GOVERNMENT POLYTECHNIC COLLEGE BHILWARA

I MID TERM: 27TH November 2017

III- Year Electronics **Maximum Marks: 15**

Attempt all questions/ सभी प्रश्नों का उत्तर देना अनिवार्य है

1. What is an oscillator? What are different types of oscillators? [2 marks]
2. Explain any 1 biasing method of FET Amplifier [3 marks]
3. Describe the circuit diagram and working of **any 1** LC Oscillator [3 marks]
4. Calculate the **Voltage gain** and **Current Gain** of a Common Source Amplifier. [3 marks]
5. How does the **Voltage Gain** of amplifier changes at low and high frequency? Write the formulae. [4 marks]

SOLUTIONS

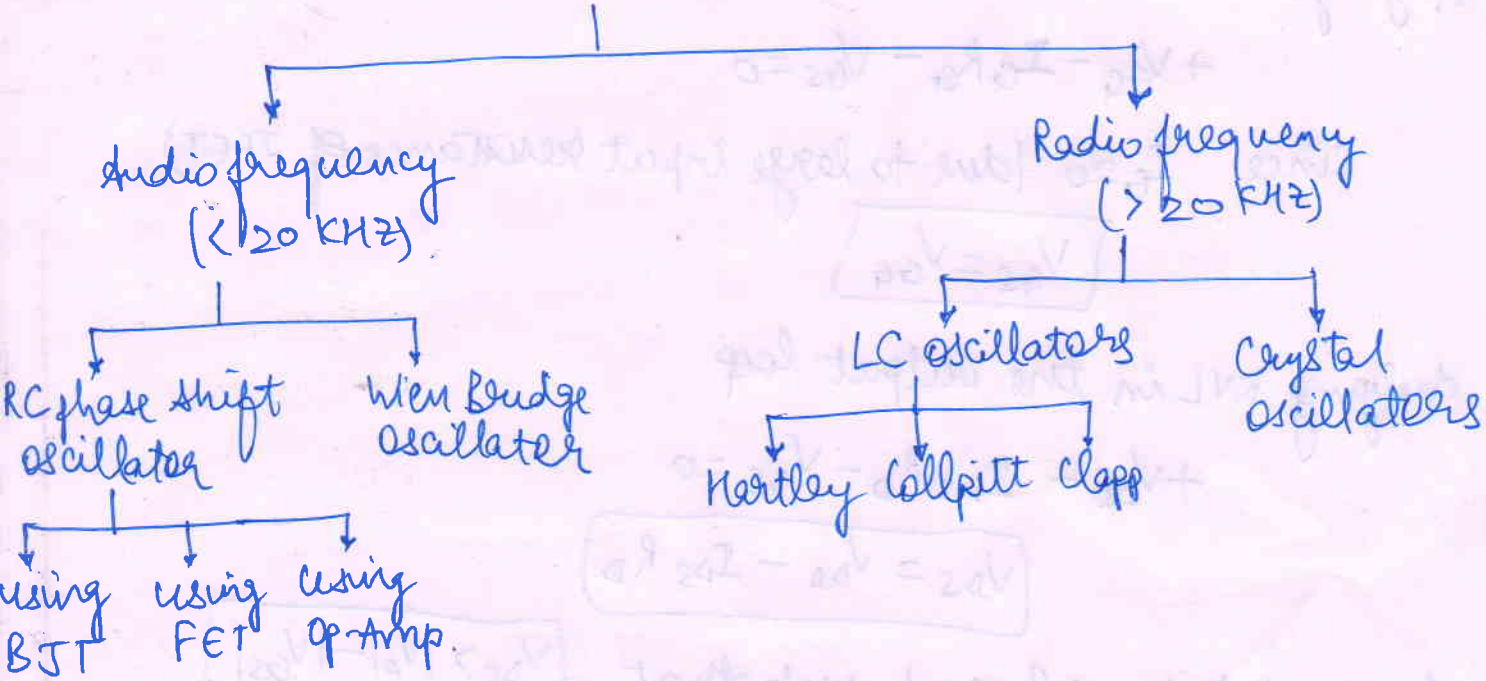
1st Mid-Term (EL-301) (27/11/2017)

① An oscillator is a circuit which generates an AC waveform without using an AC input.

→ Oscillators always produce sinusoidal waveforms

→ The circuits which generate non-sinusoidal waveforms such as square wave, triangular wave, etc. are called waveform generators

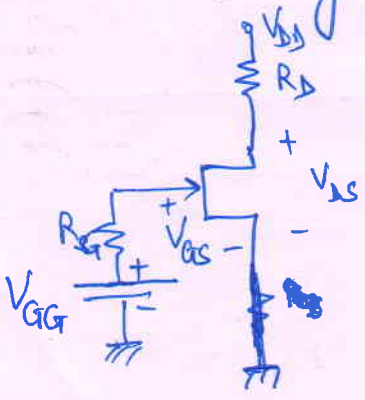
→ On the basis of frequency of operation, oscillators are classified as:



② Biasing Method of FET Amplifier

Gate Bias

The circuit used for such biasing is:



V_{DD}: Drain Supply

It is used to provide the drain current (I_{DS})

→ V_{DD} should be (+ve) for n-channel JFET

V_{DD} should be (−ve) for p-channel JFET

→ V_{GG}: Gate Supply

It maintains the gate channel junction in reverse bias and thus I_{DS} is controlled.

V_{GG} should be (+ve) for p-channel JFET

(−ve) for n-channel JFET

Applying KVL in the input loop

$$+V_{GG} - I_G R_G - V_{GS} = 0$$

Since $I_G \simeq 0$ (due to large input resistance of JFET)

$$\boxed{V_{GS} = V_{GG}}$$

Applying KVL in the output loop

$$+V_{DD} - I_{DS} R_D - V_{DS} = 0$$

$$\boxed{V_{DS} = V_{DD} - I_{DS} R_D}$$

R_D should be selected such that $\boxed{V_{DS} > |V_p| - |V_{GS}|}$

For the above condition JFET operates in saturation region.

Drawback

It requires two biasing supplies.

(3) LC oscillator

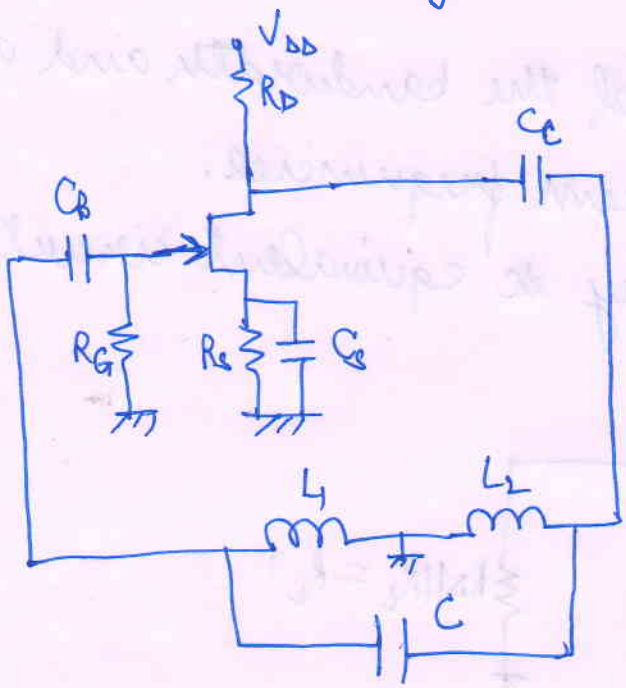
HARTLEY OSCILLATOR

→ It consists of a common source FET amplifier and an LC feedback network

→ The CS amplifier provides a phase shift of 180° between the input and output voltage waveforms

→ The LC feedback network provides an additional phase shift of 180°. Therefore the total phase shift around the loop becomes 360°, thereby satisfying Barkhausen's criteria

→

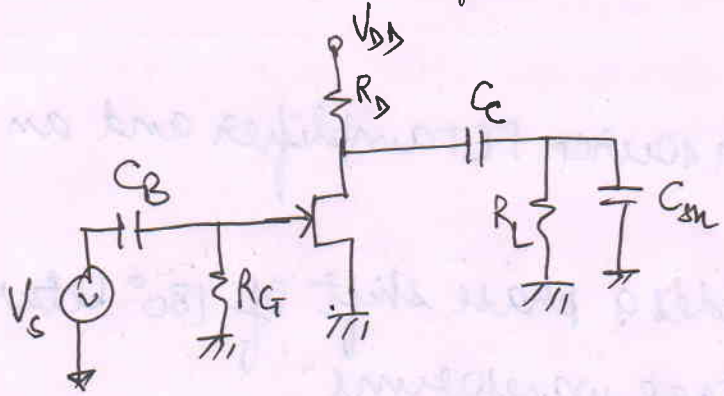


C_B and C_C prevents the shorting and drain and gate with respect to ground.

→ The frequency of oscillation is given as:

$$f_0 = \frac{1}{2\pi\sqrt{(L_1+L_2)C}}$$

(4) A common source amplifier can be shown as.

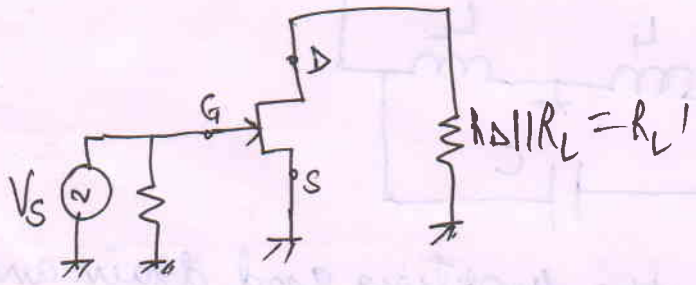


For the above circuit the source self bias configuration maintains the JFET in saturation region.

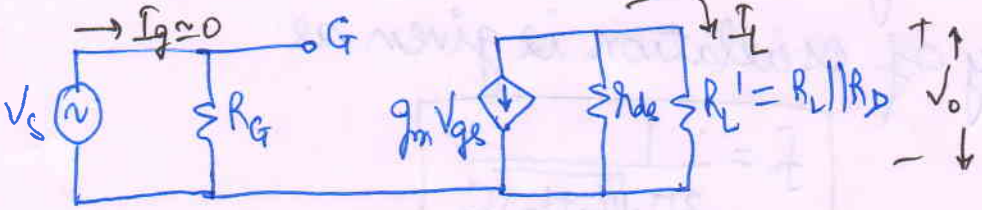
→ C_B and C_C can be considered as short circuit at medium frequencies

→ C_{SH} is used to control the bandwidth and acts as open circuit at medium frequencies.

→ The medium frequency ac equivalent circuit can be shown as:



The small signal model can be shown as,



(i) Current Gain $\quad A_I = \frac{I_L}{I_g}$

Since $I_g \simeq 0$, Hence $\boxed{A_I \simeq \infty}$

(ii) Voltage Gain

$$\frac{V_o}{V_i} = A_v$$

$$V_o = -g_m V_{gs} (r_{ds} \| R_L')$$

$$V_i = V_{gs}$$

Hence $$\boxed{A_V = -g_m (r_{ds} \| R_L')}$$

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(5) For an FET amplifier the Gain at low frequency is given as:

$$A_{VL} = \frac{A_{Vm}}{1 - j(f_L/f)}$$

or

$$\boxed{|A_{VL}| = \frac{|A_{Vm}|}{\sqrt{1 + \left(\frac{f_L}{f}\right)^2}}}$$

$$\boxed{\angle A_{VL} = 180^\circ + \tan^{-1}\left(\frac{f_L}{f}\right)}$$

The gain of an amplifier decreases at low frequencies due to the effect of large capacitors such as C_B, C_C and C_S

→ Similarly the gain at high frequencies is given as:

$$\boxed{A_{VH} = \frac{A_{Vm}}{1 + j(f/f_H)}}$$

$$\boxed{|A_{VH}| = \frac{|A_{Vm}|}{\sqrt{1 + \left(\frac{f}{f_H}\right)^2}}}$$

$$\boxed{\angle A_{VH} = 180^\circ - \tan^{-1}\left(\frac{f}{f_H}\right)}$$

(P.D. Upadhyay)