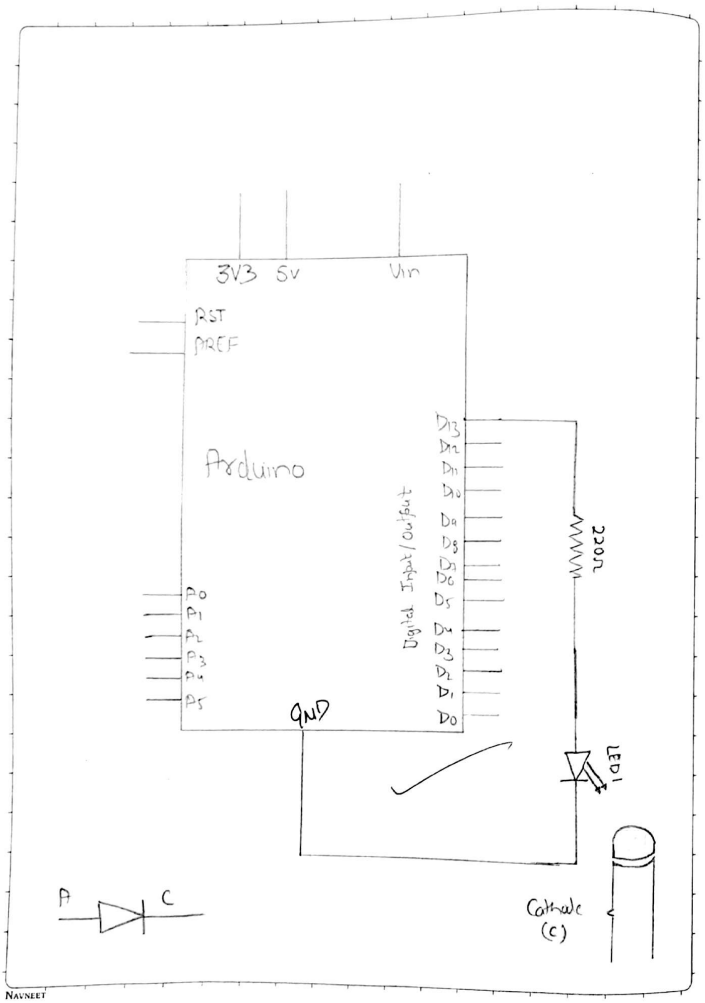


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# Assignment-1

→ **Exercise 1 :- Blink**

This example shows the simplest thing you can do with an Arduino to see physical output : it blinks a light-emitting diode (LED)

→ **Hardware Required :-** 1) Arduino Board
2) LED and the Resistor

→ **Circuit :-** To build the circuit, attach a 440-ohm resistor to either leg of diode. Attach the leg of the LED connected to the flat edge of the body (the negative leg, called the cathode) to ground. Connect the remaining leg (the positive leg, called the anode) to pin 13. Then plug your Arduino board into your computer, start the Arduino program, and select the example code given at the link2.

→ **Code :-**

```
Void setup ()
{
  pinMode (13, OUTPUT) ; // To select pin number
}
```

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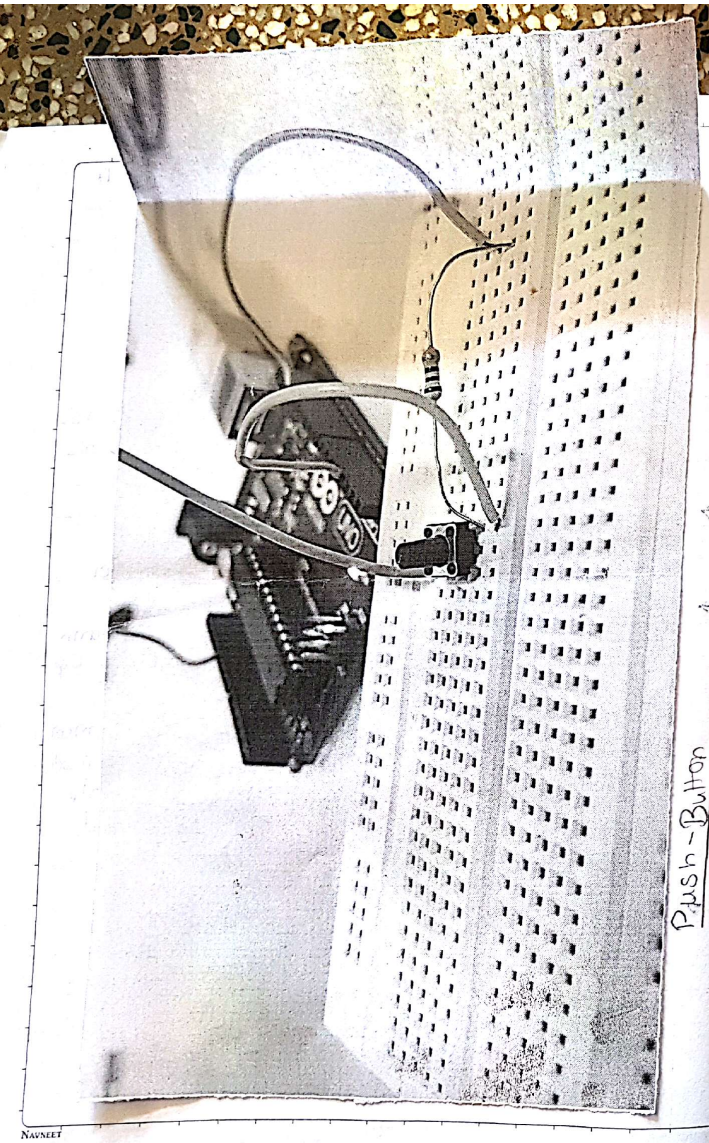

Push-Button

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```
Void loop ()
{
  digitalWrite (13, HIGH);  // Makes LED ON
  delay (1000);  // Gives delay of 1000 millisecond
  digitalWrite (13, LOW);  // Turns off LED
  delay (1000);
}
```

→ Exercise 2 :- Button:

Pushbuttons or switches connect two points in a circuit when you press them. This example turns on the built-in LED on pin 13 when you press the button.

→ Hardware :- 1) Arduino Board
2) Momentary button or switch
3) 10 K ohm resistor
4) Breadboard
5) Hook-up wire

→ Circuit :- Connect 3 wires to the Arduino board. The 1st two red and black, connect to the two long vertical rows on the side of the breadboard to provide access to the 5 volt supply and ground.

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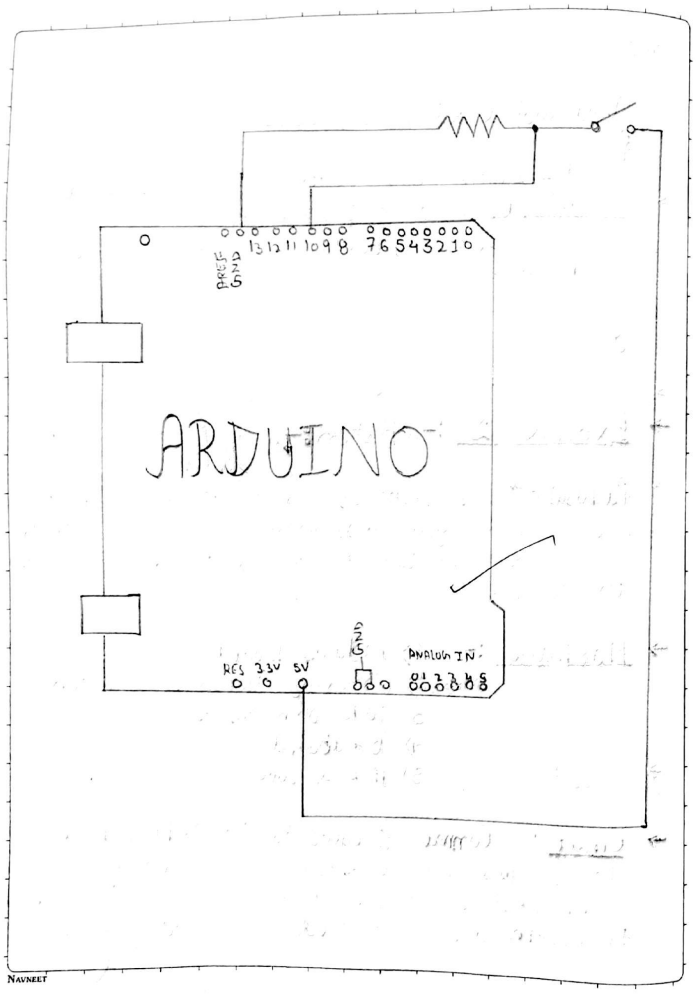


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The 3rd wire goes from digital pin 10 to one leg of the pushbutton. That same leg of the button connects through a pull-down resistor (here 10 KΩ) to ground. The other leg of the button connects to the 5 volt supply.

When the pushbutton is open (unpressed) there is no connection b/w the two legs of the pushbutton so the pin is connected to the ground (through the pull-down resistor) and we read a LOW. When the button is closed (pressed), it makes a connection b/w its two legs, connecting the pin to 5 volt, so that we read a HIGH.

You can also write this circuit in opp. way, with a pullup resistor keeping the input HIGH, and going LOW when the button is pressed. If so, the behaviour of the sketch will be reversed, with the LED normally on & turning off when you press the button.

If you disconnect the digital i/o pin from everything, the LED may blink erratically. This is because the input is 'floating' - that is, it will randomly return either HIGH or LOW. That's why you need a pull-up or pull-down resistor in the circuit.

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→ Code :-

```
Const int buttonPin = 2 ;
Const int ledPin = 13 ;
      int buttonState = 0 ;

Void setup ( )
{
    pinMode ( ledPin , OUTPUT ) ;
    pinMode ( button, INPUT ) ;
}

Void loop ( )
{
    buttonState = digitalRead ( buttonPin );

  If ( buttonState == HIGH )
  { digitalWrite ( ledPin, HIGH ) ;
  }
  Else
  { digitalWrite (ledPin, low) ;
  }
}
```

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→ Assignment Task

1) Change the amount of time the LED is of 2 sec & leaving the amount of time LED is on at 1 sec ?

Ans:-

```
Void setup()
{
  pinMode(13, OUTPUT);
}
void loop()
{
  digitalWrite(13, HIGH);
  delay(1000);
  digitalWrite(13, LOW);
  delay(2000);
}
```

2) Change the pin to which the LED is connect from pin 13 to pin 2

Ans:-

```
Void setup()
{
  pinMode(2, OUTPUT);
}
Void loop()
{
  digitalWrite(2, HIGH);
  delay(1000);
```

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```
    digitalWrite (2, LOW);
    delay (1000);
}
```

3) Hook up 8 LEDs to pin 2 through 9 (with resistor, of course) Modify the code to turn on each one in order & then extinguish them in order.

Ans:-

```
void setup()
{
  pinMode (2, OUTPUT);
  pinMode (3, OUTPUT);
  pinMode (4, OUTPUT);
  pinMode (5, OUTPUT);
  pinMode (6, OUTPUT);
  pinMode (7, OUTPUT);
  pinMode (8, OUTPUT);
  pinMode (9, OUTPUT);
}

void loop ()
{
  digitalWrite (2, HIGH);
  delay (1000);
  digitalWrite (2, LOW);
  delay (7000);
```

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```
digitalWrite (3, HIGH);
delay(1000);
digitalWrite ( 3, Low);
delay ( 6000);
digitalWrite ( 4, HIGH);
delay (1000);
digitalWrite ( 4, Low);
delay (5000);
digitalWrite ( 5, HIGH);
delay (1000);
digitalWrite (5, Low);
delay (4000);
digitalWrite ( 6, HIGH);
delay (1000);
digitalWrite ( 6, Low);
delay (3000);
digitalWrite ( 7, HIGH);
delay (1000);
digitalWrite (7, Low);
delay (2000);
digitalWrite ( 8, HIGH);
delay (1000);
digitalWrite ( 8, Low)
delay (1000);
digitalWrite ( 9, HIGH);
delay (1000);
digitalWrite (9, Low);
delay (0);
}
```

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## Assignment - 2
### Digits on 7-segment display

→ **Exercise - 1** :- Write a Arduino program to make an integer up counter i.e 0 to 9 and repeat it infinitely. Display the digits using BCD code on 7-segment display on digital trainer kit.

→ **Hardware** :- 1) Digital Trainer Kit
2) Arduino Board
3) Single core connecting wire.

→ **Theory** :- The decoder [CD4543] is a combinational digital circuit that decodes an 4-bit binary input in the range 0000 - 1001 (BCD) in to its corresponding decimal level. Example for the binary value 0101 we need to display 5. Hence the decoder will output a HIGH on segments (a, c, d, f & g) with output a Low on segment (b and e). The latch signal is normally connected to 5V via 10 K ohm resistor as per circuit diagram. This allow the decoder to decode the present binary input. When the latch is connected to 0V via the jumper provided, its logic state changes to a Low & the decoder will decode the binary input prior to the latch going low.

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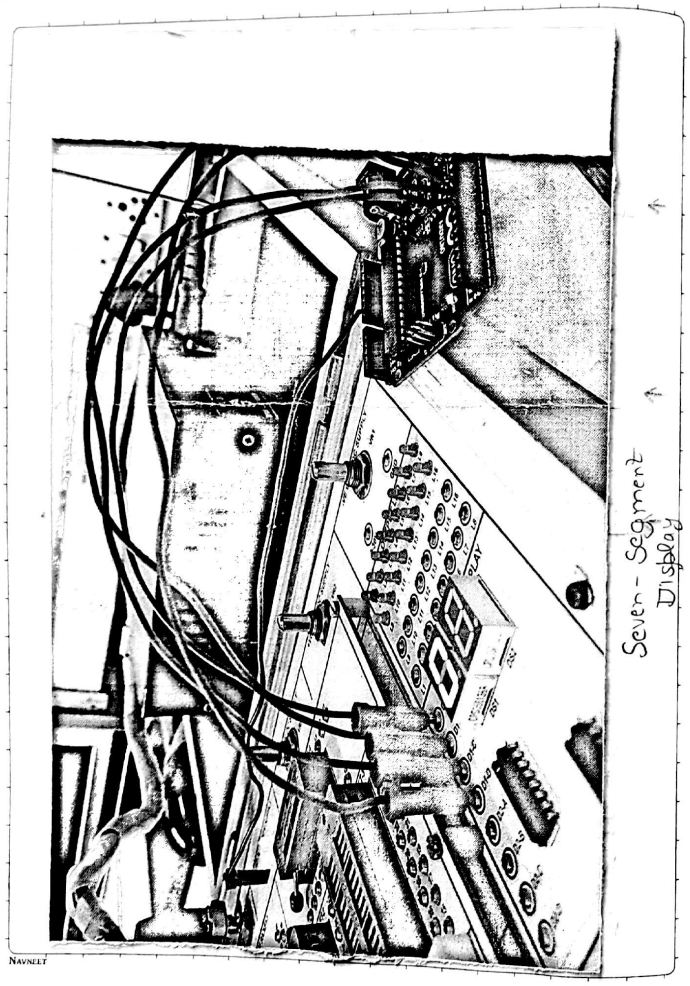

Seven - Segment Display

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→ Source Code :-

```
Void setup()
{
    pinMode (1, OUTPUT);
    pinMode (2, OUTPUT);
    pinMode (3, OUTPUT);
    pinMode (4, OUTPUT);
}
  Void loop()
{
  int i, a, b, c, d;
For (i= 0; i< 10; i++)
{
    a = i % 2;
    b = (i/2) % 2;
    c = (i/4) % 2;
    d = (i/8) % 2;

  digitalWrite (1, a);
  digitalWrite (2, b);
  digitalWrite (3, c);
  digitalWrite (4, d);
  delay (1000);
  }
}
```

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→ Exercise 2 :- Write a Arduino program to make an integer up counter i.e 00 to 99 & repeat infinitely

→ Hardware :- 1) Digital Trainker kit
2) Arduino board
3) Single Core Connecting wire

→ Theory :- The BCD is a combinational digital circuit that decodes 4 bit binary input in the range 0000 - 1001 to its corresponding value. So by using 2 of the 7 segment display we can make up a counter till 99 using the same method but a bit different code. Whereas, Arduino is the device which is used to convert the software instruction to the hardware as per our instruction & arduino acts as a medium b/w the two.

→ Source Code :-

```
void setup()
{
  pinMode (1, OUTPUT);
  pinMode (2, OUTPUT);
  pinMode (3, OUTPUT);
  pinMode (4, OUTPUT);
  pinMode (5, OUTPUT);
  pinMode (6, OUTPUT);
```

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```
    pinMode (7, OUTPUT);
    pinMode (8, OUTPUT);
}

void loop()
{
int i, a, b, c, d, j, e, f, g, h;
for (j=0; j<10; j++)
{
    e = j%2;
    f = (j/2)%2;
    g = (j/4)%2;
    h = (j/8)%2;

digitalWrite (1, e);
digitalWrite (2, f);
digitalWrite (3, g);
digitalWrite (4, h);

for (i=0; i<10; i++)
{
    a = i%2;
    b = (i/2)%2;
    c = (i/4)%2;
    d = (i/8)%2;
```

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```
        digitalWrite (5, a);
        digitalWrite (6, b);
        digitalWrite (7, c);
        digitalWrite (8, d);
        delay (1000);
      }
    }
  }
```

→ Assignment Task :-

```
void setup ()
{
  pinMode (4, OUTPUT);
  pinMode (5, OUTPUT);
  pinMode (6, OUTPUT);
  pinMode (7, OUTPUT);
  pinMode (8, OUTPUT);
  pinMode (9, OUTPUT);
  pinMode (10, OUTPUT);
  pinMode (11, OUTPUT);
}

void loop ()
{
  int a, b, c, d, e, f, g, h, i, j, k, l;
```

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```
a = 12345;

b = a/1000;   // 12
c = b/10;     // 1
d = b%10;     // 2

e = c%2
f = (c/2)%2;
g = (c/4)%2;
h = (c/8)%2;

i = d%2;
j = (d/2)%2;
k = (d/4)%2;
l = (d/4)%2;

digitalWrite (4,e);
digitalWrite (5,f);
digitalWrite (6,g);
digitalWrite (7,h);
digitalWrite (8,i);
digitalWrite (9,j);
digitalWrite (10,k);
digitalWrite (11,l);
}
```

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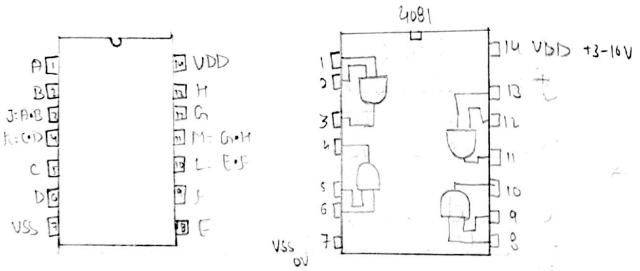
Aim:- To verify the function tables of CD 4027 & CD 4081 IC's

Hardware Required :- 1) Digital Trainer kit
2) CD 4027 & CD 4081
3) Single core connecting wires.




Data sheet of 4091

| Input 1 | Input 2 | Output |
|---|---|---|
| 0 | 0 | 0 |
| 1 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 1 | 1 |

Function Table of 4091

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# Assignment - 3

## AND Gate, J-K Flip Flop

→ Exercise - 1 :- To verify the function tables of CD4027 and CD4081 ICs.

→ Hardware Required :- 1) Digital Trainers Kit
2) CD4027 and CD4081
3) Single core connecting wires.

→ Theory :-

• CD4081 - Quad 2-In AND Gate

The CD4081 quad gate is a monolithic complementary MOS[CMOS] integrated circuit constructed with N- & P- channel enhancement mode transistor. They have equal source and sink current capabilities and conform to standard B series output drive. The devices also have buffered outputs which improve transfer characteristics by providing a very high gain. All inputs protected against static discharge with diodes to VDD and Vss. It has 14 pins in total. 7 on each side.

VDD at pin 14 and Vss is at pin 7.

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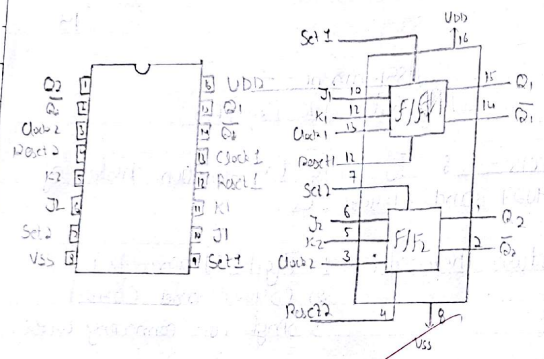


Datasheet of 4027

| J | K | Clock | S | R | Q | $\bar{Q}$ |
|---|---|---|---|---|---|---|
| X | X | X | L | H | L | H |
| X | X | X | H | L | H | L |
| X | X | X | H | H | H | H |
| L | H | ↑ | L | L | L | H |
| H | L | ↑ | L | L | H | L |
| L | L | ↑ | L | L | No change | |
| H | L | ↑ | L | L | Toggle | |

Function Table of CD4027

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→ Circuit :- The voltage was provided to the IC by connecting it to 5V supply, the connection was made at 14 pin, which was VDD. The IC was grounded, by using pin 7, ie Vss. The input slots for IA & IB were connected to the inputs. Input A, connected to the pin 1, Input B, connected to the pin 2. The output is taken from pin 3, which is connected to the LED. By changing the input inputs of A & B the functioning of AND gate is verified.

• CD4027 - Dual J-K Master/Slave Flip-Flop with set and reset.

The CD4027 dual J-K flip-flops are monolithic complementary MOS [CMOS] integrated circuits constructed with N- and P- channel enhancement mode transistor. Each flip-flop has independent J, K, set, reset and clock inputs and buffered Q & $\bar{Q}$ outputs. These flip-flops are edge sensitive to clock input and change state on the +ve-going transition of the clock pulses. Set or reset is independent of the clock and is accomplished by a high level on the respective input. All inputs are protected against damage due to static discharge by diode clamps to VDD & Vss. It is a 16 pin IC. 8 on each side.

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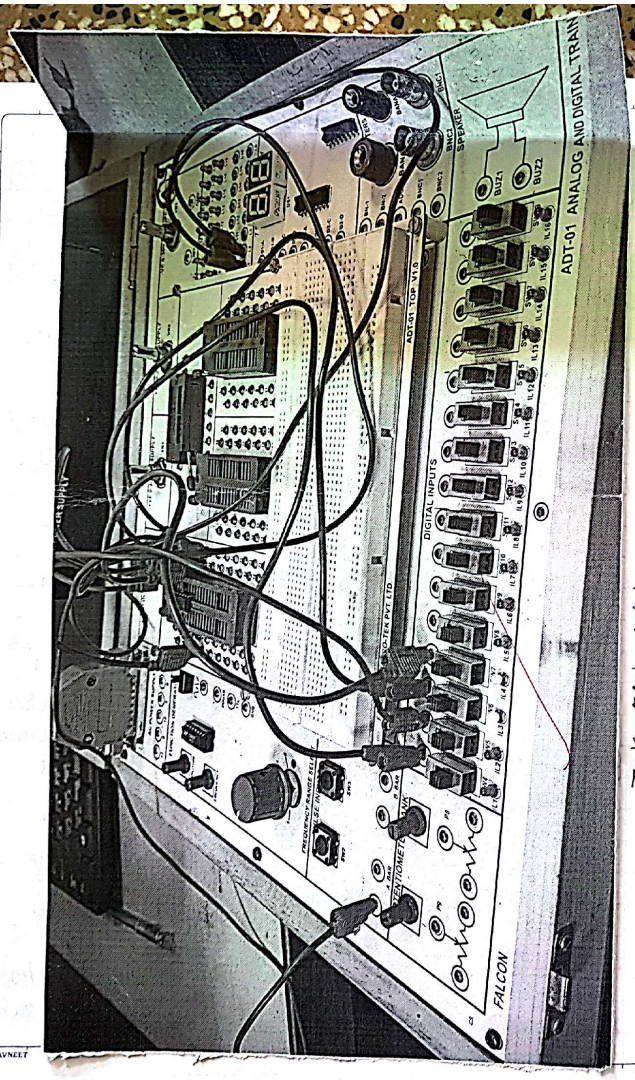


J-K flip-flop

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→ Circuit :→ The voltage/power was provided to the IC by connecting it to 5V supply, the connection ~~was~~ made at 16 pin, which is VDD. The IC is grounded, by using pin 8, ie Vss. The Q & $\bar{Q}$ are taken from the pin 1 & 2. Clock is connected in pin 3. Reset is connected to the pin 4. The the inputs, pin 5 and 6 are used for the K & J respectively. Set is connected to pin 7. For the output on Q & $\bar{Q}$, both are connected to the L.E.D. By changing the value of clock (0 & 1), then the value of Q & $\bar{Q}$ changes.

→ Reflection :→ In this assignment, we learnt

(i) How to make connection in a Digital trainer kit for a J-K flip-flop setup.
(ii) To understand working of IC's on flip-flop and their gate properties
(iii) About the AND gate.
(iv) About truth tables of IC's.

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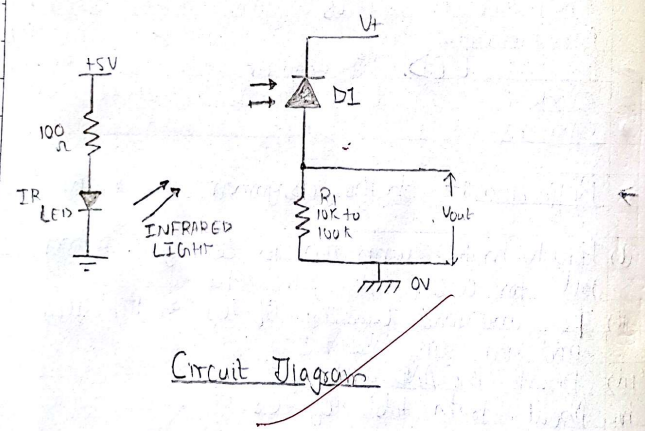
Aim:- Demonstrate the working of IR sensor and receiver & display using LED.

Hardware Required:- 1) Bread Board 2) Power Supply 3) Resistance and LED 4) IR transmitter and Receiver 5) Single core connecting wires.




Circuit Diagram

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→ Exercise 2 :- Demonstrate the working of IR sensor and receiver and display output using LED.

→ Hardware Required :- 1) Bread Board
2) Power Supply
3) Resistance and LED
4) IR transmitter and Receiver
5) Single core connecting wires.

→ Theory :- An infrared sensor is an electronic device, that emits in order to sense some aspects of the surroundings. An IR sensors measure the heat of an object as well as detects the motion. These types of sensor measure only infrared radiation, rather than emitting it that is called as as passive IR sensor. The emitter is simply an IR LED and the detector is simply an IR photodiode which is sensitive to IR light of the same wavelength as that emitted by the IR LEDs. When IR Light falls on the photodiode, the resistance and these output voltage, change in proportion to the magnitude of the IR light received.

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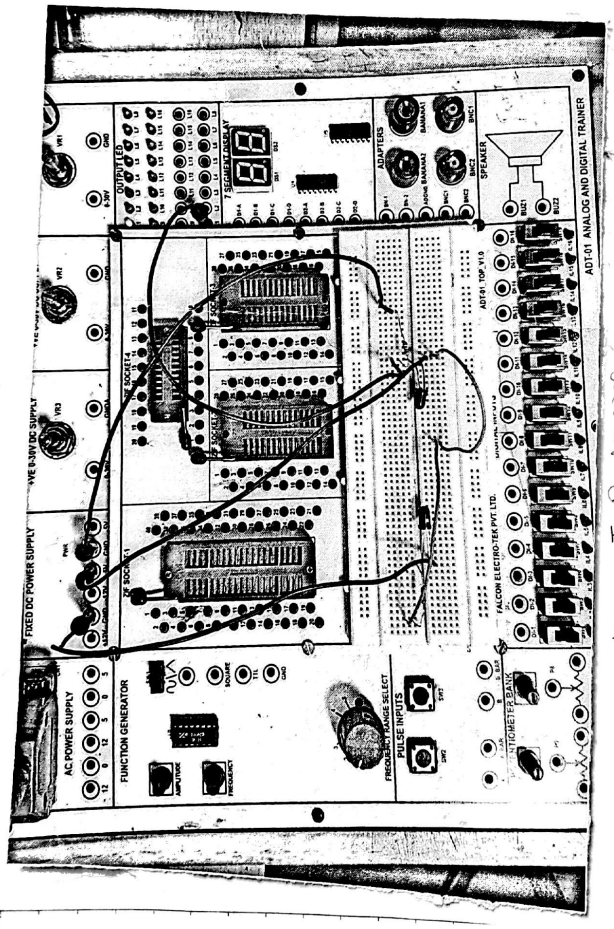


Using I-R Sensors

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→ Circuit :→ Make connection on breadboard, as shown in the diagram.

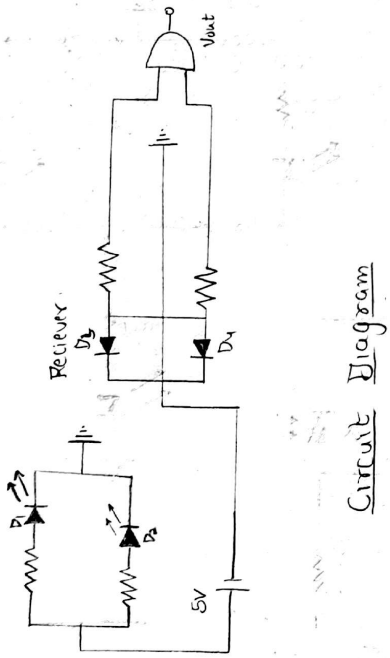
→ Reflections :- From this assignment, we got to know

(i) About IR basics and its working.

(ii) About connections and making of circuit. we get to know how display the signal using LED, which can further be display on seven-segment display. It cleared the concepts of I.R sensor, how receiver and the emitter works and what happens when an destruction comes b/w the receiver and the emitter.

Aim:- Design the two pair sensor and combine the two sensor into one signal.

Hardware Required :- 1) Digital Trainer kit, 2) Connecting wires 3) IR transmitter & reciever 4) Resistance & LEDs 5) Power supply.




Circuit Diagram



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→ Assignment Task :-

1.) Aim:- Design the two pair sensor circuit and combine the two sensors into one signal

Hardware Required :- 1) Digital Trainer kit
2) Connecting wires
3) IR transmitter and reciever
4) Resistance and LEDs
5) Power supply.

Theory :- In the experiment above, we have used two sensor and combined their output into one signal. We have use two transmitter which send their signal, this signal is combined and is fed to the 3rd transmitter. Now, the reciever of the 3rd transmitter detects the combined signal of the two sensor. So, output is taken along the reciever of 3rd transmitter. Low resistance are used in transmitter since they are forward biased and high resistance are used in transmitter since, they are reversed biased.

Reflection :- In this experiment we learn how to design a two pair sensor circuit. We combined the two signal into 1 signal and used a 3rd reciever for the output. We constructed



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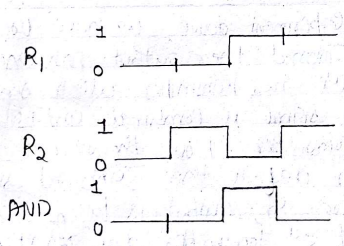
| TRANSMITTER | | RECEIVER | | AND |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 0 |
| 1 | 0 | 1 | 0 | 0 |
| 1 | 1 | 1 | 1 | 1 |

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the whole circuit on the digital kit and verified the whole experiment practically. It further enhanced our concepts and knowledge regarding the working of IR sensor & its farther application.

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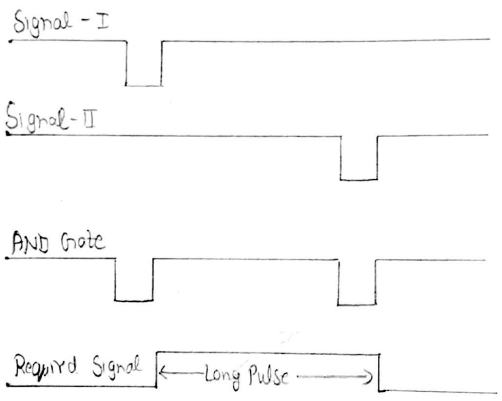
Aim:- To design 2 pair of sensor circuit and combine the sensor signal into one long pulse.

Hardware Required:- 1) Bread Board 2) Power Supply 3) Resistance & LED 4) IR transmitter & receiver 5) Digital Trainer kit 6) CD 4027 & 4081 IC

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2) Aim:- To design 2 pair of sensor circuit and combine the sensor signal into long pulse

Hardware Required:-
1) Bread Board
2) Power Source
3) Resistance and LED
4) IR transmitter and reciever
5) Digital trainer kit
6) IC CD4027 and IC CD4081

Theory:- IR transmitter is a forward biased p-n junction and IR reciever is a reverse biased PN junction. We make 2 pair of sensor circuit. Now the output of these 2 circuit becomes input of CD4081 IC. It is an AND gate. For creating a long pulse the output of the AND gate become the clock of CD4027 IC, which is a the flip-flop. Now we can create pulse in a JK flip-flop.

Reflection:- In this assignment task, we get to know about IR transmitter and reciever and its pulse relation. Also, we get to know to combine two pulse by AND Gate when we have two pair of IR sensor. It is illustrated in diagram.

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Aim :- To construct a circuit which will record & display the length of time taken by the throwing arm on the Mangonel to pass b/w the sensor mounted on the chassis

Hardware Required :- CD4027, CD4081, Breadboard, Connecting wires, Digital trainers kit of 7-segment display, Power supply.

Input Signal :-

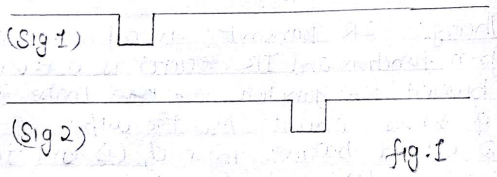


fig. 1

Required Signal :-

fig. 2



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## Assignment-4
## Assembly of Hardware & Software

- Aim :- To construct a circuit which will record & display the length of time taken by the throwing arm on the Mangonel to pass b/w the sensor mounted on the chassis.

The circuit is required to :-

1) Accept the individual inputs from the two sensors on the Mangonel
2) Combine two signal into one
3) Convert two short pulse into one long pulse
4) Deliever this pulse to the relevant input on the Arduino Board
5) Facilitate resetting by Arduino.

- The Input Signal :- The input signal received from the sensor on the Mangonel are shown in fig. 1

- Required Signal :- The signal required for the Arduino program is shown in fig. 2.



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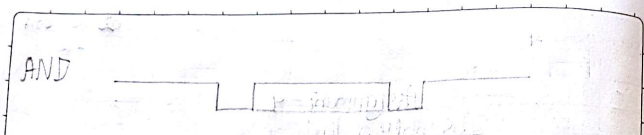
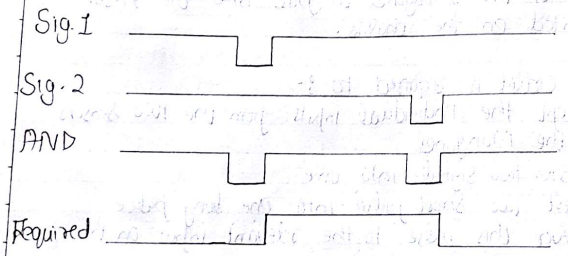
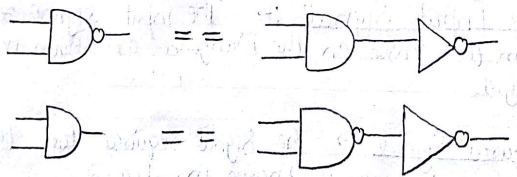



AND & NAND Logic Output (fig.3).




Logic Comparison chart.



Logic Inversions

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- How do we achieve this ? :→

In order to make one signal out of the two, we'll need to combine the two individual signal. This is done by means of combination logic ckts. The best choices for combining our two signals into one are AND & NAND gates, as either will preserve the signal from each individual sensor whilst also combining the two signals into one. It is important to note that NAND is simply inverted AND. The output from NAND & AND gates are given in fig.3.

Looking at the AND output signal, it could be argued that we already have a long pulse from this step alone - however, the long pulse b/w the two short pulses given by the AND logic is not an accurate measurement of the transit time of the arm because the pulse length is shortened by the width of the 2nd pulse. We need to generate a single long pulse as shown in fig.4., which extends from either the rising or falling edge of the 1st pulse, to the correspondingly edge of the 2nd pulse.

This can be achieved by using the 2 shorter pulses in the output of the AND gate to 'toggle' or 'clock' the output of a latching logic device. For this we use JK flipflop.

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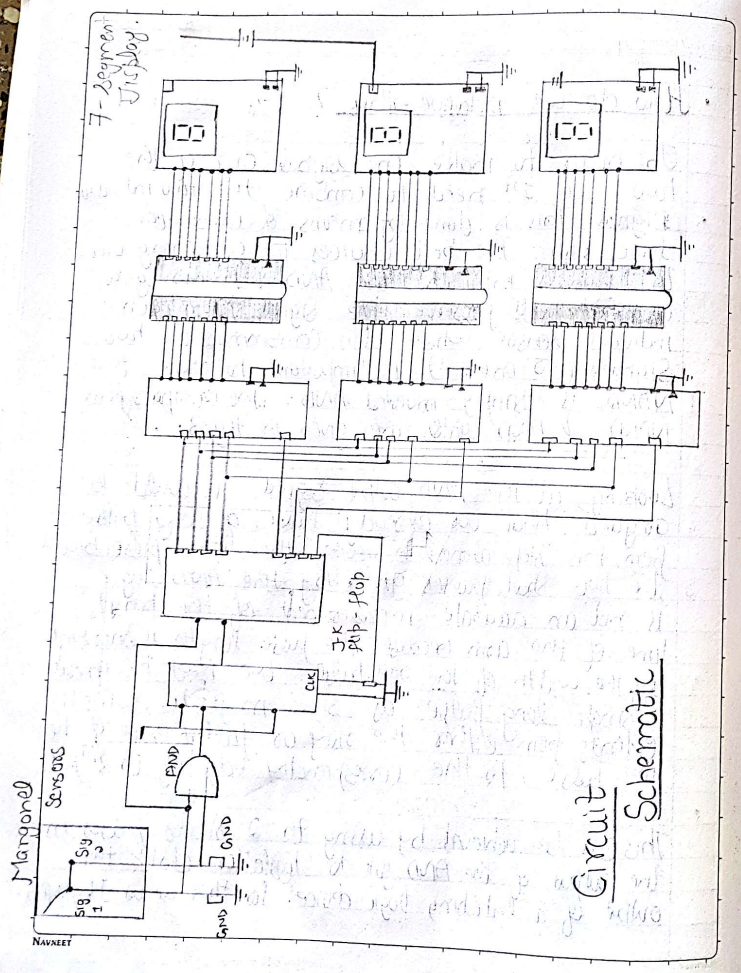


Circuit Schematic

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The J-K flip-flop is the most versatile of the basic flip-flops. It has two inputs traditionally labelled J & K. If J & K are different then the output Q takes the value of J at the next clock edge. If J & K are both low, then no change occurs. If J & K are both high at the clock edge then the output will toggle from one state to the other. This toggle application means that we can use the two signal pulses from the output of the AND gate to cause the output of the flip-flop to change state, hence allowing us to create one long pulse b/w the corresponding edges of the two shaker pulses. The device also has set and reset function which will be useful for clearing the output states when we want to start a new timing run.

The output of our J-K flip flop then goes to the appropriate input of Arduino and from there the program in the Arduino will measure the length of the pulse and output the appropriate values to the various registers on the display.

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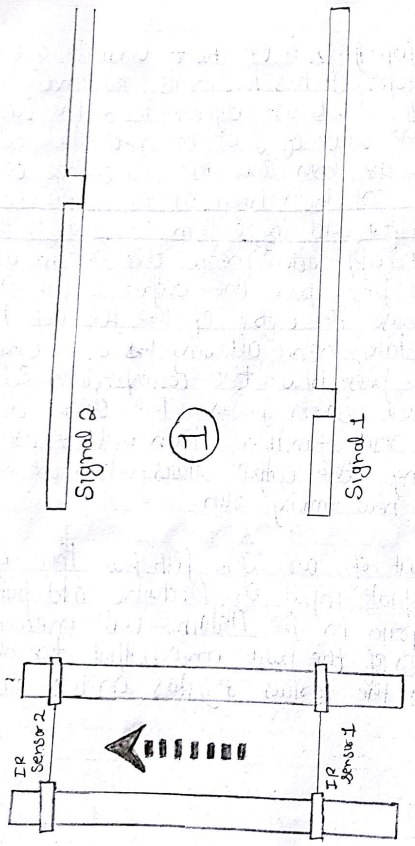


Stage 1 → Getting the Signals

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- Hardware Required :→

1) CD 4027 2) CD4081 3) Bread Board 4) Connecting wires
5) Digital trainer kit for 7-segment displays
6) Power Supply

- Software Required :→ Arduino.

→ Implement the real hardware on the breadboard, at the input side of the Arduino in the Mangonel design problem. Write the required software code and display the time elapsed in the Mangonel arm movement b/w the two sensor locations. Demonstrate the hardware and software by attaching to a real Mangonel.

- Source Code :→

```
Void setup()
{
    pinMode (2, INPUT);
    pinMode (13, OUTPUT);
    pinMode (12, OUTPUT);
    pinMode (11, OUTPUT);
    pinMode (10, OUTPUT);
    pinMode (9, OUTPUT);
```

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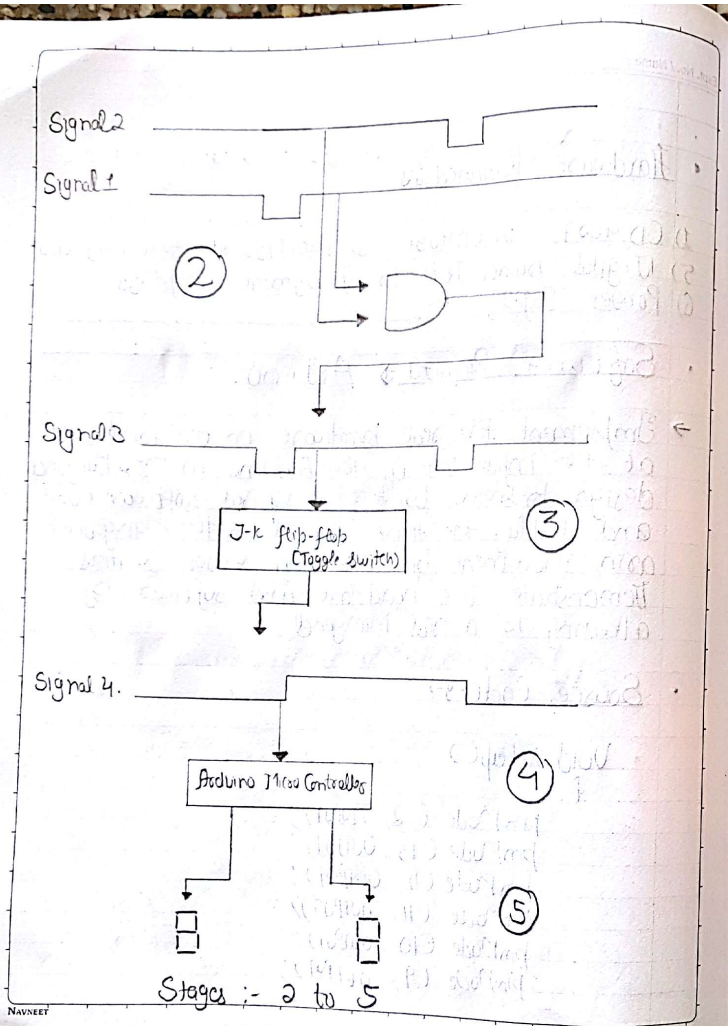


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```
pinMode (8, OUTPUT);
pinMode (7, OUTPUT);
pinMode (6, OUTPUT);
Serial.begin(9600);
}
void loop()
{
int a,b,c,d,e,f,g,h,i,j,k;
unsigned int t = pulseIn(2, HIGH, 1000000000);
k = t/1000;
j = k/10;
i = k%10;
a = (i%2);
b = (i/2)%2;
c = (i/4)%2;
d = (i/8)%2;
digitalWrite(13, a);
digitalWrite(12, b);
digitalWrite(11, c);
digitalWrite(10, d);
e = (j%2);
f = (j/2)%2;
g = (j/4)%2;
h = (j/8)%2;
digitalWrite(9, e);
digitalWrite(8, f);
digitalWrite(7, g);
digitalWrite(6, h);
```

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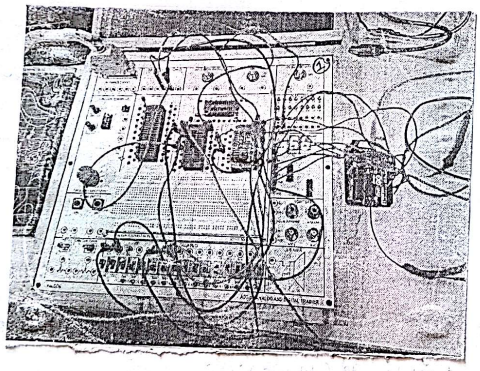

Digital - Trainer kit with all connections

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```
Serial.println(t);
}
```

- Reflections :-> In this experiment, we learnt how to construct a circuit which will record and display the length of time taken by throwing arm on the Mangonel to pass b/w the sensors mounted on the chakes. We learnt how to convert two signals into a single signal by using the AND gate. We also made the pulse width more easy to measure by feeding the output of AND gate to the clock of JK flip flops and keeping it in toggling condition. It enhanced our understanding and concept of JK flip flops and AND gate. We also made a source code to measure the pulse width and fed it to Arduino. This helped us to use pulse in function and strengthened our concepts on programming. Thus, we learnt how can we measure and display speed of the arm of Mangonel, and this has application on many other day to day things. Thus, we were able to understand electronical part of Mangonel.

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