GPCET

Assignment - 2

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1.	Compare BJT, FET and MOSFET characteristics

Ans: (i) FET operation depends only on the flow of majority carriers - holes for P-channel FET's and electrons for N-channel FET's. Therefore, they are called Uni-polar devices. BJT operation depends on both minority and majority current devices.

(ii) As FET has no junctions and the conduction is through an N-type (or) P-type semiconductor material, FET is less noisy than BJT.

(iii) As the input circuit of FET is reverse biased, FET exhibits a much higher impedance (in the order of 100 MΩ) and lower output impedance and there will be an high degree of isolation between input and output. So, FET can act as an excellent buffer amplifier but the BJT has low input impedance because its input circuit is forward biased.

(iv) FET is voltage controlled device, i.e, voltage at the input terminal controls the output current, whereas BJT is a current controlled device, i.e, the input current controls the output current.

(v) FET are much easier to fabricate and are particullary suitable for IC's because they occupy less space than BJT's.

(vi) The performance of BJT is degraded by neutron radiation because of the reduction in minority carrier life time, whereas FET can tolerate a much higher level of radiation since they donot relay on minority carriers for their operation.

(vii) The performance of FET is relatively unaffected by ambient

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temperature changes. As it has negitive temperature coefficient at high current levels, it prevents the FET from thermal breakdown. The BJT has a positive temperature coefficient at high current levels which leads to thermal breakdown.

(viii) Since FET does not suffer from minority carrier storage effects, it has higher switching speeds and cutoff frequencies. BJT suffers from minority carrier storage effects and therefore has lower switching speed and cutoff frequencies.

(ix) FET amplifiers have low gain bandwidth product due to the junction capacitive effects and produce more signal disortion except for small signal operation.

(x) BJT's are cheaper to produce than FET's.

(xi) In enhancement and depletion types of MOSFET, the transverse electric field induced across an insulating layer deposited on the semi conductor material controls the conductivity of the channel.

(xi) The gate leakage current in a MOSFET is of the order 10^{-12} A. Hence input resistance of a MOSFET is very high in the order of 10^{10} to 10^{15} Ω.

xiii) The output characteristics of JFET are flatter than those of MOSFET.

xiv) The depletion type MOSFET may be operated in both depletion and enhancement mode.

xv) MOSFET are easier to fabricate.

xvi) MOSFET is very suspectable to over load voltage and

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needs speacial handiling during installation. It gets damaged easily if it is not properly handled.

(xvii) MosFET has zero set off voltage. As it is symmetrical device, the source and drain can be interchanged. These two properties are very useful in analog signal switching.

(xviii) Signal digital CMOS circuits are avilable which invokes near-zero power dissipation and very low voltage and current requirements. This make them most suitable for protable systems.

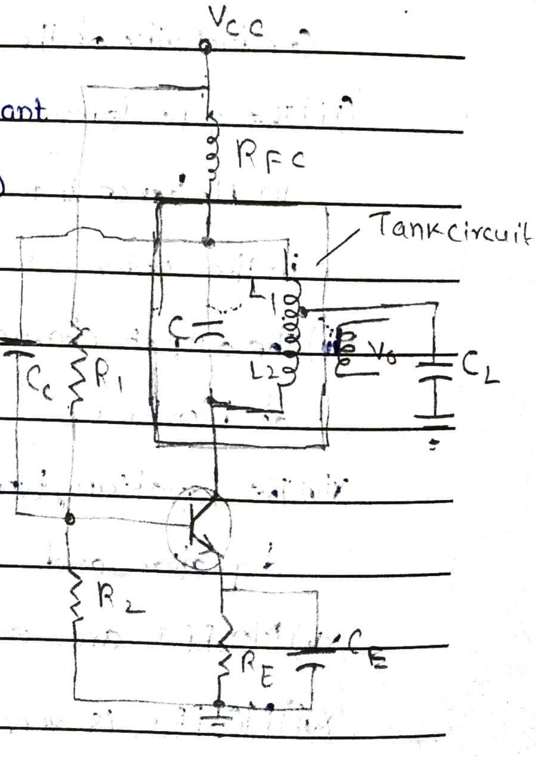
2. Write about different Oscillators.

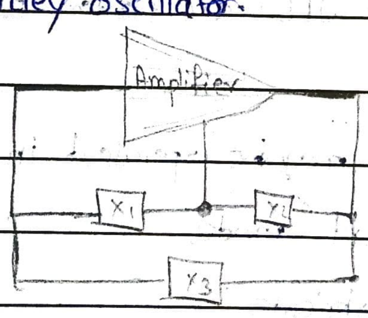
Oscillator: is a circuit which produces a continuous, repeated, alternating waveform without any input.

Types of oscillators

① Hartley Oscillator:-

If the elements in the basic resonant circuit of are X_1 and X_2 (inductors) and X_3 (capacitor), the circuit is Hartley oscillator.





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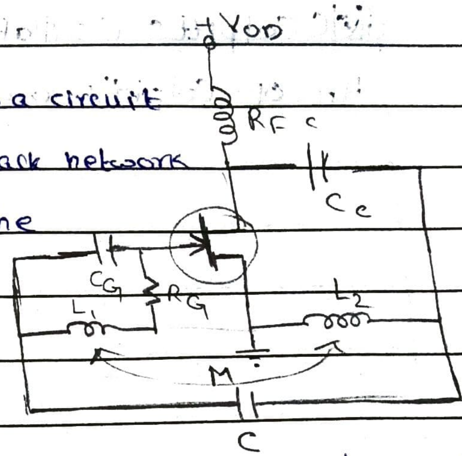
② **FET Hartley Oscillator:-**

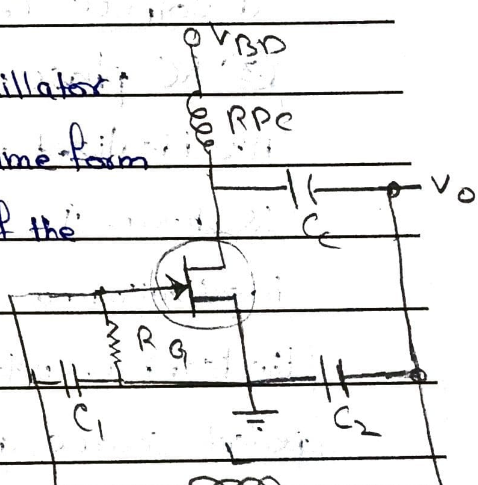


An FET Hartley oscillator circuit is a circuit which is drawn so that the feed back network conforms to the form shown in the basic resonant circuit. Note, however that inductors L_1 and L_2 have a mutual coupling M, which must be taken into account in determining the equivalent inductance for the resonant tank circuit. The circuit frequency of oscillation is the given approximately by

$$f_o = \frac{1}{2\pi\sqrt{L_{eq}\,C}}$$ with $L_{eq} = L_1 + L_2 + 2M$

③ **Colpitts Oscillators:-**

① **FET Colpitts oscillator:-**



A pratical version of an FET Colpitt's oscillator is shown Fig. The circuit is basically the same form as Hartley Oscillator, with the addition of the components needed for dc bias of the FET amplifier. The oscillator frequency can be found to be

$$f_o = \frac{1}{2\pi\sqrt{L\,C_{eq}}}$$ where $C_{eq} = \frac{C_1 C_2}{C_1 + C_2}$

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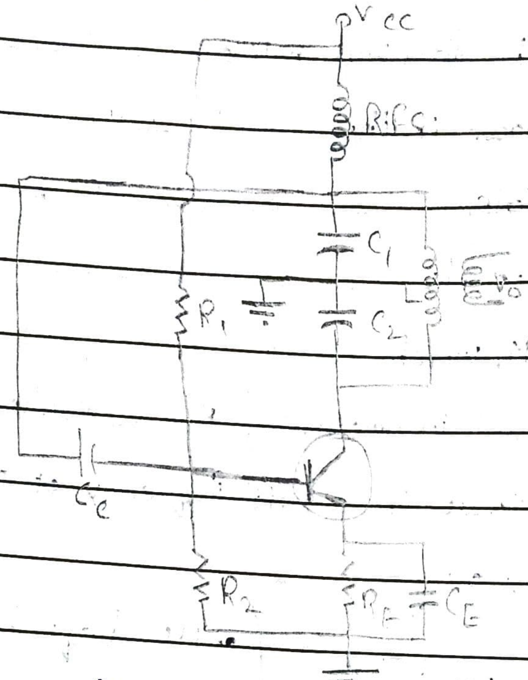
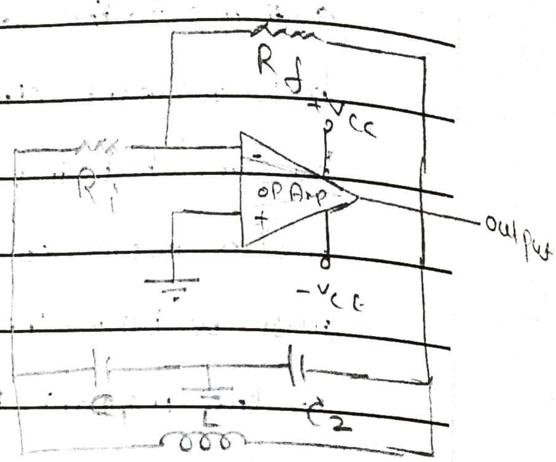
(ii) IC Colpitts Oscillator:

An op-Colpitt's oscillator circuit is shown:

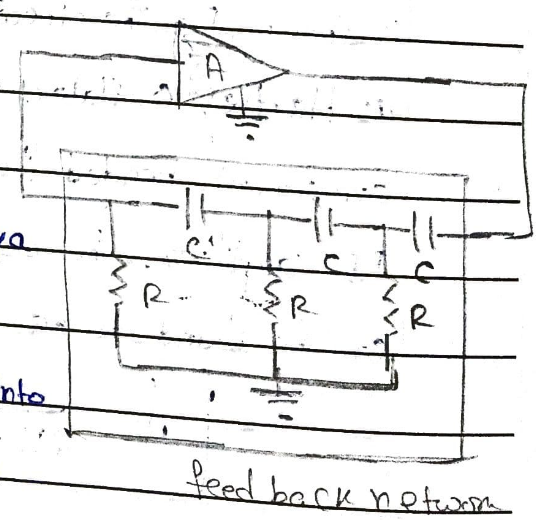




Again, the op-amp provides the basic amplification needed while the oscillator frequency is set by an LC feed back network of a Colpitts Configuration.

③ RC phase Shift Oscillator:-

An idealized version of this circuit is shown. In the present idealization, we are considering the feed back network to be driven by a perfect source and output of the feed back network to be connected into a perfect load. We are interested in the attenuation of the network at the frequency at which the phase shift is exactly 180° and phase shift is 180°.



$$f = \frac{1}{2\pi RC\sqrt{6}} \quad ; \beta = \frac{1}{29}$$

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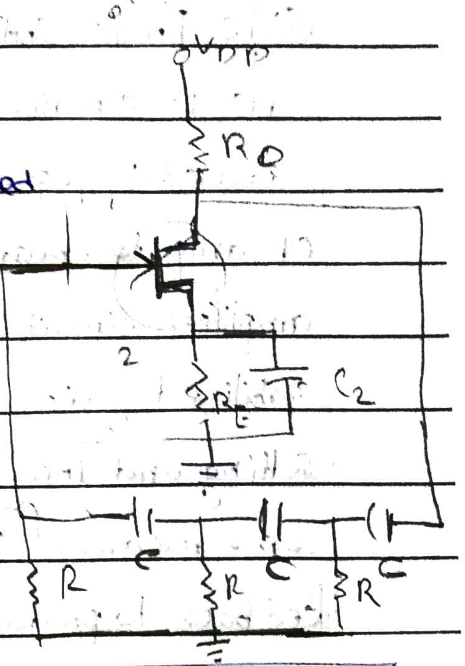
④ FET Phase-Shift Oscillator:-



The circuit is drawn show clearly that amplifier and feed back network. The amplified stage is self-baised with a capacitor bypassed sourse resistor Rs and drain bias resistor RD.

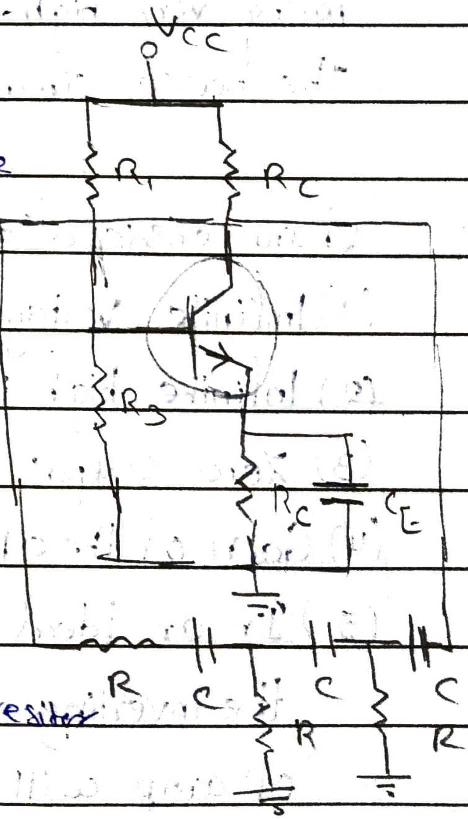
The FET device parameters of intrest are gm an rd from FET amplifier theory,

The amplifier gain magnitude is calculated from $|A| = g_m R_L$

$$R_L = \frac{R_D r_d}{R_D + r_d}$$

$$f = \frac{1}{2\pi\sqrt{6}RC}$$

⑤ Transistor Phase Shift Oscillator:-



If a transistor is used as the active element of the amplifier stage, the output of the feed back network is loaded appreciably by the relatively low input resistance (hie) of the transistor. In this connection, the feed back signal is coupled through the feed back resistor R in series with the amplifier stage input resistor (Ri)

$$f = \frac{1}{2\pi RC}\frac{1}{\sqrt{6+4(R_C/R)}}$$

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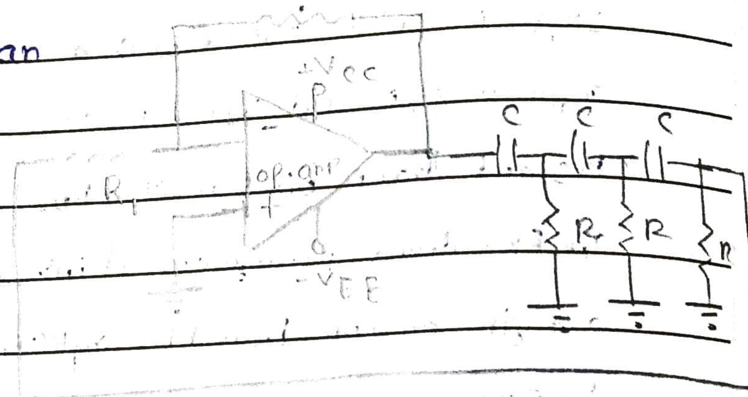
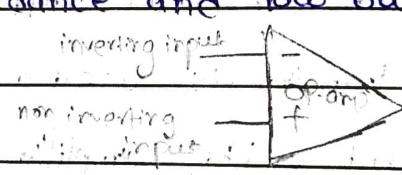
(6) Ic Phase shift Oscillator:-

As Ic circuits have become more popular, they have been adapted to operate in oscillator circuits. One need to by an OP-amp to obtain an amplifier circuit of stabilized gain setting and incooparate some means of signal feed back to produce an oscillator circuit as shown.



3 (a) Define OP-Amp and write characteristics of an ideal OP-Amp

Operational Amplifier (OP-Amp):- is a very high gain amplifier having very high input impedance and low output impedance. The basic circuit is



Characteristics of an Ideal OP-Amp:-

(1) Infinite Voltage gain

(2) Infinite high input impedance

(3) Zero Output impedance.

(4) Gain of the OP amp is independent of frequency,

(5) In an Ideal OP amp, if no voltage is applied to the inverting and non-inverting input pins the op amp will output a voltage 0.

(6) In ideal amp, the ac voltage which is fed into the

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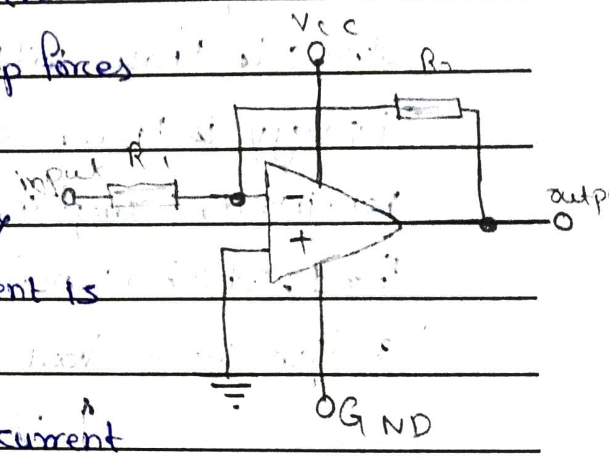
op amp to be amplified will swing all the way up for the DC positive supply rail on

(7) In an ideal op amp, the output will swing instantly to the amplified voltage value. There will be no time dealy between the time time voltage is input to op Amp till the time it is output

3(b) Compare inverting & non-inverting amplifiers?

(a) Inverting operational amplifier:

In inverting op-amp, the op-amp forces the negitive terminal to equal to positive terminal, which is commonly ground. Therefore, the input current is determined by Vin / R1 ratio



In this configuration the same current flows through R2 to the output. Ideally, current does not flow into the operational amplifier's negitive terminal due to its high Zin. The current flowing from the negitive terminal through R2 creates an inverted voltage polarity with respective to VIN. This is why these op amps are labelled with an inverting configuration. Vout can be calculated with,

$$V_{out} = -\left(\frac{R_2}{R_1}\right) \times V_{IN}$$

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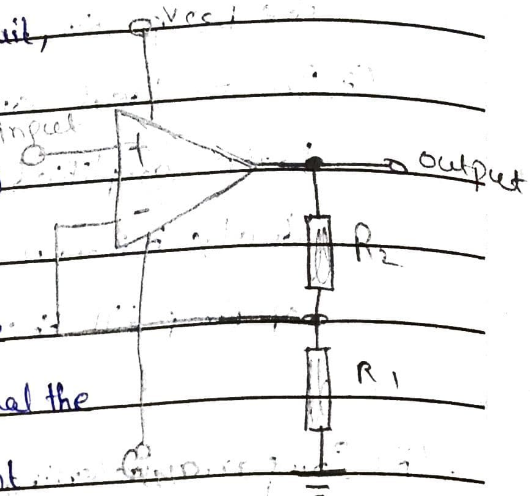
(b) Non - Inverting operational amplifier.

In an non-inverting amplifier circuit, the input signal from the source is connected to the non-inverting(+) terminal.



The operational amplifier forces the inverting(-) terminal voltage to equal the input voltage, which creates a current flow through the feed back resistors. The output voltage is always in Phase with the input voltage, which is why this topology is known as non - inverting. Note that with a non-inverting amplifier, the voltage gain is alway greater than 1, which is not always the case with the inverting configurations. Vout can be calculated as

$$V_{out} = \left(1 + \frac{R_2}{R_1}\right) \times V_{IN}$$