**Design and Construction**

Elements of metal detector

The first step was to determine the types of the circuits that are to be used in the project, and the needed frequency was calculated to determine the values of the components used. The following factors should be considered while selecting the material.

1. Availability of the materials.
2. Comfortably of the materials for the working condition.
3. The cost of the materials which is available at the desired value.

After considering availability, cost and property of materials we choose the following materials.

1. voltage comparator (op-amp 741)
2. Diode
3. Resistor
4. Transistor
5. Capacitor
6. LED

Construction of circuit

Since the electromagnetic principles support the fact that whenever there is a metallic object in an electromagnetic field there would be an electric current flowing in this object and via versa, based on this fact the design was started and the first step in the design was to introduce an electronic circuit

that produces an electromagnetic field. Search was done and the best choice found was the Colpitts Oscillator, it was found that the Colpitts oscillator can produce the required magnetic field.

Design analysis

Design was done based on the principle of operation keeping in mind availability of components and getting the output in tangible manner i.e. using LED. So, two circuits were to be used, first the circuit which produces the magnetic field and second the circuit that monitors the output.



Figure: block diagram Metal detector

coil

The coil is a at spiral coil, with 13 turns, which have the diameter of 12 cm. we will use copper wire has a diameter of 1.5 mm. The coil is made in the spiral shape to get the magnetic \_eld as wide as possible.

* Typical copper wire
* wire diameter=1.5mm
* Coil diameter=12cm
* Turn of coil =13

We can find our cross-sectional area

= 3.14\*(

=

so, we can calculate our average radius and inductor size.

A = (Di/25.4 + N (W/25.4 + S/25.4)) \*1/2

= (120mm/25.4 + 13(1.5mm/25.4))/2

= 2.74inch

Coil inductance

L= /30\*a-11\*(Di/25.4)

= (/30\* 2.74-11 \* (120/25.4))

= 41.91 \* 10

N=Turns on coil; A=Average Radius; Di=Inner Diameter; W=Wire width; S=Spacing between wires

Our total capacitance will be

C\_Total = (C1 \_ C2)/ (C1 + C2) (4.12)

= 39nF \_ 39nF=39nF + 39nF (4.13)

= 19:5nF

Main circuit (Colpitts Oscillator circuit)

The Colpitts Oscillator is a type of LC oscillators. This circuit consists of an LC resonance sub-circuit connected between the emitter and the base of a single stage transistor amplifier producing frequency output. By the current flowing through the coil a magnetic field is induced around the coil,

when a metallic object enters field region a magnetic field induces in the object which reduce the field of the circuit,

* The Oscillator makes a frequency change when some metal is near the detector coil. At the same the inductance will change.so we will have input voltage change also.
* The system will accept the change of input and compare with the reference voltage



Figure: Colpitts Oscillator

Frequency output of the circuit

**F**\_oscilation = 1/

=1/

=81.72ph

This is the operation (reference frequency).

**Voltage comparator (op-amp 741)** The main function of this comparator is to accept the input from the Colpitts oscillator and compare with the reference voltage assigned.



Figure: Comparator

**Induction Circuit** In this circuit LED is connected to output terminal of our voltage comparator. whenever the frequency of our Colpitts oscillator there will a change of input voltage, our system will notify the change by the LED.



Figure: Output Display

**Amplifier circuit**

The main purpose of this circuit to produce amplify the signal generated from the Colpitts LC oscillator.



Figure: Amplifier circuit

**Possible Cases**

* When there is no other \_eld near to our inductor

There is no change of input voltage, so the input to comparator are equal

Vout=input voltage-reference voltage

Vout=0

When there is no metal our input to comparator will be fully sinusoidal. So, the LED will blink more. But it is just blinking.

* When there is another field near to the metal detector

Out inductance will change, also our input voltage has a slight difference

V\_out= V\_input - reference voltage

Input voltage > reference voltage

So, the LED will light.

Whenever there is metal near to the system, the inductance will change, the frequency of the Colpitts decrease. Eventually the frequency drops. As we know a signal having low frequency is called DC.so our led stops blinking and just bright.