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OSCILLATOR

Defⁿ:- The devices or circuit which is used to generate or produce the sinusoidal oscillation's with desired change in frequency is called oscillator.

Advantages of oscillators:-

(i) It is a non rotating device.
(ii) Due to absence of moving parts, the operatio of oscillator is quite silent.
(iii) An oscillator can produce the signal fro small-freq. (50 HZ) to large-freq. (> 100 MHZ)
(iv) The frequency of oscillations can be easily changed by changing parameters
(v) It has good frequency stability
(vi) It has very high efficiency

TYPES OF OSCILLATOR:-

Depending on the nature of o/p oscillator's are classified as
(i) Sinusoidal oscillator's
(ii) Non-sinusoidal oscillator's

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(i) Sinusoidal oscillators:- The oscillators which generates sinusoidal oscillations with change in freq. are called sinusoidal oscillato.

(ii) Non-sinusoidal oscillators: The oscillators which generates the Non sinusoidal waveform such as square, triangular are called Non. sinusoidal oscillator

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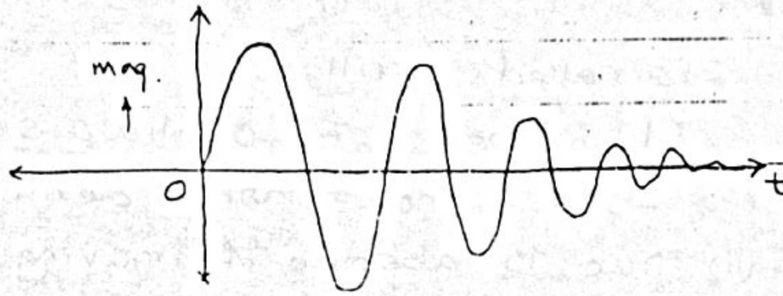
TYPES OF OSCILLATIONS :-

- Damped oscillations
- Undamped osci.

Damped Oscillations:- The oscillations whose magnitude is changes with respect to time are called damped oscillations.

e.g.



Undamped Oscillations: The oscillations whose magnitude remains constant irrespective of increase the time are called undamped oscillations.

e.g.

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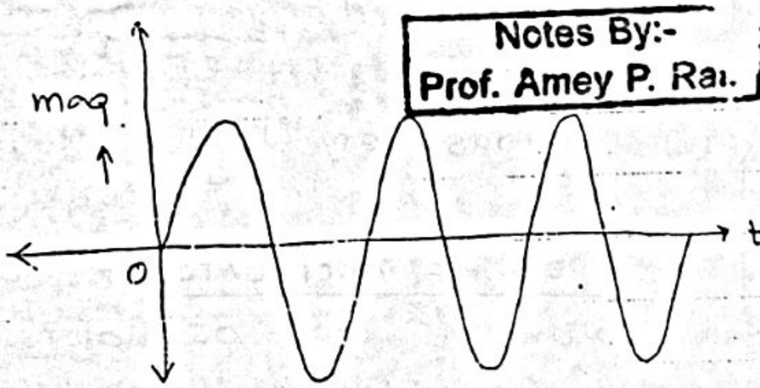

TANK CIRCUIT :- (oscillatory circuit):

It is a parallel combination of capacitor and inductor used to produce the oscillation's. with desired frequency. consider inductor and cap. are connected in parallel through switch 'SW'. as shown,

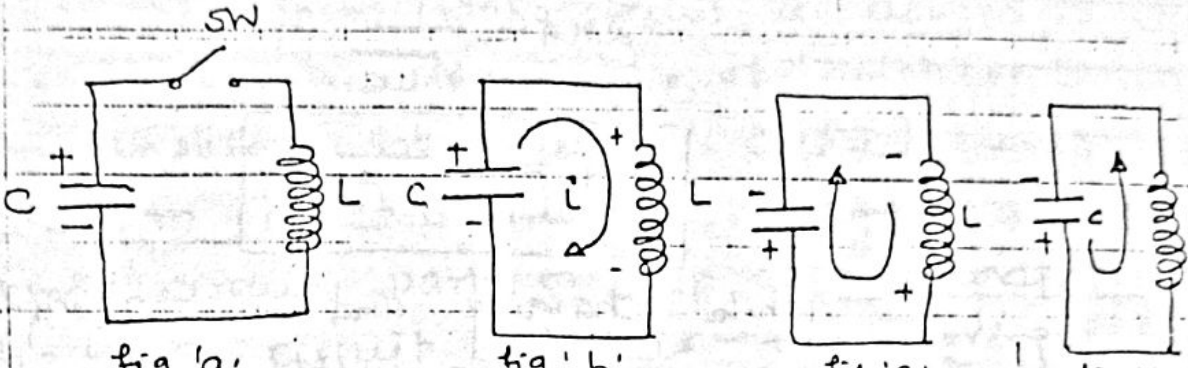

fig 'a'. fig 'b' fig 'c' fig 'd'

Initially capacitor is charged towards it's maximum value by using ext. dc source. when the capacitor is full charged switch 'SW' is closed so that capacitor will start discharging through inductor 'L' which stores the energy in it ($E = \frac{1}{2} LI^2$) when capacitor is fully discharged, energy stored in inductor is max. Now, inductor starts supply energy to the capacitor keeping the same dirn of current so that capacitor will start charging toward's it's max. value with opposite polarity shown in fig 'c'. when energy of inductor decay's completely, capacitor is fully charged. and again it will start discharging through the inductor in opposite dirn which will again store the energy in the inductor. thus charging and discharging of capacitor will generate the oscillations with desired freq. and the freq. of oscillation can be calculated by —

$$X_L = X_C$$

$$\therefore \omega L = 1/\omega C$$

$$\therefore \omega^2 = \frac{1}{LC}$$

$$\therefore \omega = \frac{1}{\sqrt{LC}}$$

But $\omega = 2\pi f$

$$\therefore 2\pi f = \frac{1}{\sqrt{LC}}$$

$$\boxed{\therefore f = \frac{1}{2\pi\sqrt{LC}}}$$

While charging and discharging of capacitor some amount of energy will lost which will produce domped oscillations so that to recovery the losses taking place in tank circuit it is necessary to provide feed back to the tank circuit.

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BLOCK DIAGRAM OF OSCILLATOR :-

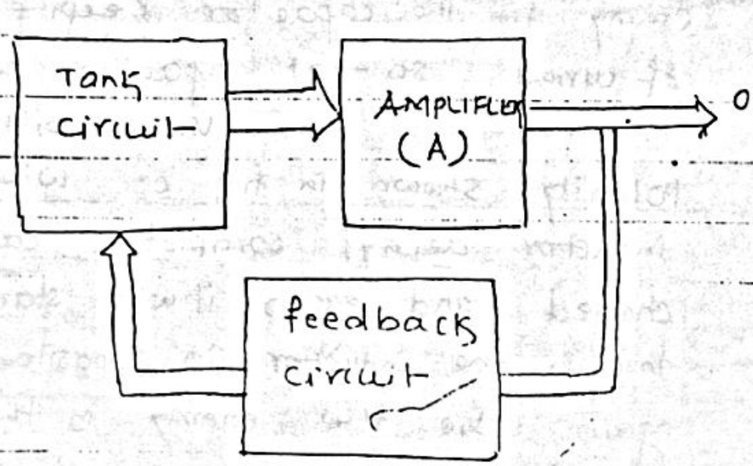

Fig show's the block diagram of oscillator it consist's of tank circuit, amplifier and feed back circuit where tank circuit is used to produce the sinusoidal oscillation and with change in frequency.

The o/p of tank circuit is applied to the amplifier so that o/p of amplifier is in amplified form having desired level. and to overcome the losses taking place in tank circuit, part of o/p is feed back to the tank circuit which is +ve having phase shift of 0° or 360°.

BARKHAUSION CRITERION :- Barkhausion criterion for the oscillator used to generate the desired oscillations state that -

(i) It requires +ve feedback.
(ii) phase shift should be 0° or 360°.
(iii) $\beta A_v = 1$.

TYPES OF SINUSOIDAL OSCILLATORS :-

- (i) Collector tuned Oscillator
- (ii) Hartley Oscillator
- (iii) colpitts Oscillator
- (iv) Clapp Oscillator
- (v) crystal Oscillator
- (vi) RC Phase shift
- (vii) Wien-bridge oscillator.

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(1) TUNED - COLLECTOR OSCILLATOR :-

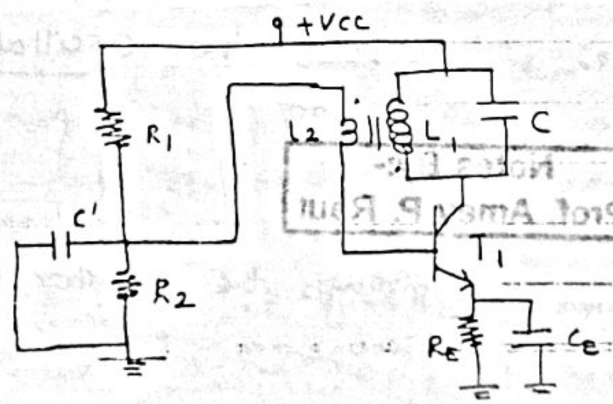

fig shows the collector tuned oscillator in which tank circuit form's by C and L_1 connected at the collector of transistor and R_1 and R_2 is a voltage divider biasing resistor's used to provide sufficient voltage at the base of transistor.. c' and C_E are the by pass capacitor's for resist R_2 and R_E. and L_2 is used to provide the feedback for the tank circuit. through the transistor as an amplifier.

When the circuit is energised by switching on the supply. the collector current start's increasing to the quiescent value. this current charges the capacitor 'C'. when the capacitor is fully charged, it discharges through the inductor L_1 which will cause to induced emf in it. when capacitor is fully discharged, the magnetic field produced by inductor will collapses and charge's the capacitor in opposite dir^n. when the capacitor will charge towards its max. value, it will again discharges. through inductor L_1. thus it will produces the oscillations of desired frequency -

$$\boxed{f = \frac{1}{2\pi\sqrt{LC}}}$$

when the capacitor is discharges through the inductor, by the mutual inductio phenomenon emf is induced in the L_2

which will again applied to the tank circuit through amplifier to recovery the losses taking place in tank circuit. Here tank circuit and transistor is used to provide the phase of 360° or 0°.

(ii) HARTLEY OSCILLATOR :-

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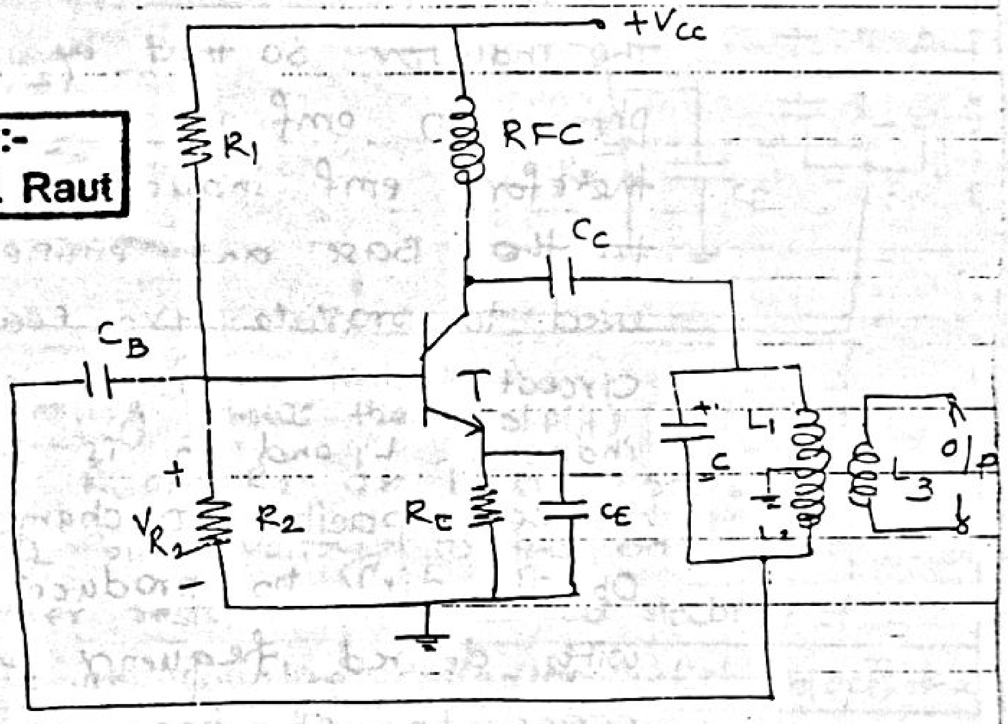

$$V_{R_2} = \left(\frac{V_{CC}}{R_1 + R_2}\right) R_2$$

Fig shows the hartley oscillator in which R_1 and R_2 are the biasing resistors use to provide sufficient biasing voltage to the base of transistor. C_C and C_B are the coupling capacitors which blocks the d.c. current. R_E is used to improve the stability and C_E is a bypass capacitor for resistance R_E. Here RFC is act as a load of transistor which is used to Neglect the effect of external magnetic field. the tank circuit formed by C, L_1 and L_2 is connected betn the collector and the Base of transistor.

When the circuit is energised by switching on the supply collector current start flowing through the circuit which charges the capacitor 'c' towards its max. value. When the capacitor is fully charged. it start's discharging through the inductor L_1 and L_2 which stores the energy in the inductor. So that by the self induction phenomenon emf is induced in L_1 and L_2. therefore emf induced in L_2 is applied to the Base and emitter of transistor used to provide +ve feedback to the tank circuit. when capacitor is fully discharges. inductor L_1 and L_2 is supplied energy to the capacitor to charge it again in opposite dirn. to produce the oscillation with desired frequency which is measured across L_3. of frequency,

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$$\boxed{f = \frac{1}{2\pi\sqrt{LC}}}$$

Where $L = L_1 + L_2 + 2M$

Here tank circuit and transistor's is used to provide a phase shift of $0°$ or $360°$ to obtain desired oscillations.

(iii) COLPITTS OSCILLATOR :—

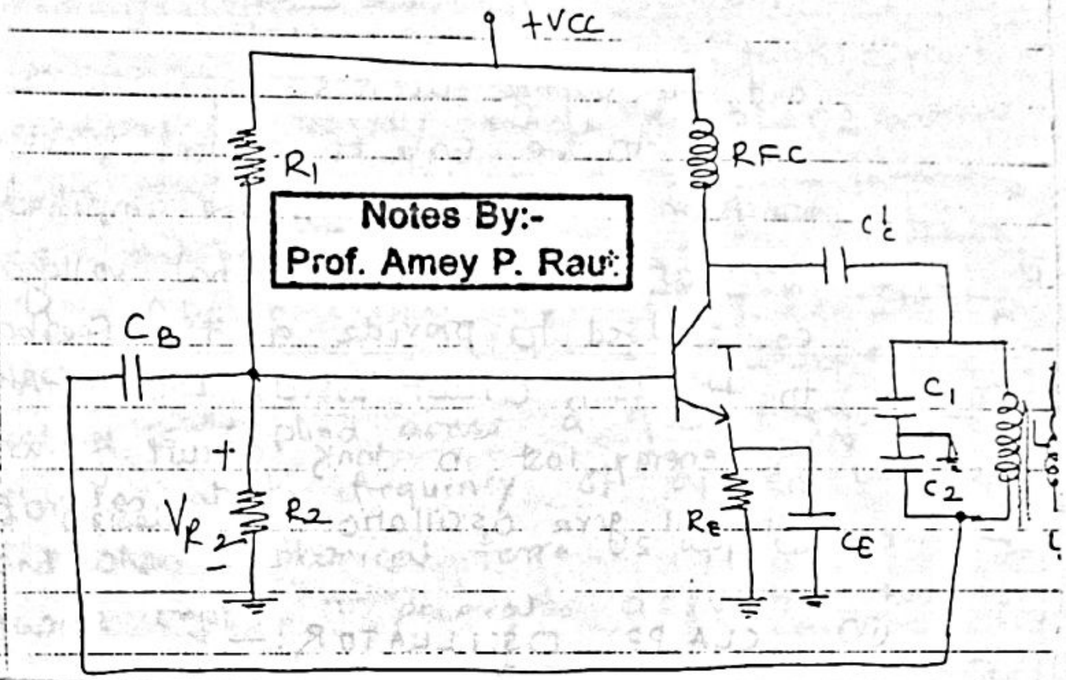


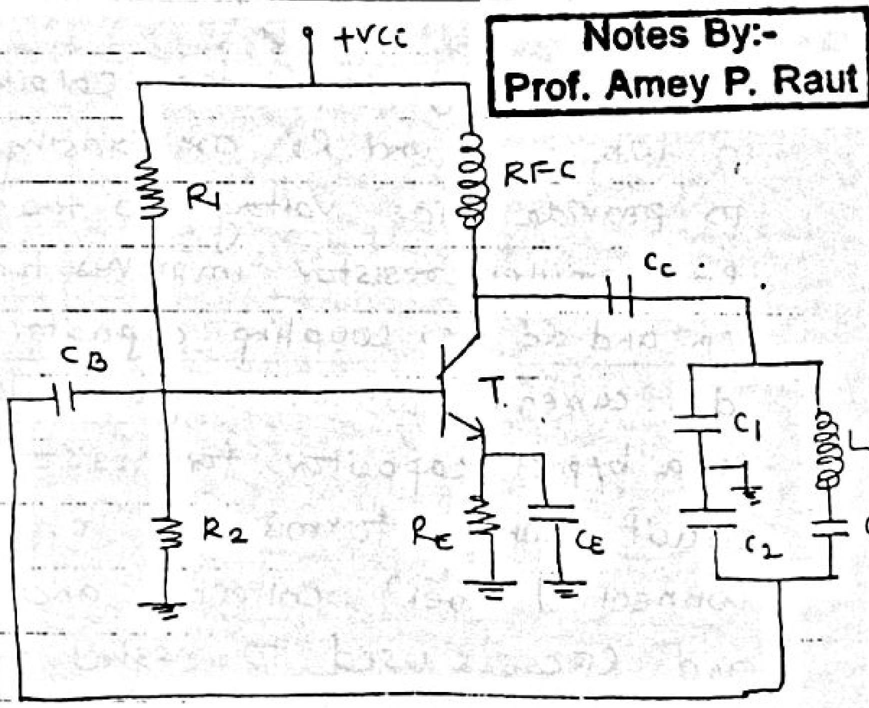
Fig shows the Colpitt's oscillator, in which R_1 and R_2 are biasing resistor's used to provide bias voltage to the base of transistor. R_E : emitter resistor improves the stability of ckt. C_B and C_c are coupling capacitor which block the d.c. current allows to pass to the a.c. signal. C_E is a bypass capacitor for resistor R_E and tank circuit which form's by C_1, C_2 and L is connected bet^n collector and Base of transistor. and RFC is used to neglect the effect of external magnetic field. and blocks the a.c. current.

When the circuit is energised by applying Vcc. capacitor's C_1 and C_2 charges towards it's max. value. when the capacitor's are fully charged, it will discharges through inductor L. which causes to produce the oscillations of freq. $\boxed{f = \frac{1}{2\pi\sqrt{LC}}}$

Where $C = \frac{C_1 C_2}{C_1 + C_2}$

and the voltage accross capacitor C_2 is applied to the Base to emitter junction of transistor which appear in the amplified form at the collector. so that voltage of C_2 is used to provide a +ve feedback to the tank circuit which will recovery the energy lost in tank circuit. thus the ckt will give oscillations of desired freq.

(iv) CLAPP OSCILLATOR :-



It is an improved version of colpitt's oscillator in which extra capacitor C_3 is connected in series with inductor of tank circuit to neglect the effect of variation's of transistor parameter and stray capacitor.

(V) Crystal Oscillator :- It is basically a tuned oscillator. The crystal oscillator uses a piezoelectric crystal as a resonant tank circuit. The crystal is usually made of quartz material which provides high degree of accuracy and freq. stability.

Quartz crystal is working on piezo electric effect. Which states that when an a.c. voltage is applied across a quartz crystal, it vibrates at the frequency of applied voltage. And when mechanical force is applied to the quartz crystal it generates a.c. voltage betⁿ its two opposite faces which is called inverse piezo electric effect. It is available for the freq. of 15KHZ to 10MHZ.

Equivalent ckt of crystal :-

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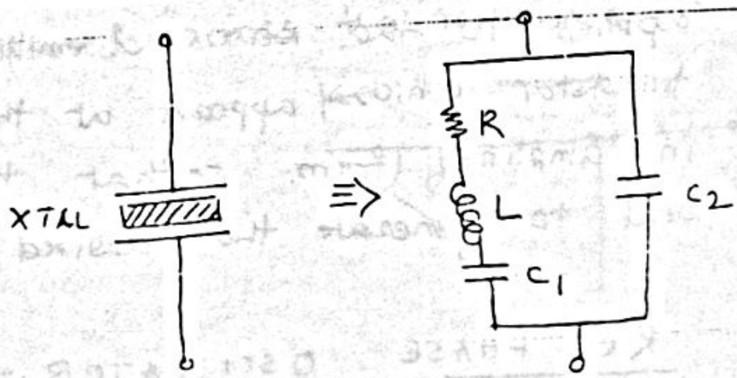
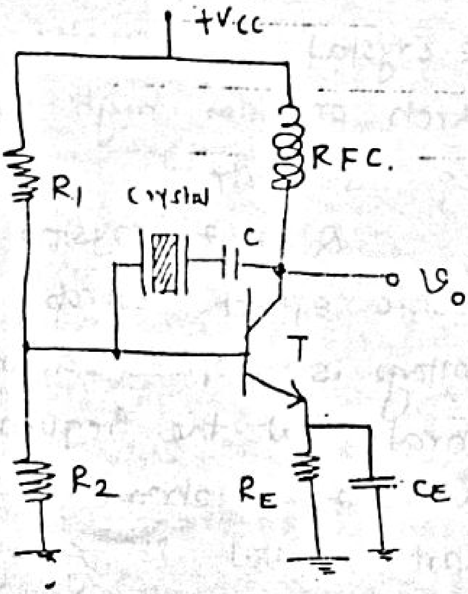


$$f = \frac{1}{2\pi\sqrt{LC_1}}$$

$$C = \frac{C_1 C_2}{C_1 + C_2}$$

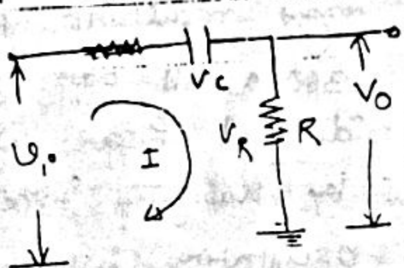
Crystal Oscillator:- Below fig shows the crystal oscillator which consists of R_1 and R_2 are biasing resistor's used to provide bias voltage at the base of transistor. R_E is used to improve the stability and C_E is a by pass capacitor for R_E. Here RFC is used to provides for d.c. bias while decoupling any a.c. signal on the power lines from affecting the o/p signal. crystal is connected b/w the collector and the Base of transistor through the capacitor 'C'.



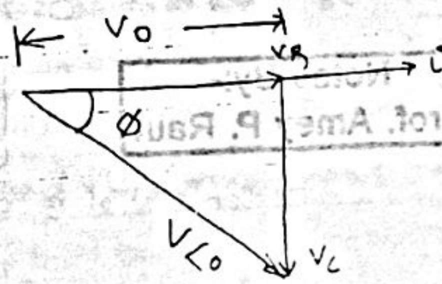
When the ckt is energised by applying Vcc. voltage is appear's across the crystal which will produces the oscillation of desired frequency. which will also applied to the Base and emitter of transistor which appears at the collector in amplified form. so that this ckt is used to generate the desired oscillations.

(V) RC PHASE OSCILLATOR:- these oscillators employ resistors and capacitors are used to generate low or audio freq. signals. Hence they are also called as audio freq. oscillators. the tuned (LC) oscillators are not suitable for low freq. because of size of inductor and capacitor

we know that single stage ampl^r not only amplifies the signal but produces the −ve feedback so that when part of o/p is feed back to the i/p it decreases the o/p which will not be able to generate the oscillation. so the to generate the oscillation's feedback required is +ve i.e. part of o/p should be applied to the i/p with proper phase shift which can be obtained by using R-C N/W's. Let us consider one R-C ckt −



Here Resistance and capacitance are connected in series across the voltage V_i and o/p is measured across the resistance. ∴ taking I as ref.



from the above vector diagram, we can say that R-C N/W is used to provide the phase shift bet^n i/p and o/p voltage. so that value of R & C is adjusted such that it will give a phase shift of 60°.

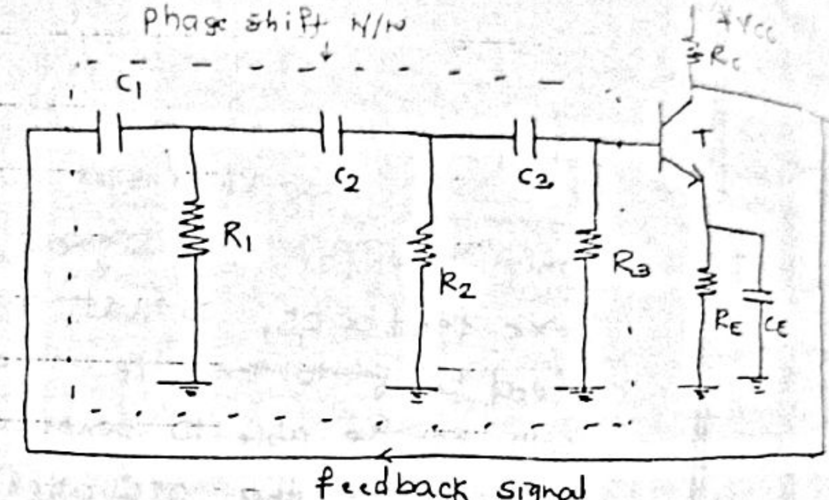


fig. shows the R-C phase shift oscillator. it consists of 3 R-C sections to give phase shift of 180° and transistor also provides a phase shift of 180° so that ~~now~~ resultant phase shift of the N/W is 360 which will be provide the oscillations at desired freq. When the circuit is energised by applying +Vcc. the circuit start oscillating which oscillation start due to minor variation in d.c. supply which will be maintained due to the feedback. the freq. of oscillations is given by

$$\boxed{f_0 = \frac{1}{2\pi\sqrt{6}\cdot RC}} = \frac{0.065}{RC}$$

(vi) WIEN BRIDGE OSCILLATOR :-

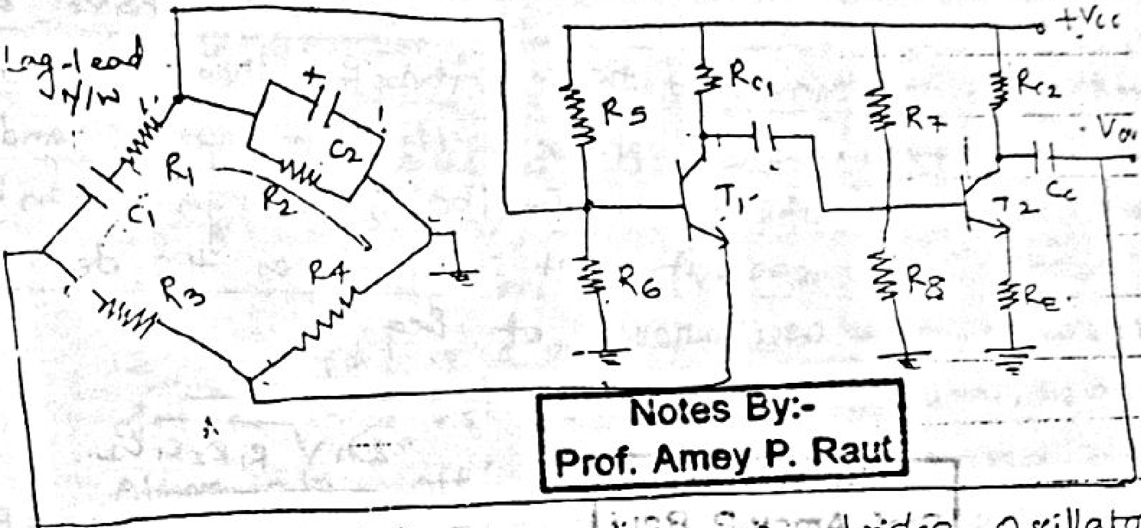


fig. show the wien bridge oscillator which is used to overcome the disadvantage of R-C phase shift oscillator. when RC phase shift is used to have a variable freq circuit it is difficult to adjust equally the value of capacitors of phase-shift N/W. it consists of a two stage RC coupled amplifier, which provide an phase shift of 360° or 0°. so that the feedback N/W has no need to produce any phase shift. the feedback network consists of C_1-R_1, C_2-R_2 (lead-lag N/W) and R_3-R_4 a voltage divider. the lead-lag network provides a positive feedback to the i/p of the first stage the voltage divider provides -ve feedback to the ~~emitter~~ of T_1 transistor.

When the circuit is energised by switching on the supply, a small random oscillat appearing at the base of T_1 transistor are amplified, at its collector. these oscillations are further amplified at the collector of T_2 transistor. since the oscillations at the collector of T_2 transistor have been inverted twice. therefore these oscillations are in phase with i/p signal. and part of o/p is feedback through wien bridge n/w & till it produces the desired oscillations of freq.

$$f_0 = \frac{1}{2\pi\sqrt{R_1 R_2 C_1 C_2}}$$

$$\boxed{f_0 = \frac{1}{2\pi RC}}$$

$\because R_1 = R_2 = R$

$\therefore C_1 = C_2 = C$