XPERIMENT :- To Determine the coupling co-efficient of a Piezoelectric crystal.

quipment used :- 1. Piezoelectric crystal, 5nos crystal of Standard value mounted in side the ox and connections brought our the terminals.

. Resistance box 10-100 ohm,

. Inductance box 10-100mH

. Capacitance box 1nF – 10nF.

. AC Voltmeter 0-10V, 6. AC Current Meter 0-5mA, 07. Frequency Source 1Hz-2mHz

ormula Used :- Coupling coefficient $K_c = 1/Q$

Where $Q = \frac{1}{R}\sqrt{\frac{L}{C}}$ Hz

Series Resonant frequency $f_s = \frac{1}{2\pi\sqrt{LC}}$ Hz $= \frac{1}{2\pi\sqrt{LC}}$ Hz

Parallel Resonant frequency $f_p = \frac{1}{2\pi\sqrt{LC_T}}$ Hz $= \frac{1}{2\pi\sqrt{LC_T}}$ Hz

Where L = Inductance in hennery

C = Capacitance in farads

$$C_T = \frac{C \times C_m}{C + C_m}$$

Quality Factor

$$Q = \frac{f_1}{F_2 - f_1}$$

THEORY :- A quartz crystal exhibits the property that when mechanical stress is applied across the faces of the crystal, a difference of Potential develops across opposite faces of the crystal. This property of a crystal called the piezoelectric effect. Similarly if a voltage applied across one set of faces of the crystal causes mechanical distortion in the crystal shape.

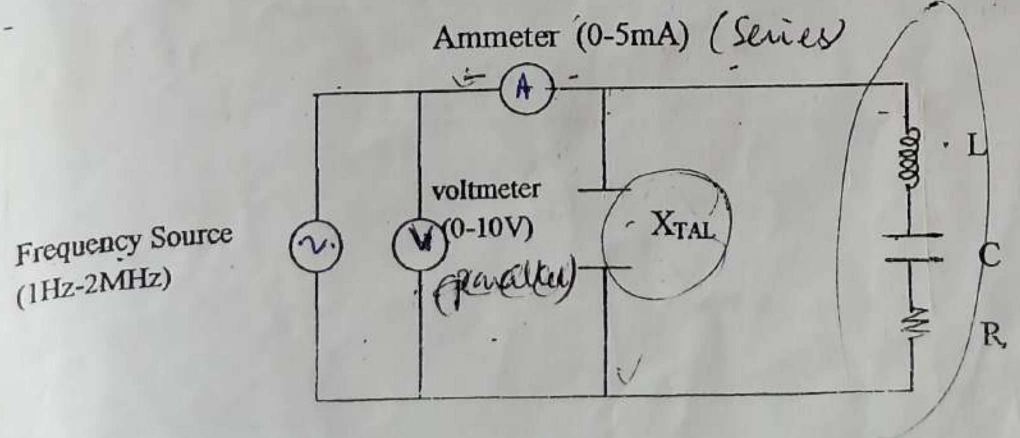
When alternative voltage is applied to crystal, mechanical vibrations are set up. Thease vibrations having a natural resonant frequency dependent on the crystal.

Although crystal has electro mechanical resonance, we can represent the crystal action by an equivalent electrical resonant circuit as shown in fig. 1. the inductor L and Capacitor C electrical equivalents of the crystal mass and compliance. While resistance R is an electrical equivalent of the crystal structure is internal friction. The shunt capacitance Cm shows the capacitance due to mechanical mounting of the crystal. Because the crystal losses represented by R1 are small, the equivalent crystal Q (Quality factor) is high typically 20,000 values of Q upto 106 can be achieved by using crystal.

Series and Parallel Resonance :- Crystal as represented by the equivalent electrical circuit can have two resonant frequencies.

- One resonant condition occurs when the reactance of the series RLC leg are equal (and opposite). For this the series resonant impedance is very low (equal to R)
- The other resonant condition occurs at a higher frequency when the reactance of the series resonant leg equal the reactive of the capacitor Cm. This is a parallel or anti resonance condition of the crystal. At this frequency the crystal offers very high impedance to the external circuit. The graph between current (I) or impedance (Z) as shown in fig 2.

Circuit Diagram



V = ... Volt

S.No.	Frequency Hz - MHz	Current (I) mA	Impedance $Z = \frac{V}{I}$
1			
2			
3			
4			
5			

Table No. 2

Capacitance of Piezoelectric crystals measured by the capacitance meter.

X_{TAL}, MHz	Capacitance (Cm) pF
4.096	12.3
4.433	13.5
6.144	14.5
8.0	15.2
11.059	12.9

±10 pF

CALCULATIONS

Plot the graph between frequency and Impedance Z

Value of coupling co-efficient Kc $= \frac{F2 - F1}{F1}$ ⟶ from the graph

Theoretical value of coupling coefficient Kc $= \frac{1}{Q}$

Percentage error = ... %

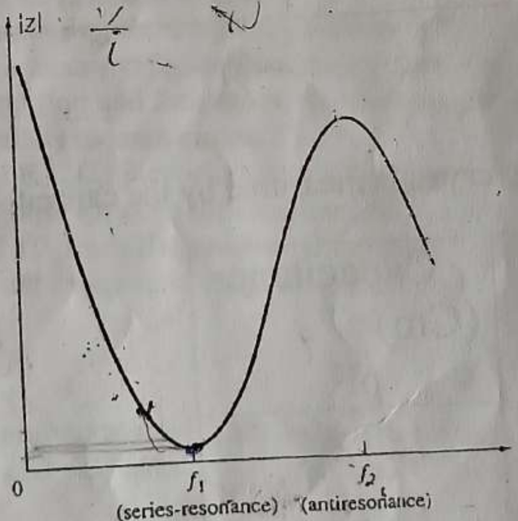


Figure 18.32 Crystal impedance versus frequency.