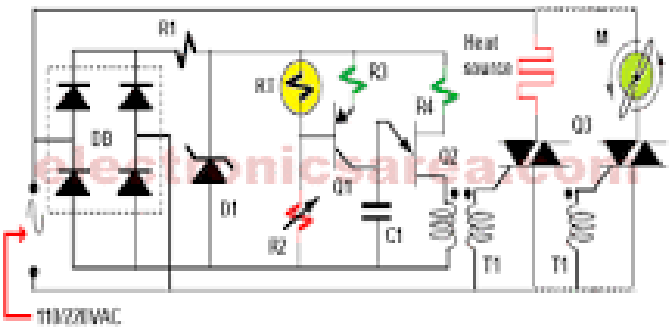


Diagram 5. Shows Triac use as Temperature Control

This heat control using thermistor and TRIAC circuit, is designed to control the temperature of a room, either by using a heat source such as an electric oven heating element or by using a fan or any cooling device.Feb 15, 2017.

A TRIAC circuit can control the temperature of a room by using a heat source, like an electric oven, or a cooling device, like a fan. The circuit uses a thermistor or thermal resistance to measure the room's temperature, which determines the conduction angle of the TRIAC.

Triacs are thyristors that act as switches for alternating current (AC). They are made up of two silicon controlled rectifiers (SCRs) that gate current flow in opposite directions. A small signal applied to the triac's gate terminal controls the switch.

Triacs control motor speed by varying the voltage applied to the motor. This is done by chopping out parts of the AC line's sinusoidal waveform. The average current flowing into the load can be controlled by applying a trigger at a specific phase angle of the AC.

Triacs offer good speed regulation and high efficiency compared to resistive speed control methods. (Electronics Area)

Triac is a semiconductor device primarily used to control alternating current (AC) circuits by acting as a bidirectional switch, meaning it can conduct current in both directions when triggered by a gate signal, making it ideal for applications like light dimmers, motor speed controllers, and other power control systems where AC power needs to be regulated.

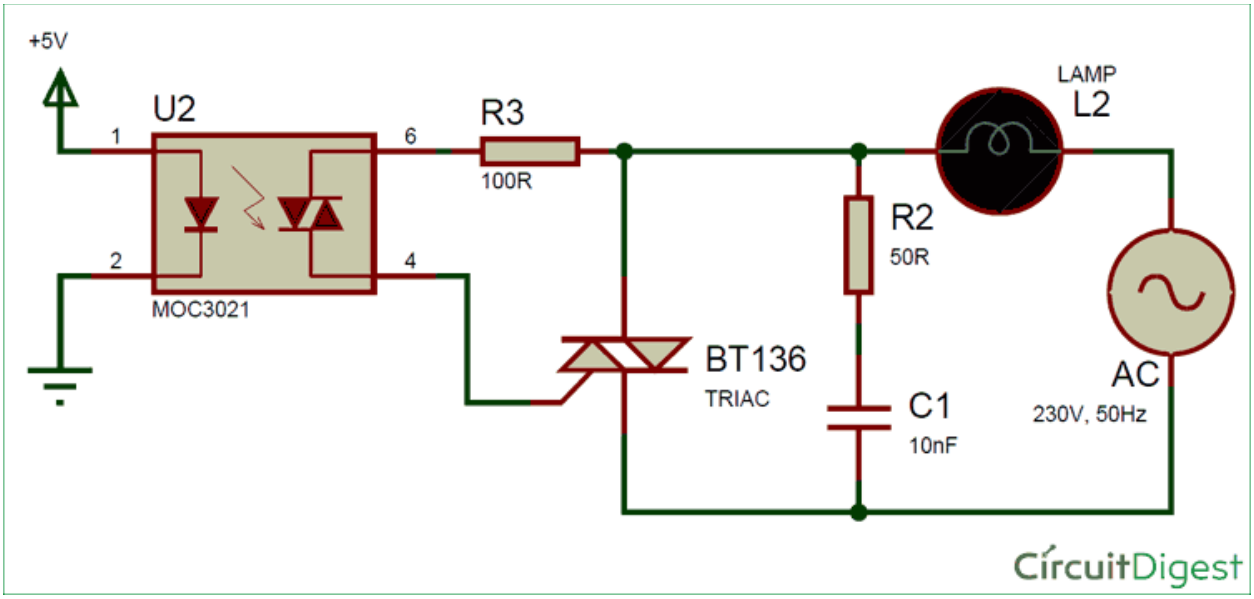


Diagram 6. Triac as AC circuits control

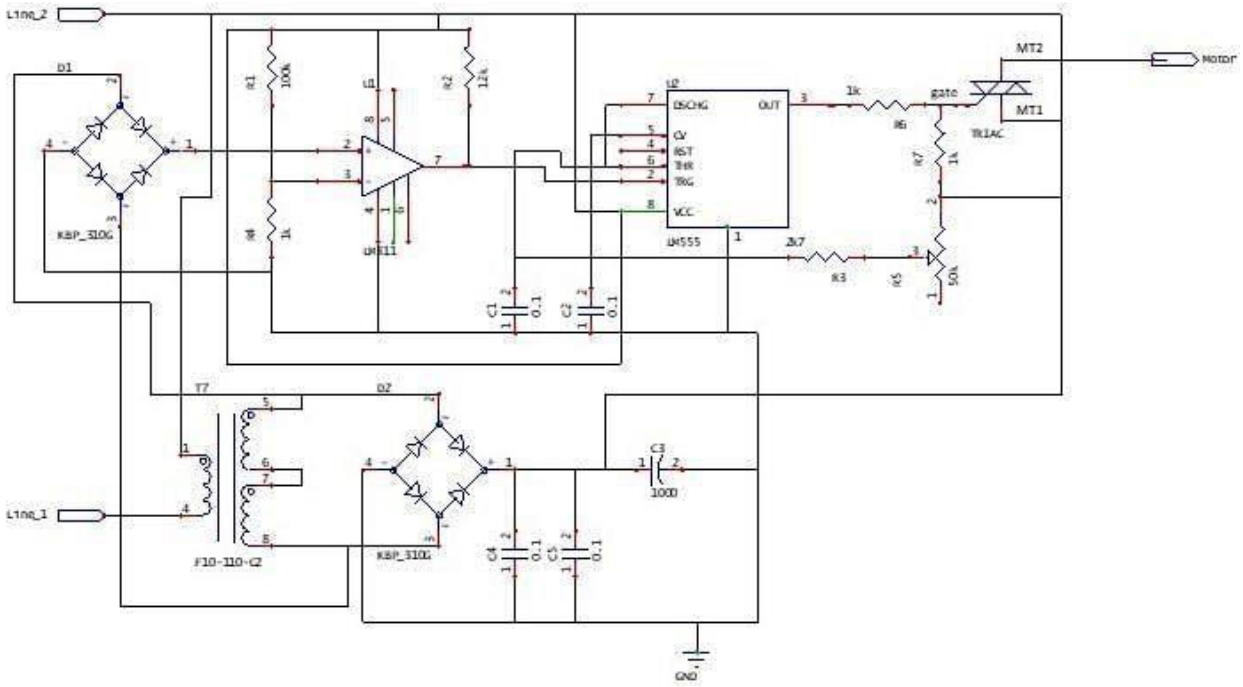


Diagram 7. Triacs used as Motor Controller

The Triac selected is a BTA216, which is rated for 600 V peak off-state voltage, a maximum continuous current of 16 A, and a peak current capability of 140 A to comfortably handle inductive load switching for motors. The 16 A of continuous current will allow the device to power any load that can be connected to a standard 120 V, 15 A circuit. The critical rate of rise is specified as at least 30 V/µs, so no snubber circuit should be required. The trigger voltage of the BTA216 is specified to be 1.5 V.

Some small signal driving electronics, consisting mainly of a comparator and an analog timer, controls the switch point in the sinusoidal waveform for gating the Triac, which determines how much of the AC wave to "chop out", thus varying the effective voltage to the motor and controlling its speed. A single potentiometer allows the speed control. The circuit schematic for this reference design is shown in Diagram 6. Triac as Motor Speed Control.

MOSFET - is a four terminal device. The voltage applied to the gate terminal determines if and how much current flows between the source and the drain ports. The body represents the fourth terminal of the transistor. Its function is secondary as it only serves to modulate the device characteristics and parameters.

When a voltage is applied to the gate that is larger than a given value called the threshold voltage V_T a conducting channel is formed between the drain and source. In the presence of a voltage difference between the latter two, current flows between them . The

conductivity of the channel is modulated b the gate and source, the smaller resistance of the conducting channel and the larger the current. (John M Rabaey, 1995)

MOSFETs or Metal Oxide Silicon Field Effect Transistors, were invented to overcome the disadvantages posed by FETs, such as the slow operation, high drain resistance, and moderate input impedance. In this article, let us learn about the basics of MOSFET. Below is the symbol of MOSFET and Basic Construction.

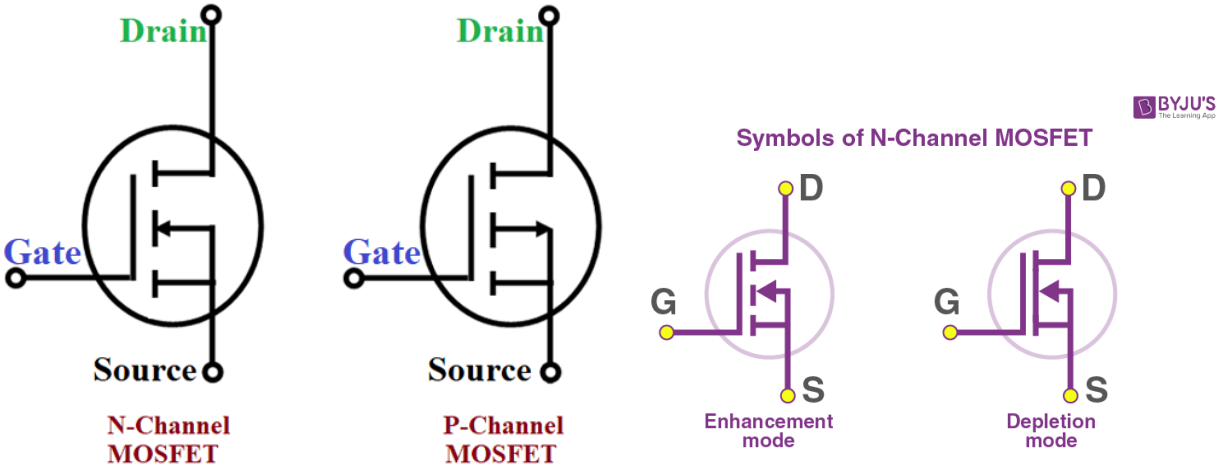


Diagram 8. MOSFET Symbols

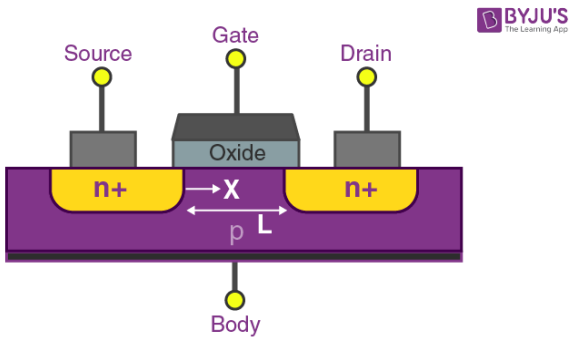


Diagram 9. MOSFET Construction

Sensors function to sense external quantities like LDR (Light Dependent Resistors). While actuators functions to control external quantities such as heat actuators, resistive heaters that output the dissipated power as heat. Bulb as light actuators, Light emitting diode and seven segment display. Liquid crystal display (LCDs) – consist of two sheets of polarized glass with a thin layer of oily liquid crystals sandwich between them. Solenoids – consists of an electrical coil and a ferromagnetic slug that can move into, or out of the coil. DC motors – are extensively used in precision position control systems and other electronic systems, particularly in low power application. Sound actuators such as speakers and ultrasonic transducer. Neil Storey (2006)

In Combinational Logic Circuit, Logic Gates are in five (5) Basic Types: AND, OR, NOR, NAND and Inverter. Diagram 10. shows Below.

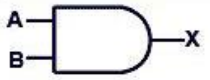
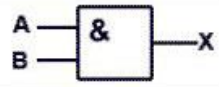
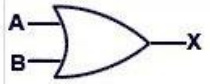
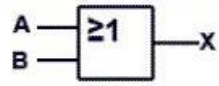
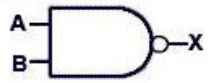
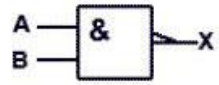
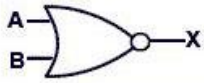
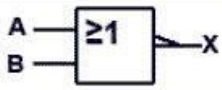
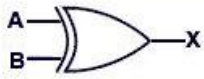
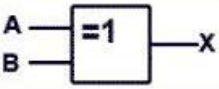
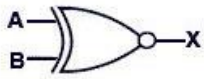
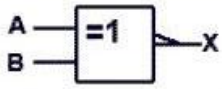
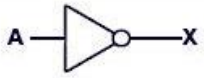
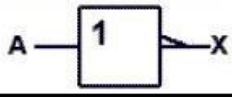
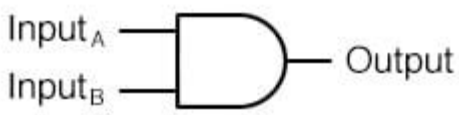
ANSI Symbol	IEC Symbol	NAME
		AND
		OR
		NAND
		NOR
		XOR
		XNOR
		NOT

Diagram 10. Digital IC symbol

AND Gate. The rule for an AND Gate is that it must have all of its inputs high in order to get an output. (Hernan, 2007). Sometimes called the “all or nothing gate”, it is a two switch in series. Switch A and Switch B for example to get the output lamp to light, both switches should be close. (Tokheim, 2008)

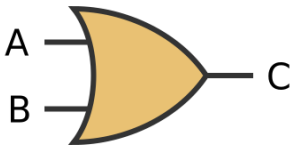
Below is the Truth Table.

2 - input AND gate



A	B	Output
0	0	0
0	1	0
1	0	0
1	1	1

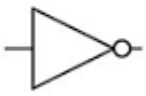
OR Gate – has a high output when either or both inputs are high; any 1 input a = 1 output. (Hernan, 2007). It is sometimes called the any or all gate". The output lamps will light when either or both of the input switches are closed but not when both are open. (Tokheim, 2008). Below is the Truth Table.



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

Inverter - If the input is high , the output is low, if th input is low, the output is high. (Hernan, 2007).

Inverter



Input	Output
0	1
1	0

NAND Gate – is an AND Gate followed by an inverter. Below is the Truth Table.

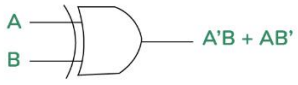
Q = A NAND B

Truth Table

Input A	Input B		Output Q
0	0		1
0	1		1
1	0		1
1	1		0

An XOR gate, which stands for "Exclusive OR", is a digital logic gate that outputs a "high" signal (typically represented as 1) only when exactly one of its two inputs is "high", meaning the inputs must be different to produce a high output; its symbol is typically depicted as a plus sign within a circle (⊕) and its function is to check if only one of two inputs is true, not both.

XOR Gate



Truth Table

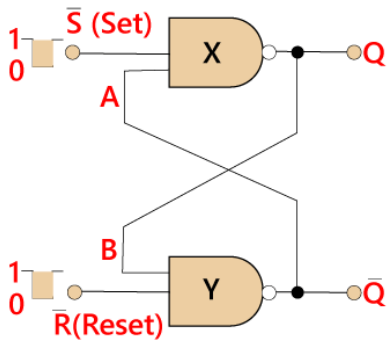
A (Input 1)	B (Input 2)	X = A'B + AB'
0	0	0
0	1	1
1	0	1
1	1	0

Decoder – is a multiple input, multiple output logic circuit that converts coded inputs into coded outputs where the input and output codes are different. (Wakerly, John F. 2002). A Digital Decoder has 2 n outputs and accepts n inputs. Only the output that corresponds to the binary numbers on the input lines is activated. Decoders are used in many digital circuits, they can be used to select memory addresses, and to decode instructions in a computer. Examples of Decoder are 74LS138. It is a 3 to 8 line decoder, it has 3 inputs and 8 outputs, 3 enable pins- two active lo and one active high. 74LS154 – 4 line to 16 line decoder, simply b trying both G inputs LOW. Then the output corresponding to the SELECT input is LOW and all other outputs are HIGH (Greenfield, Joseph 1994).

Sequential Logic Circuit

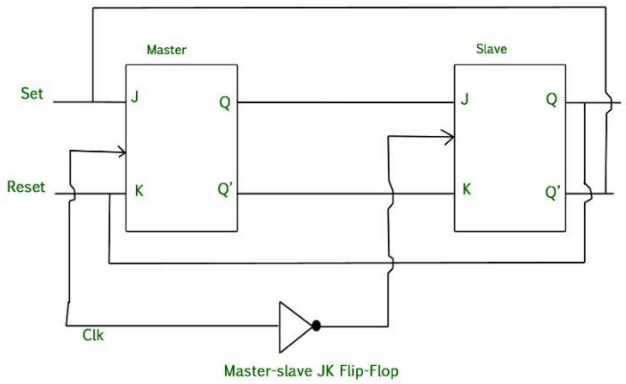
Flip Flop – is a binary storage device capable of storing one bit of information. Sequential circuits may use many flip flops to store as many bit as necessary. Flip Flops are classified as RC Flip Flops and Master Slave JK Flip Flops. (Wilson). Flip Flops are basically a bistable multivibrator whose output either a logic 1 or a logic 0. The Flip Flop is the simplest and widely used memory devices. Tirol Benjo U.(1995) Below are the circuit diagram of SR Flip Flop. It is constructed using 2 NAND Gates crossed coupled connection.

SR Flip Flop



Circuit

Master Slave JK Flip Flop



Master-slave JK Flip-Flop

One **flip-flop** acts as the "**Master**" **circuit**, which triggers on the leading edge of the clock pulse while the other acts as the "**Slave**" **circuit**, which triggers on the falling edge of the clock.

Unlike the JK Flip-flop, the basic S-R NAND flip-flop circuit has many advantages and uses in sequential logic circuits but it suffers from two basic switching problems.

- 1. the Set = 0 and Reset = 0 condition (S = R = 0) must always be avoided
- 2. if Set or Reset change state while the enable (EN) input is high the correct latching action may not occur

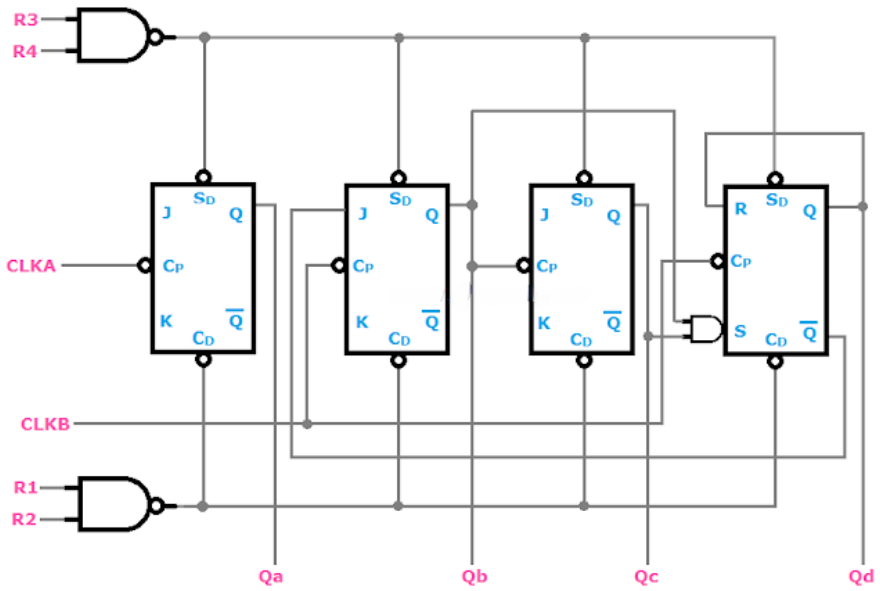
Then to overcome these two fundamental design problems with the SR flip-flop design, the JK flip Flop was developed. (Electronic Tutorials)

Counter

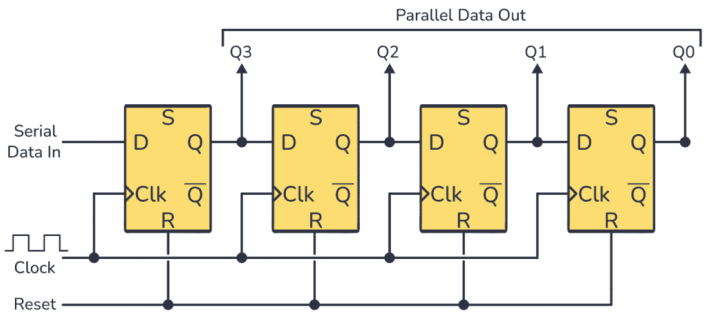
A counter is a device that tracts and stores the number of times an event or process has occurred. (Wikipedia). A counter is drive by a clock signal and can be used to count the number of clock cycles in a sequential circuit. There are types of counters namely ripple counter. An n bit binary counter can be constructed with just n flip flops and no other components. (Wakerly, 2002).

A counter is constructed by cascading multiple flip flops together where the output of each flip flop is connected to the clock input of the next allowing the circuit to count rising edge of a clock signal. Specific example is a Decade Counter, which counts ten different states and then reset to its initial states. A simple decade counter will count from 0 to 9. (Geeks for Geeks)

Below is a circuit diagram of 0 to 9 decade counter. It consist of 4 cascaded flip flops.



SHIFT REGISTERS – A shift register is comprised of a number of JK or D flip flops cascaded in a number of string so that on clocking, the contents contained in each stage are moved , or shifted, either one stage to the left or to the right. A simple shift register is shown below.



Shift Registers (4) Broad Categories –

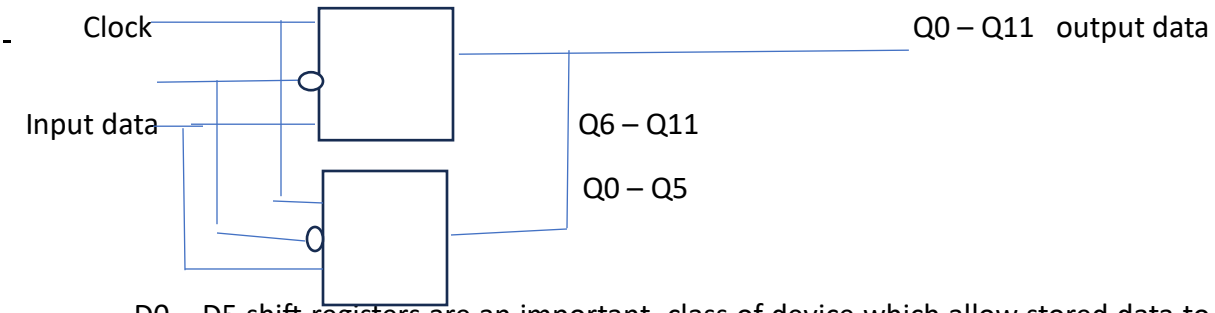
(a) Serial In Serial Out (SISO) :– Input data enter the shift register serially and the data are taken from the output lead in serial fashion delayed by a number of clock pulses equal to the number of storage cells.

(b) Serial In Parallel Out (SIPO): Input data enter the shift register serially but the data are taken from the output leads in a parallel fashion. This requires more than one output lead since the bits are read in groups of multiple bits. For example, if the bits represent a BCD code, the output bits are read in groupings of four to represent one BCD word.

(c) Parallel in Serial Out (PISO) : This type of shift register has the capability of loading the data in more parallel and shifting the data out serially. This register uses NAND gates and inverters with the flip flops to properlysequence the input data.

(d) Parallel in Parallel out (PIPO): This type of Parallel access shift register is considerablymore complex because of the additional gate that must be added. It can be thought of as a parallel combination of SISO shift registers. (Roden Martin S. 1982)

A 12 bit parallel input/ output register is easily constructed from two 6 bit SN74147 IC register by connecting the clock and clear inputs of the two ICs. Larger registers can be constructed by connecting several smaller registers shown below. (Yarbrough, John M.2001).



D0 – D5 shift registers are an important class of device which allow stored data to be moved from 1 bit position to another. To illustrate the principles Fig. 6 – 27 shows four D flip flops connected to form one type of shift register. Suppose that each flip flop has been reset so that the outputs Qa, Qb, Qc, Qd form the output word 0000.

If Da is set to logic 1, then the output after two clock pulses are as follows:

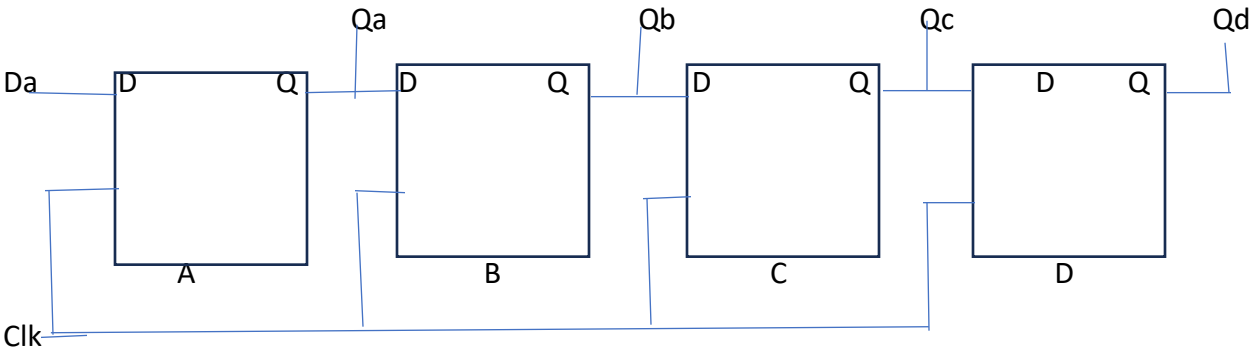


Fig 6.27 A 4 Bit shift register made from D type Flip flop

	Qa	Qb	Qc	Qd
Da 1- initial values	0	0	0	0
After Clock 1	1	0	0	0
After Clock 2	1	1	0	0

On the first clock edge a 1 was entered into the Qa position. On the next pulse, this 1 was shifted to Qb. And siince Da was still 1 a new 1 was loaded into Qa. Now suppose that on each clock edge, each bit of a data is shifted one place to the right.

	Qa	Qb	Qc	Qd
Da – 0 initial values	1	1	1	1
After clock 3	0	1	1	0
After clock 4	0	0	1	1
After clock 5	0	0	0	1
After clock 6	0	0	0	0

Data is lost from Qd positions.Since tha Da input is held at 0. The new data added to to Qa is a succession of 0s. (Crecraft, 2003).

Parallel in serial out shift register and the waveform for loading the binary number equivalent to 9 and shifting it out to the right. A flip flop has a 0 on the j input and 1 on the k input. This will cause the Q output of the A flip flop to go to 0 after the falling edge of the clock input. If the shift register was clocked four times, the Q output of all the flips flops will would be 0. And stay 0 until the shift register was broadsided loaded of parallel loade with a new binary number.

The Q outputs of the flip flops will not change as long as the parllel load input is 1, since this enables the NAND gates.

When the parallel load input falls to 0, the NAND gates are inhibited, and their outputs go to 1, because any 0 into a NAND Gate produces a 1 on the output. The shift register is now loaded with the binar number desired. The PRESET and CLEAR are 1, which means when the falling edge of the clock

occurs, the shift register will shift each bit right one place, shift out a 1 on the right. After 4 clock pulses, the number will be shifted out to the right, and the shift register will be empty or 0 and ready for a new number. (Bignel, 2007)

Definiton of Terms

Trainer – A Trainer gadget is a device or software that helps people train for a specific activity or skill. Trainers can be used for physical training such as exercise machines or for learning skills.

MOSFET - means metal oxide semiconductor field effect transistor is a type of field effect transistor most commonly fabricated by controlled oxidation of silicon. It has an insulated gate, the voltage of which determines the conductivity of the device.(Wikipedia)

Counter - In digital electronics is a circuit that records and displays the number of times an event occurs.

Digital IC - Found in computers, counters and other "electronic counting device". Processes binary numbers only 0 & 1.

Demultiplexer - take a single input line and fan it out to one of many output . (Greenfield, 1994)

Multiplexer - several input line to a single output (Greenfield, 1994) .

Register- Flip flops in Cascade . output of one flip flop is connected to the input of the next flip flop. (Morris Mano, 2002)

Flip Flops - A "flip-flop" is a circuit that can store a single bit of data (either a 0 or 1) and has two stable states, essentially acting as a basic memory element within a digital system, changing its state only when triggered by a clock pulse; it is considered a fundamental building block of sequential logic circuits.

Combinational Logic Circuit - A combinational logic circuit is a digital circuit that uses logic gates to produce outputs based on the current inputs. These circuits have no memory of previous inputs. It can perform mathematical operations .

Sequential Logic Circuit - A sequential logic circuit is a digital circuit that produces an output based on both the current input and the sequence of previous inputs. Sequential logic circuits are used in many digital devices, such as televisions.

Decoder - is a combinational logic circuit that takes a binary input code and converts it into a unique output signal.

AND Gate -An AND gate is a digital logic gate that produces an output signal when all of its inputs are active or true. The output is 1 only if all inputs are 1 . If one of the input is 0 the output is 0.

OR Gate - An OR gate is a digital logic gate that outputs a "true" signal when any of its inputs are "true". It's a fundamental component of digital electronics and is used in many electronic devices.

Shift Registers - A shift register is a digital circuit that stores and moves binary data in a sequential manner. It's made up of a chain of flip-flops that are connected by a clock signal. Register capable of shifting its binary information in one or both directions is called a shift register. The logical configuration of shift register consist of a chain of flip flops in cascade, with the output of one flip flop connected to the input of the next flip flop . All flip flops receive common clock pulses, which activate the shift from one stage to the next. Mano, Morris (2002)

Thyristor - a four-layered semiconductor rectifier in which the flow of current between two electrodes is triggered by a signal at a third electrode.

Breadboard - a board for making an experimental model of an electric circuit.

Logic Gates - A logic gate is a simple digital circuit that takes binary inputs and produces a binary output. They are the fundamental building blocks of digital systems, and are used in most electronic devices, such as smartphones and tablets.

Knowledge Gaps

This Trainer is different from other available trainer since it features dual trainer for industrial electronic trainer and digital IC Trainer. The connectors utilize a modified breadboard cut and measured and place in the output of the power supply . This trainer is furnished with circuit diagram for the students to follow and do their experiments. Other Trainer consists of pathcords, stackable from rear and both end, 4mm spring which are not sold in the local electronics store. Another Trainer consists of small binding post and small banana plug suited for the binding post which are not available in electronic stores. This trainer connectors are out of research as to what best connectors that occupy less space and has accuracy.

Addressing the Gap

As a mandatory function of a State University, Faculty should be involve in the research. Part of the research is to design a gadget that differs from the one existing. This project has a unique features namely on its connectors and dual functionality. Most of the Trainers commercially available are exclusive only for Digital IC Trainer. The Trainer of Analog and Digital IC are already existing, this trainer has different name and strategy as to its assembly and features. Other Trainer are machine fabricated that our school lacks the equipment and machine, so it's the Faculty to initiate by doing research, less expensive since the aluminum framing are out of TV antenna aluminum scraps. Some components are available and it needs to be put in an enclosure and that's the beginning of this Trainer conception. The inputs and outputs are modified breadboard parts. To eleborate further attach are the image of different digital Trainer. In the appendices. As observe in the picture of Digital IC Trainer most are using the Binding post as jacks while the connectors are binding post which accumulate bigger spaces and costly, unlike my gadget is only a solid wire connectors and modified breadboard. These features are not utilize with the commercial Digital Trainer.

Research Design and Methodology

The study utilize the project making of the descriptive method of research which aim to construct an Assembling Electronic and Digital IC Trainer. It involves planning, designing, constructing of the project following a procedure.

1st – experimentation on Gating Effect of SCR, Triac, MOSFET Motor Controller, Relay- LDR Night switch.

2nd – IC experimentation. Logic Gates experiment with their truth Table if it works The Digital IC experimented were 7400 – Quad 4 input NAND Gate, 7402 – Quad 4 input NOR Gate dual JK Flip Flop.

3rd – The 7432 – Encoder

4rth – The 7490 – 0 to 9 Decade Counter

5th – The 74194 shift Register IC and 74HC595 shift register IC.

<u>Circuit Assembly .</u>

a. 5 Volts Power Supply.
b. -12V , Gnd, +12 Volts Power Supply.
c. Clock generator circuit.
d. Digital and Logic circuit for experimenting Digital IC.
e. PCB Designing
f. Photomasking using masking Tape.

g. Etching – removing the design using Ferric Chloride.
h. PCB boring holes.
i. Mounting of components on the PCB.
j. Soldering the terminal leads of the component and #18 hook up wire.
k. Test the functionality of the circuit.

Enclosure Assembly -

a. Measuring aluminum tube to its desired length.
b. Cutting of alumum framing to the desired length.
c. Filing edges sharp edges of the aluminum after cutting.
d. Boring holes on the aluminum tube.
e. Joining of aluminum frame using stove bolts and blind rivets.
f. Forming of rectangular shape for switch mounting on hard plastic using small flat file.
g. Fasten switches using epoxy.
h. Cut inputs and outputs using breadboard.
i. Fasten inputs and outputs using epoxy.

Carrying Case Assembly

a. Cut the ½" plywood 2 pcs – 17" length and width 1"
b. Using wooden plane smooth the edges keep it straight.
c. Join the length(17") and width (1") using 1" nails and with wood glue.
d. Lay out plywood as the floor and cut.
e. With sand paper smooth the surface of the plywood ready for painting.
f. Measure the 1"X1" lumber and cut 17" X 1'
g. Join the finished dimensions and cover with ¼" plywood and paint.
h. After thoroughly dried attached the 2" pair hinges, hook, and door knob.

Refer to the pictorial drawing of the enclosure with the dimensions.

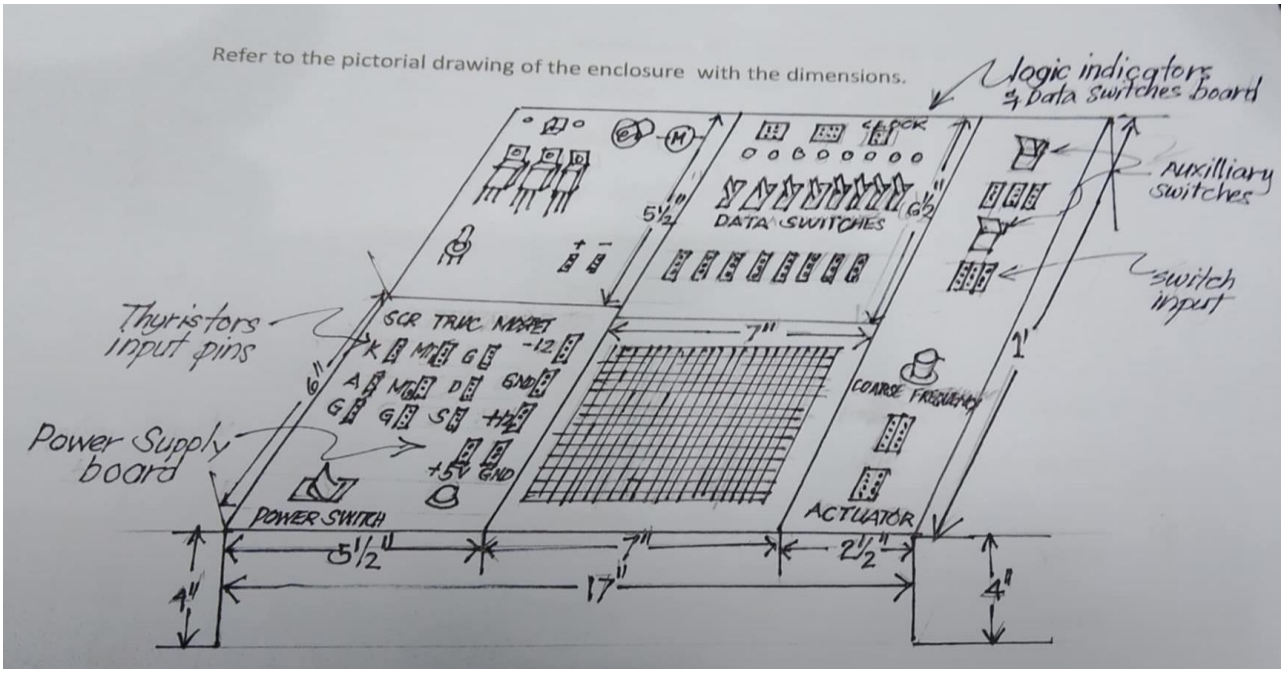


Figure 1. Dimensions of the aluminum framing of the Trainer and the divisions where circuits are mounted. The wirings are safely place at the bottom part of the enclosure.

Figure 2. Picture of the Modified Electronic and Digital IC Trainer with a carrying case.

It shows the experiment breadboard, data switches for experimenting logic gates, the right side shows the switches used for experimenting the SCR , Triac, MOSFETS, LDR, Relay , and the inputs for the actuator. The upper left side can be seen are the LDR, LED , Relay, with transparent accrelic board.

Supplies and Materials

Table I. Shows the estimated unit cost, description of the supplies and Materials used in the construction of the project.

Quantity	Unit	Material Description	Unit Cost	Total Cost
50	Pcs.	Resistors ¼ W	.50	Php 25.00
5	Pcs.	PCB 2X3”	Php 28.00	Php 140.00
1	Pc.	750mA Transformer 12 0 12V	160.00	160.00
10	Pcs.	Slide switch	7.50	75.00
1	Pc.	LM 350 T voltage regulator IC	198.00	198.00
2	Pcs.	74LS76 IC	150.00	300.00
2	Pcs.	CD 4013	48.00	96.00
2	Pcs.	Breadboard 6”	120.00	240.00
1	Pc.	LM318	98.00	98.00
30	Meters	Soldering lead	16.00	480.00
5	Pcs.	LM 555 IC	10.00	50.00
22	Meters	Hook up wire #18	16.00	352.00
14	Pcs.	Diode 1N4001	1.50	21.00
4	Pcs.	Electrolytic capacitor 1,000uf/16V	10.00	40.00
4	Pcs.	PCB 2X3”	24.00	96.00
3	Pcs.	Transistor 2N3904 2N3906	3.5	10.50
40	Pcs.	Stovebolt 1/8 X ½ “	.80	32.00
30	Pcs.	Blind rivet 1/8 X ½’	.50	15.00
2	Pcs.	Potentiometer mono (100 K)	12.00	24.00

1	Pc.	7812 voltage regulator IC	17.00	17.00
1	Pc.	7912 negative voltage regulator IC	20.00	20.00
1	Pc.	`7805 voltage regulator IC	20.00	20.00
2	Pcs.	Drillbit 2/64 “	13.00	26.00
13	Pcs.	LED (red)	3.80	49.4
1	Pc.	Machinist vise	951.00	951.00
1	Pc.	Flat file 4”	330.00	330.00
1	Pc.	Unistar file handle	45.00	45.00
1	Sachet	All purpose epoxy	77.00	77.00
1	Sachet	Epoxy durasteel plus 5	98.00	98.00
1	Pc.	Hacksaw blade Lennox	50.00	50.00
15	Pcs.	Bolt with nut 3 cm X 25	4.00	60.00
1	Pair	Hinges 2”	12.00	12.00
1	Pc.	Hook 2”	4.00	4.00
1	Pc.	Handle	50.00	50.00
1	sheet	sandpaper	18.00	18.00.
2	pcs.	1x1x6” lumber	42.00	84.00
1	Pc.	Stickwel 250 g. wood glue	65.00	65.00

Total : Php 4, 332. 90

Financial Requirements:

A.	Total Cost of Supplies and Materials	Php 4,332.90
B.	Honorarium for the researcher	2,000.00
C.	Miscellaneous (Bondpaper, Printing, Gasoline)	1,000.00
	Overall Cost=	7,332.90

2. Tools and Equipment and their Function

Tools and Equipment	**Function**
Long nose pliers	Use to hold screws in a confine spaces.
Diagonal Cutting Pliers	Cutting and stripping wire insulator
Soldering iron	Use to join component terminal in the PCB
Hack Saw with Blade	Use to cut pieces of aluminum, or plastic.
Electric drill	Use to bore holes in the PCB, plastic chassis for mounting switches, neon lamps etc.
¼ drill bit, 1/8, ¼ drill bit	Driven by electric drill where bolts and nuts, rivets are fasten.
Hand Riveter	Use to join aluminum framing for the enclosure.
Flat File 4”	Use to shape rectangle holes fro switch mounting either aluminum or plastic.
Round File 1/8 – ½ “	Use to shape round holes in plastic casing for mounting of fuse and potentiometer.
Machinest vise	Use to hold aluminum for cutting in vertical position.
C Clamp	Use to hold aluminum for cutting in horizontal position.
Philip screw driver	Use to drive philips (+) screw driver
Flat Head screw driver	Use to drive flat (-) screws.
Multi Tester	Used to measure contiuity in the cicuit, voltage , electronics component testing.

Construction Time Frame

Activities	Weeks						
	1	2	3	4	5	6	7
A. Planning & Designing							
B. Analysis & signal Tracing							
C. PCB Designing							
D. Circuit Assembly							
E. Enclosure Assembly							
F. Testing & Revising							
						Total	32 Weeks

Findings and Results

The functionality of the Trainer was done by experimenting digital IC both Combinational and Sequential Logic IC. Among the Digital IC's experimented was the Logic Gates namely: 7408 Quad 4 input AND Gates, 74 LS 86 XOR Gat (e, 74LS32 (OR Gate) , CD4011 NAND Gate by showing their Truth Table Value using this Trainer.

Aside from Logic Gates, I also experimented the sequential Logic IC like the CD4013 D Flip Flop IC and the CD4017 Decade Counter IC and succesful result was obtained. The heart of the sequential Logic circuit is the clock generator. I done a lot of experiments on Clock Generator Circuit and failed, however I come up to a simple clock generator circuit that is responsible in testing sequential logic IC.

On Electronic Experiment was the Triac Gating Effect, SRC Gating Effect and MOSFET as a switch.

IV. Results and Discussions.

The following truth Table for Logic Gates was proven using this Trainer.

74LS08 (Quad AND Gate)

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

74LS86 (X OR Gate)

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

CD 4011 (Quad 2 input NAND gates)

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

74LS32

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

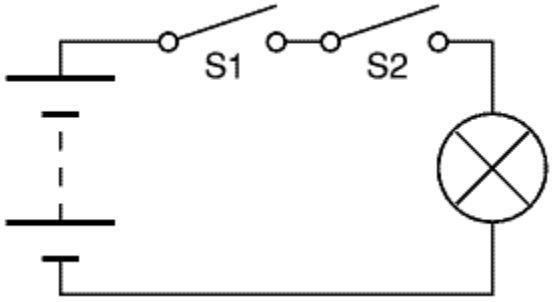
For the sequential logic circuit , first is the flip flop using CD4013 were experimented and the Trainer provides accurate result that a flip flop is a bistable state, meaning it has two outputs X and negated X or $\overline{X}$. X means 1 while negated X means 0. Flip Flops will ony operates upon the application of clock pulse.

On the electronic Trainer it shows how the SCR and TRIAC differs. With the output using bulbs, the SCR triggers only the positive triggering voltage, while the TRIAC cab be triggered whether the triggering voltage is positive or negative and these proves that the SCR is unidirectional while TRIAC is bidirectional switching thyristor.

On Electronic Experiment was the Triac Gating Effect, SRC Gating Effect and MOSFET as a switch. The MOSFET can be controlled by only touching the gate and the motor rotates. To stop the rotation is short the gate to ground. Another circuit involves in this trainer is the LDR (Light Dependent Resistor and Relay combination. LDR is a component which works on light and Relay is a switching device by means of magnetic field.

Discussion

Based on the findings of the Truth Table as illustrated for 7408 it is a two switch connected in series. That if 1 switch is open current cannot flow.



For CD4011, if both inputs are 0 or either of the inputs has 1 it yields 1. But if both inputs are high, the output is 0. CD4011 is a NAND Gate integrated circuit (IC) that has a multiple functions, including pulse circuitry design and generating timed signals.

For 74LS86, if the inputs has 1 and 0 the output is 1. But if the inputs are both 0 or both 1, the output is zero. X OR gate functions by producing a high output only when its inputs are different meaning it outputs a 1 if one input is 0 and the other is 1 and the outputs a 0 if both inputs are the same either (0 or 1) essentially acting like a “either/ or “ logic making it usefula for applications like error detection, parity checking, simple binary addition and basic encryptio due to its ability to “toggle” between states based on differing inputs. (google.com/search q. functions of XOR gate)

For 74LS32 is applied in constructing various basic logic gate circuits, such as encoders, decoders. Additionally it is implemented in more intricate set ups like, multiplexers, demultiplexers, oscillator circuits. (google.com/ search q= functions + of+ 74LS32).

The CD4011 is a quad 2-input NAND gate integrated circuit (IC) that has the following functions:

- **Pulse-driving circuits**: The CD4011 can be used to design pulse-driving circuits that generate timed signals for electronic systems.
- **High gain**: The CD4011's buffered inputs and outputs provide high gain, which improves transfer characteristics.
- **Detecting low inputs**: The CD4011 can detect if a single input to a digital system has gone low. (google. Com/ search?q=functions +of+74LS32)

The CD4017 is a decade counter integrated circuit (IC) that counts from 0 to 10 and decodes the output into decimal numbers. It has a variety of functions, including:

- **Counting**: The CD4017 counts up by one for each rising clock pulse. When it reaches 9, it starts over at 0.
- **Decoding**: The CD4017 decodes the output into decimal numbers.
- **Clock enable**: The CD4017 has a clock enable pin that controls whether the counter counts through all 10 outputs or pauses at the current output.
- **Reset**: The CD4017 has a reset pin that can be used to limit the number of counts. For example, to make the counter count to 5 instead of 10, the reset pin can be connected to the counter's pin 1.
- **Anti-lock strobe**: The CD4017 has an anti-lock strobe that ensures the counter counts in the correct sequence.

CO signal: The CD4017's CO signal completes a carry every 10 clock input cycles.

(Google.com/ search? Q = Functions + of + CD4017)

Conclusion

Therefore, I conclude that this Trainer is of great help to the Comp. Tech and Electronic Students because they have less time usually 1 hour for project making as a vehicle of instruction thereby as an alternative is to perform experiment with the presence of this Trainer. In a

classroom, sharing of knowledge can be accomplished through lecture and hands on and this can be provided using this Trainer. Learning is interesting once it is accompanied with hands on and cognitive and skills development will be achieve.

The cost of this Trainer compared to the commercially available is one fourth. Based on the fact, some Digital Trainer cost Php 10,000 to Php25,000.00, but this Trainer amounts only to Php5,000.00. Several Activity can be perform through this Trainer. If it will be failed, the circuit can be freely open to allow repairing. Moreover, the parts included are commercially available in the local electronics store, unlike the commercial available.

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https:// www. Electronics – tutorials.ws> sequential . seq. 2

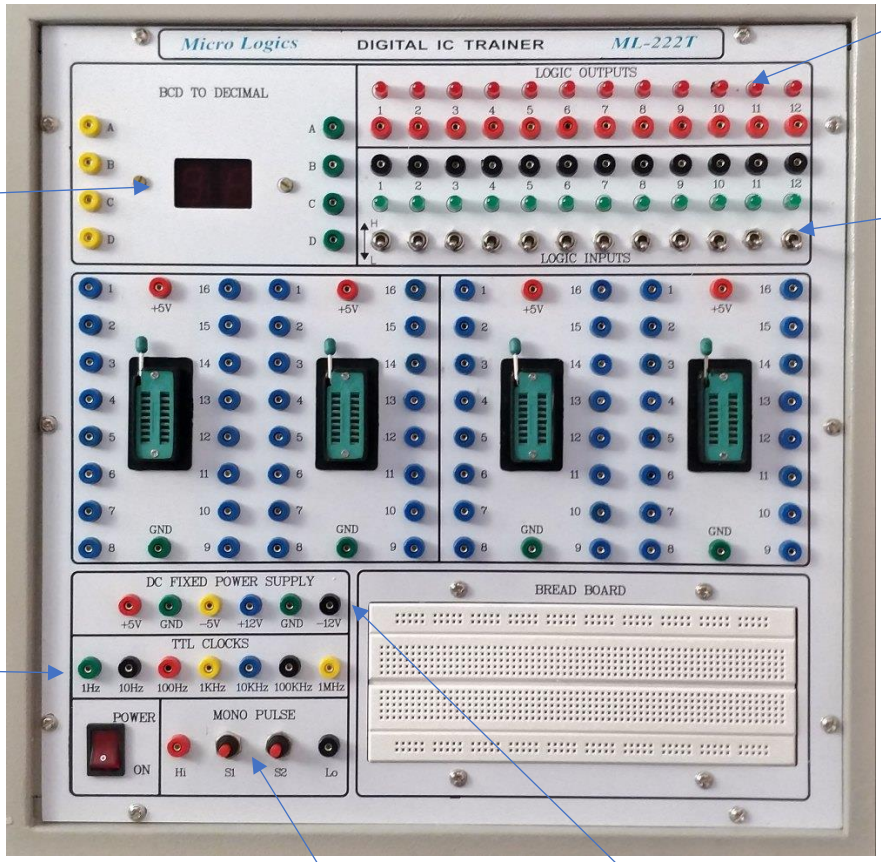
google.com/ search q= function + of +XOR + Gate &gs

google.com/search? Q= functions + of + 74LS 32

google. Com/ search? q= shift+register+definition+in+ digital+ electronics

APPENDICES

PICTURES OF COMMERCIALLY AVAILABLE DIGITAL TRAINER



Logic outputs

Digital IC Trainer - manufacturer Micro Logics

Features of a Trainer

Mono Pulse

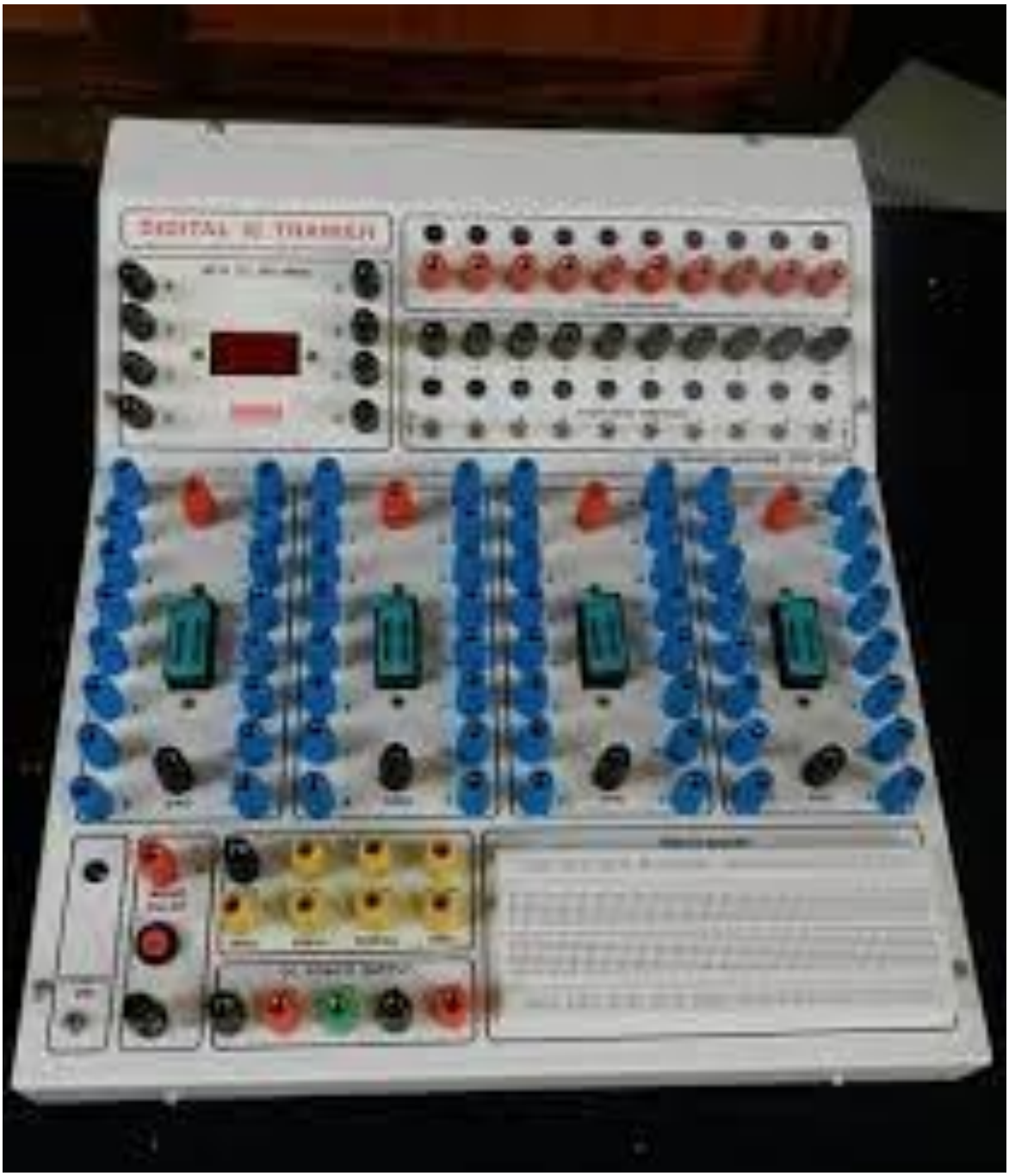
DC Fixed Power Supply

Logic inputs

TTL Clocks

+5V GND +12V GND -12V

BCD to Decimal 7 segment display



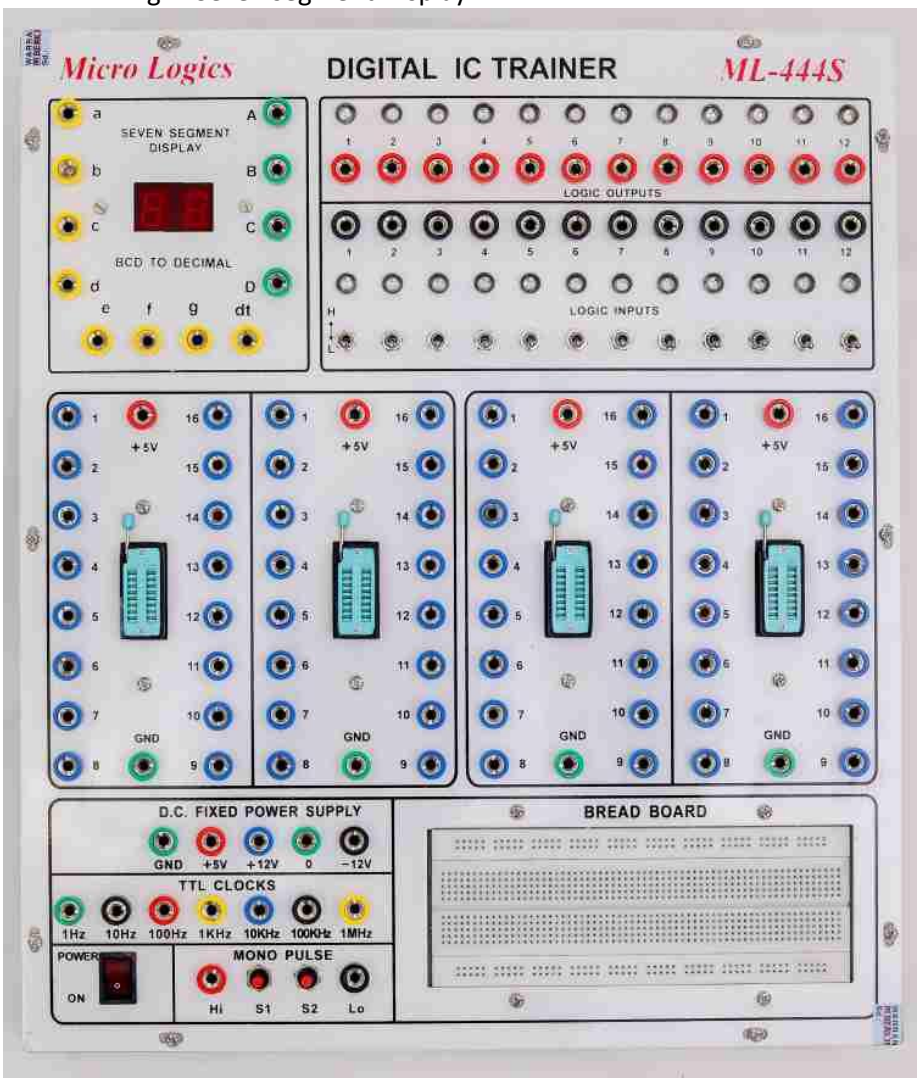
Features of a Digital Trainer

The same as Trainer above , most of Digital Trainer has the following features:

a. Built in IC mounted on the board with terminal output pins for experimentation. Logic Gates IC such as 74LS00.

b. DC output power supply -12V and + 12V and GND. DC power supply GND & +5V.

c. Logic outputs
d. Logic Inputs
e. Counter IC mounted on the board such as 74LS90 with terminal outputs.
f. Flip Flop IC mounted on the board such as 74LS74 with terminal outputs.
g. Seven segment Display



Digital IC Trainer – Model ML- 444S - Manufacturer – Micro Logics

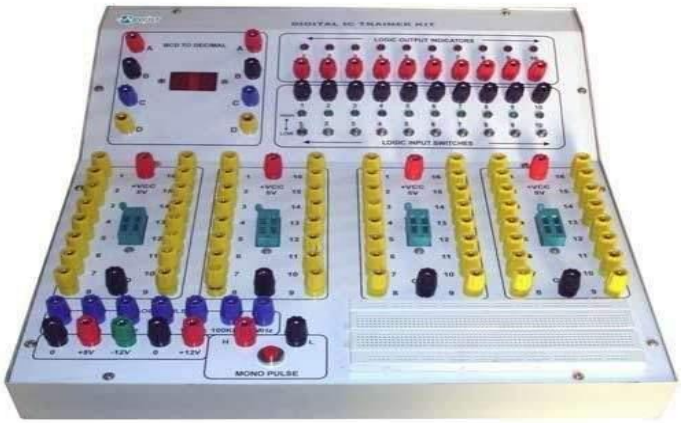
This Trainer features the following:

a. DC Fixed Power supply – GND, +5V, +12V 0 -12V h.breadboard
b. TTL clocks
c. Mono Pulse
d. Logic Outputs
e. Logic inputs
f. IC mounted on the board with terminal inputs.
g. 7 Segmant Display

This Trainer features :

a. IC electronic components mounted on the board where the terminal outputs colored yellow, has + (positive) terminals colored red and - (negative) terminals colored black **.**

b. 7 segment display with input terminals.
c. Power Supply = +5V, GND -12V GND +12V
d. Mono pulse
e. Logic input and output



This Trainer features:

a. No IC mounted on the board., but it has a clock and pulse generator.
b. Clock generator
c. Pulse generator
d. 7 segment display
e. Pulse Selector
f. logic indicators
g. Logic indicators