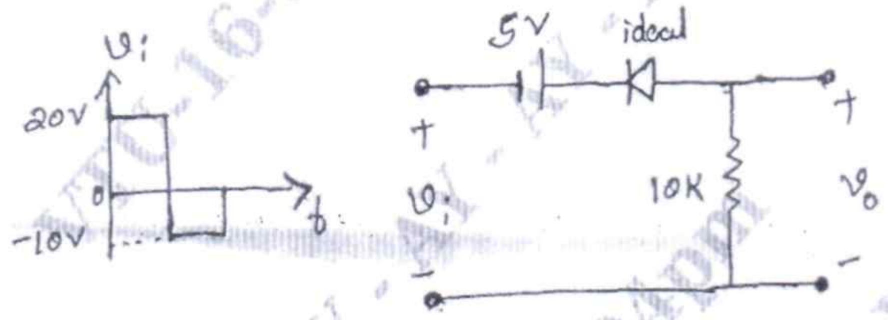
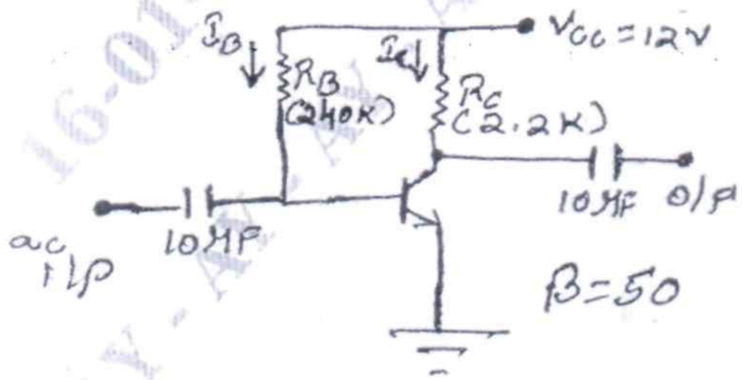
CBCS SCHEME

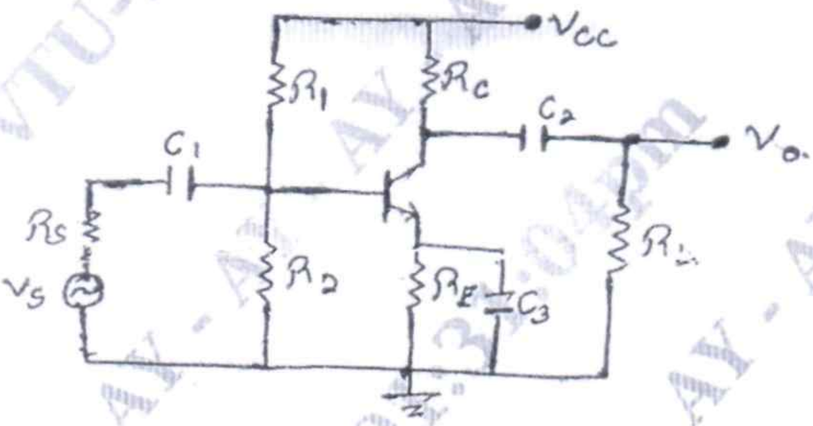
USN | | | | | | | | | | | **BEE303**

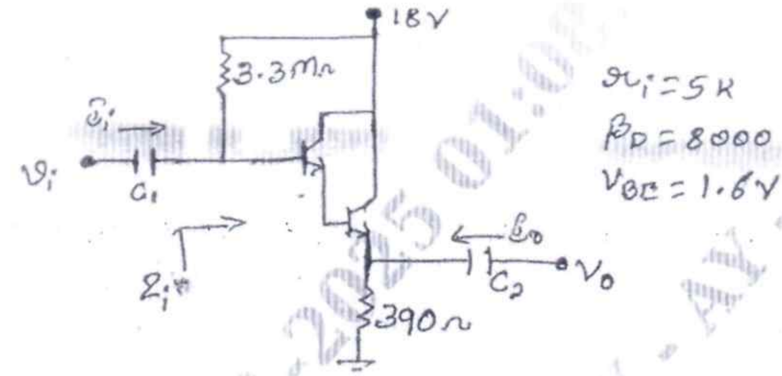
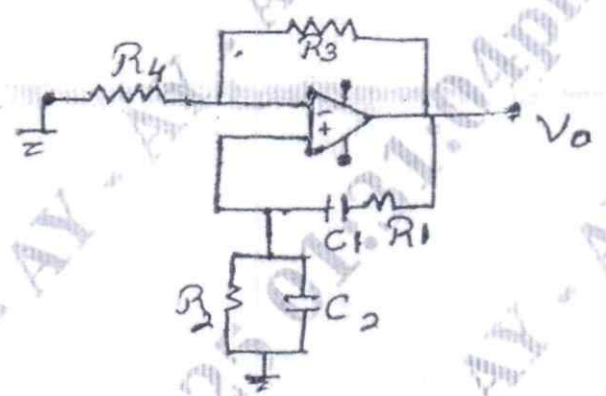
Third Semester B.E./B.Tech. Degree Examination, Dec.2024/Jan.2025
Analog Electronic Circuits

Time: 3 hrs.   Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. M : Marks , L: Bloom's level , C: Course outcomes.

		Module – 1	M	L	C
Q.1	a.	Explain the operation of positive shunt clipper.	8	L2	CO1
	b.	Derive an expression for the stability factor $S_{(VBE)}$ and $S_{(ICO)}$ for fixed bias circuit.	6	L3	CO1
	c.	For the circuit shown in Fig Q1(c), sketch the output voltage waveform.  Fig Q1 (c)	6	L3	CO1
		OR			
Q.2	a.	With circuit diagram, explain voltage divider biasing circuit. Also derive the I_B and V_{CE}.	8	L2,3	CO1
	b.	Draw and explain the working of negatives peak clamper.	6	L1,2	CO1
	c.	Determine the following for the fixed bias configuration shown in Fig Q2(c). i) I_{BQ} and I_{CQ} ii) V_{CEQ} iii) V_B and V_C iv) V_{BC}  Fig Q2(c)	6	L3	CO1

		Module – 2			
Q.3	a.	State and prove dual of miller's theorem	6	L1,4	CO2
	b.	Define h-parameters. Draw the h-parameter model of a transistor in CE mode.	6	L1,2	CO2
	c.	Obtain midband analysis of BJT single stage amplifier. Derive expression for current gain and input impendence.	8	L3,4	CO2
		OR			
Q.4	a.	Mention various capacitors effects on frequency response. Derive equations for miller input capacitors and miller output capacitance.	10	L1,3	CO2
	b.	Consider a single stage CE amplifier with $R_s = 1K$, $R_1 = 50K$, $R_2 = 2K$, $R_c = 2K$, $R_L = 2K$, $h_{fe} = 50$, $h_{ie} = 1.1K$, $h_{oe} = 25\ \mu A/V$ and $h_{re} = 2.5 \times 10^{-4}$ as shown in Fig Q4(b). Find A_i, R_i, R_o, A_v.  Fig Q4(b)	10	L3	CO2
		Module – 3			
Q.5	a.	Explain the need of a cascading amplifier. Draw and explain to block diagram of two stage cascade amplifier.	8	L2	CO3
	b.	For voltage series feedback amplifier, derive an expression for input impedance and output impedance.	8	L3	CO3
	c.	A feedback amplifier has a gain of 1000 without feedback. Find the gain with feedback for a negative feedback of 10% (gain in dB).	4	L3	CO3
		OR			
Q.6	a.	Draw a feedback amplifier in block diagram form. Identify each block and explain its function.	10	L1,2	CO3

	b.	For the Darlington emitter – follower shown in Fig Q6(b), calculate i) The DC bias voltage V_B, V_E, V_C and current and I_B and I_C ii) The input and output impedances iii) The voltage and current gains iv) The ac output voltage for V_i = 120mV.  Fig Q6(b)	10	L3	CO3
		Module – 4			
Q.7	a.	Ananlyze the working of series fed directly coupled class A power amplifier with respect to efficiency.	8	L4	CO4
	b.	Design the component values of wein bridge oscillator of Fig Q7(b) for a frequency of oscillations of 4 KHz.  Fig Q7(b)	4	L4	CO4
	c.	Explain the characteristics of crystal with neat diagram, explain the crystal oscillation in series resonances circuit.	8	L2	CO4
		OR			
Q.8	a.	Examine the basic principle of oscillators.	6	L4	CO4
	b.	An ideal class B push pull power amplifier with input is output transformers has V_{cc} = 20V, $N_2 = 2N_1$ and $R_L = 20\Omega$. The transistors has h_{FE} = 20. Let the input be sinusoidal. For maximum output signal at $V_{CE(P)} = V_{CC}$. Determine : i) The output signal power ii) The collector dissipation in each transistor iii) Conversion efficiency	6	L3	CO4

	c.	Discuss the different types of power amplifiers.	8	L4	CO4
		Module – 5			
Q.9	a.	Explain the basic operation and characteristics of n-channel depletion type MOSFET.	10	L2	CO4
	b.	Derive expression for z_i, z_0, A_v for voltage divider bias circuit using FET.	10	L3	CO4
		OR			
Q.10	a.	With neat diagram, explain the construction of n channel JFET.	10	L2	CO5
	b.	Data sheet for a JFET indicates that I_{DSS} = 10mA and $V_{GS(off)}$ = -4V. Determine the drain current for V_{GS} = 0V, -1V and -4V.	6	L3	CO5
	c.	Discuss the difference between JFET and MOSFET.	4	L4	CO5

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Jun..- December 2024 - Jan 2025

Analog Electronic Circuits (BEE303)

Subject Code : BEE303.

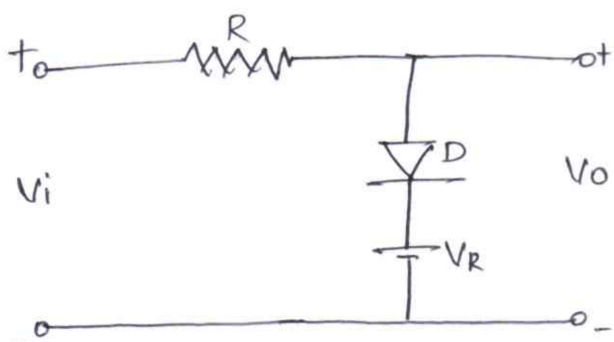
Semester : 3rd

Prepared By : Prof. Ravindra Motekar.

Module 1

1a) Explain the Operation of Positive Shunt Clipper —— 8M.

→



In ||el clipper, diode appears in the parallel branch or shunt with the applied input signal

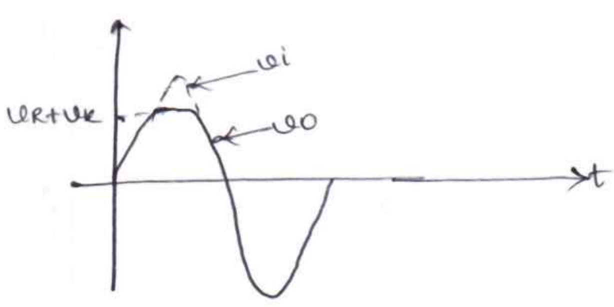
$v_i \geq V_R + V_K$

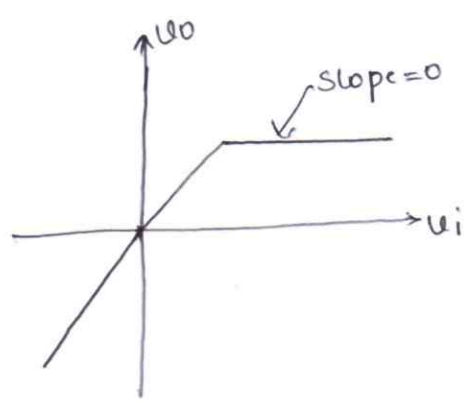
from the equivalent ckt, we find that

$v_o = V_R + V_K$ for $v_i \geq V_R + V_K$

$v_i - iR - v_o = 0$

or $v_o = v_i$, for $v_i < V_R + V_K$





1b) Derive an expression for stability factor $S(V_{BE})$ & $S(I_{CO})$ for fixed bias circuit — 6M

→ $$S(I_{CO}) = \frac{\partial I_C}{\partial I_{CO}}$$

$$I_B = \frac{V_{CC} - V_{BE}}{R_B}$$

But $V_{CC} >> V_{BE}$

$$I_B \approx \frac{V_{CC}}{R_B}$$

$$\frac{\partial I_B}{\partial I_C} = 0.$$

$$\therefore S(I_{CO}) = 1 + \beta$$

$$S(V_{BE}) = \frac{\partial I_C}{\partial V_{BE}}$$

$$V_{CC} = I_B R_B + V_{BE}$$

$$\therefore V_{BE} = V_{CC} - I_B R_B.$$

But $I_B \approx \frac{I_C}{\beta}$

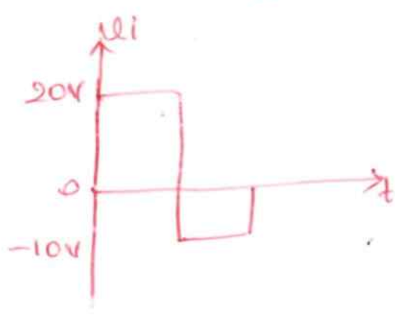
$$\therefore V_{BE} = V_{CC} - \frac{I_C}{\beta} R_B$$

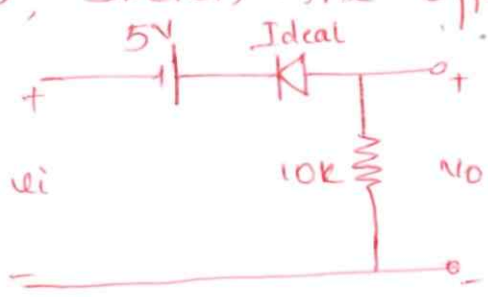
Differentiating w.r.t V_{BE}, keeping β constant, we get

$$1 = 0 - \frac{R_B}{\beta} \frac{\partial I_C}{\partial V_{BE}}$$

$$\therefore S(V_{BE}) = -\beta / R_B.$$

1(c) for the ckt shown, sketch the o/p vltg waveform → 6m



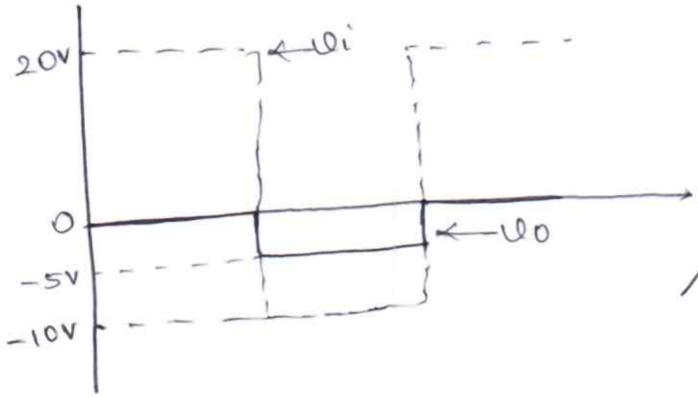


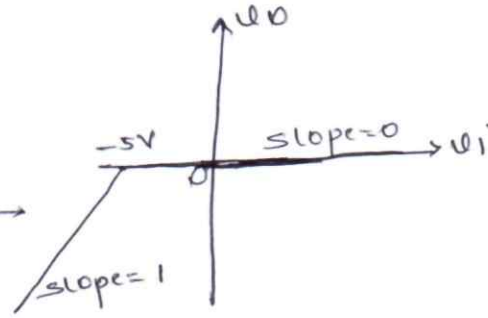
$v_i + 5 - v_o = 0$

$v_o = v_i + 5$ for $v_i \geq 4.3V$

when $v_i = 20V$

$v_o = 20 + 5 = 25V.$

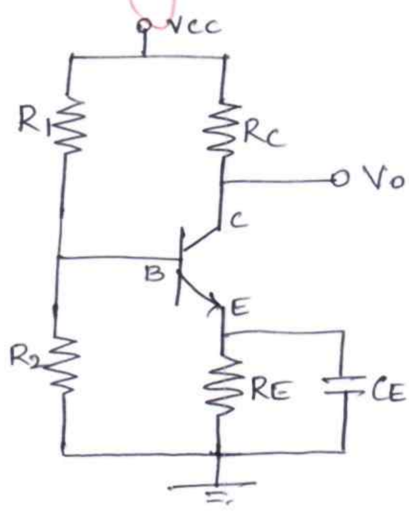




OR

2(a) With neat ckt diagram, explain voltage divider biasing ckt. Also derive I_B & V_{CE}. (8M)

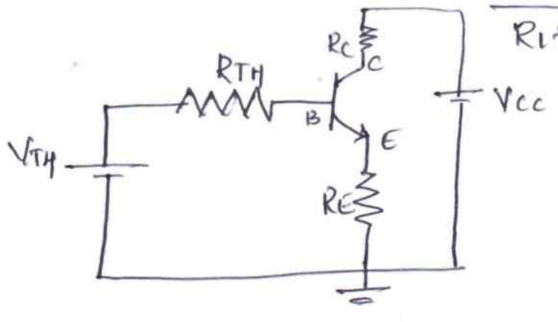
→



To find V_{TH} & R_{TH}. Using Thevinin's theorem.

$$V_{TH} = \frac{V_{cc} \cdot R_2}{R_1 + R_2}$$

$$R_{TH} = R_1 || R_2 = \frac{R_1 R_2}{R_1 + R_2}$$



Applying KVL to i/p ckt we get

$V_{TH} - I_B R_{TH} - V_{BE} - I_E R_E = 0$.

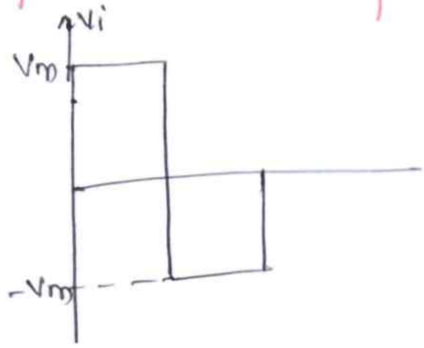
$$\therefore I_B = \frac{V_{TH} - V_{BE}}{R_{TH} + (1+\beta) R_E}$$

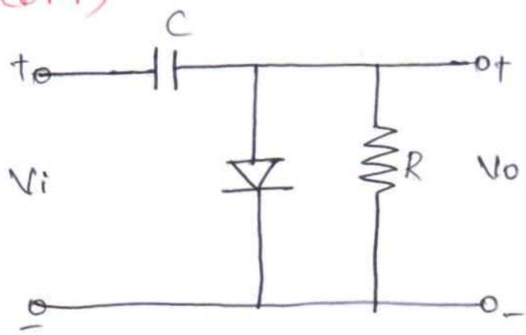
& $V_{CE} = V_{CC} - I_C R_C - I_E R_E$

$$V_{CE} = V_{CC} - I_C (R_C + R_E)$$

2(b) Draw & explain the working of Negative peak Clamper (6M)

→





By KVL equⁿ $V_i - V_C - V_K = 0$

$V_C = V_i - V_K$

$V_i = V_m$

$V_C = V_m - V_K$.

& Writing KVL equⁿ again.

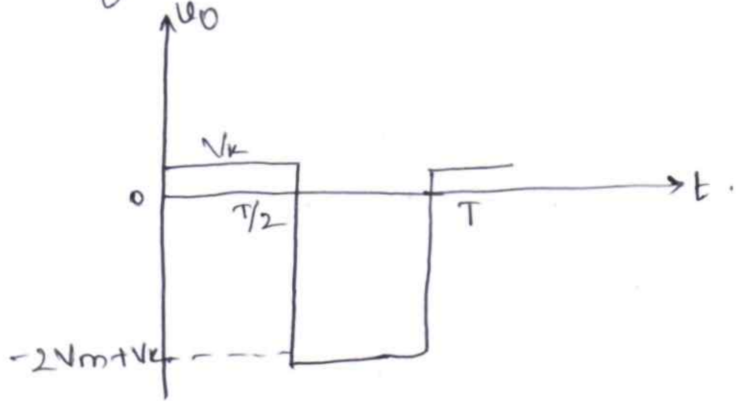
$V_i - V_C - V_O = 0$

$V_O = V_i - V_C$

$V_C = V_m - V_K$.

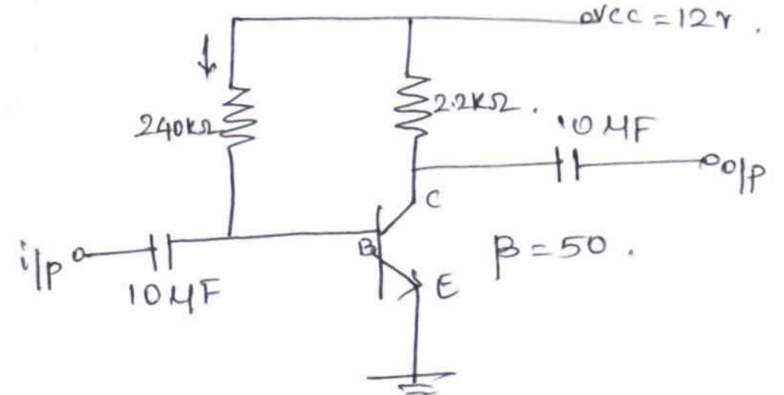
$\therefore V_O = V_i - [V_m - V_K]$.

O/P waveform is.



2(c) Determine the foll for the fixed bias configuration shown in fig. (6M)

(i) I_{BQ} & I_{CQ} ii) V_{CEQ} iii) V_B & V_C iv) V_{BC}.



(i) $I_B = \dfrac{V_{CC} - V_{BE}}{R_B} = \dfrac{12 - 0.7}{240 \times 10^3} = 47.08\,\mu A.$

$I_C = \beta I_B = 50 \times 47.08\,\mu A = 2.35\,mA.$

(ii) $V_{CE} = V_{CC} - I_C R_C$

$= 12 - (2.35m)(2.2 \times 10^3)$

$= 6.83\,V.$

iii) $V_{BE} = V_B - V_E$

$\therefore V_B = 0.7V$

$V_{CE} = V_C - V_E$

$\therefore V_C = 6.83V.$

(iv) $V_{BC} = V_B - V_C$

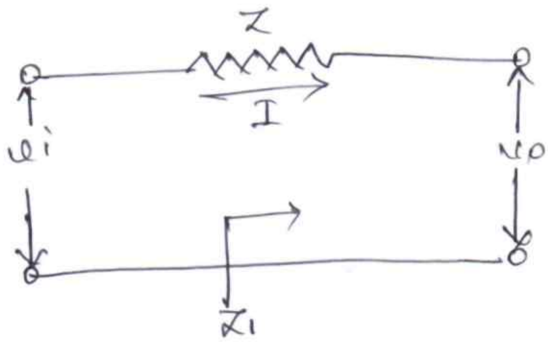
$= 0.7 - 6.83$

$= -6.13V.$

Module 2

3(a) State & prove dual of Miller's theorem. (6M)

→



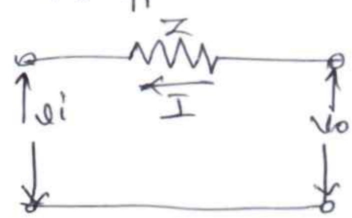
$Z_1 = \frac{V_i}{I}$

where, $I = \frac{V_i - V_o}{Z} = \frac{V_i\left[1 - \frac{V_o}{V_i}\right]}{Z}$

$\therefore Z_1 = \frac{Z}{1 - A_v} = \frac{Z}{1-k}.$

Miller's theorem states that effect of resist 'Z' on the o/p ckt is ratio of Vo to current I which flows from o/p to i/p.

$\therefore Z_2 = \frac{V_o}{I}$



where, $I = \frac{V_o - V_i}{Z} = \frac{V_o}{Z}\left[1 - \frac{V_i}{V_o}\right]$

$= \frac{V_o\left[1 - 1/A_v\right]}{Z}$

$= \frac{V_o\left[\frac{A_v - 1}{A_v}\right]}{Z}$

$\therefore Z_2 = \frac{Zk}{k-1}$

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

3(b) Define h parameters. Draw the h-parameter model of a transistor in CE mode. (6M)

→ $h_{11} = \frac{V_i}{I_i}\Big|_{V_o=0}$ $h_{12} = \frac{V_i}{V_o}\Big|_{I_i=0}$

$h_{21} = \frac{I_o}{I_i}\Big|_{V_o=0}$ $h_{22} = \frac{I_o}{V_o}\Big|_{I_i=0}$.

from the above discussion we say that all 4 parameters are not the same. They are different & all have different units. Hence called as hybrid parameters.

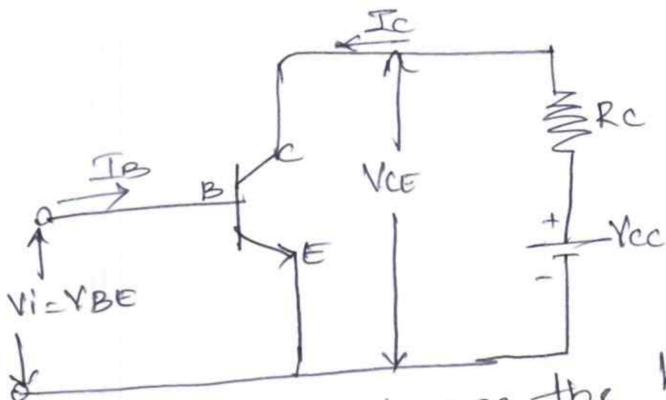
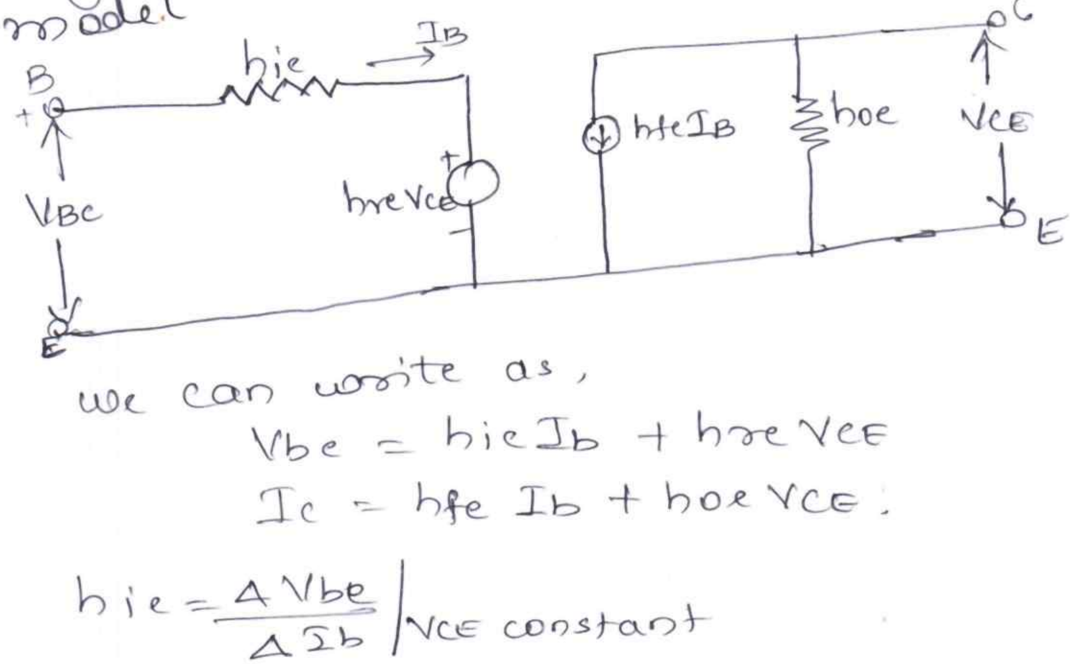


fig below shows the h-parameter equivalent model



we can write as,

$V_{be} = h_{ie} I_b + h_{re} V_{CE}$

$I_c = h_{fe} I_b + h_{oe} V_{CE}$.

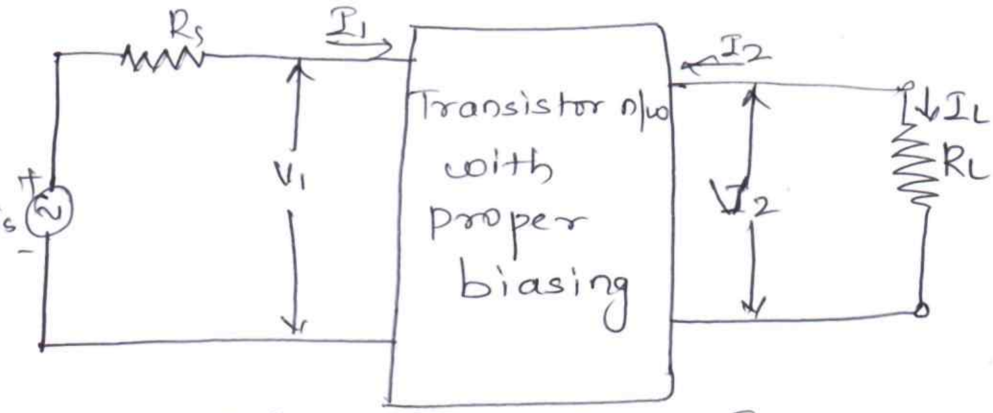
$h_{ie} = \frac{\Delta V_{be}}{\Delta I_b}\Big|_{V_{CE}\text{ constant}}$

$h_{re} = \frac{\Delta V_{BE}}{\Delta V_{CE}}\Big|_{I_b\text{ constant}}$ & $h_{oe} = \frac{\Delta I_c}{\Delta V_{CE}}\Big|_{I_b\text{ constant}}$

$h_{fe} = \Delta I_c / \Delta I_B \Big|_{V_{CE}\text{ constant}}$

(3c) Obtain midband analysis of BJT single stage amplifier. Derive expression for A_I & Z_i - - - (8M)

→



* Current Gain :- $A_I = \frac{I_L}{I_1} = \frac{-I_2}{I_1}$

from ckt, $I_2 = h_f I_1 + h_o V_2$

$\therefore I_2 + h_o I_2 R_L = h_f I_1$

$\therefore (1 + h_o R_L) I_2 = h_f I_1$

$\therefore \frac{I_2}{I_1} = \frac{h_f}{1 + h_o R_L}$

$$\therefore A_I = \frac{-I_2}{I_1} = \frac{-h_f}{1 + h_o R_L}$$

* Input Impedance (Z_i)

$R_i = \frac{V_1}{I_1}$

$\therefore$ from i/p ckt we have,

$V_1 = h_i I_1 + h_r V_2$

$\therefore Z_i = \frac{V_1}{I_1} = \frac{h_i I_1 + h_r V_2}{I_1}$

$$\therefore Z_i = h_i - \frac{h_r h_f R_L}{1 + h_o R_L}$$

OR

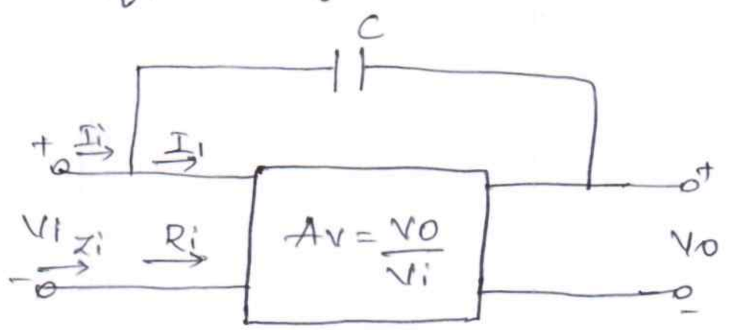
4(a) Mention various Capacitors effects on freq response. Derive expression for Miller's i/p & o/p Capacitance (10m)

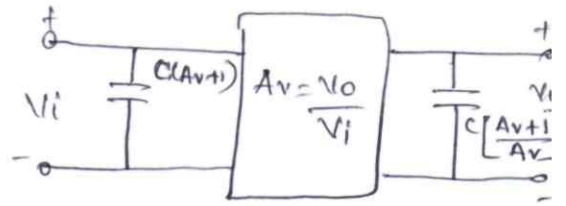
→ 1) Effect of Coupling Capacitors:-

$$X_C = \frac{1}{2\pi f C}$$

2) Effect of Bypass Capacitors.

3) Effect of Internal transistor capacitances





let $I_i = I_1 + I_2$

$$I_i = \frac{V_i}{Z_i} \quad \& \quad I_1 = \frac{V_i}{R_i}$$

$$\& \; I_2 = \frac{V_i - V_O}{X_C} = \frac{V_i - A_V V_i}{X_C} = \frac{(1-A_V)V_i}{X_C}.$$

$$\therefore I_i = \frac{V_i}{Z_i} = \frac{V_i}{R_i} + \frac{(1-A_V)V_i}{X_C}.$$

$$\frac{1}{Z_i} = \frac{1}{R_i} + \frac{1}{X_{CM}}.$$

$$\frac{1}{2\pi f C_M} = \frac{1}{(1-A_V)(2\pi f C)}$$

$$\therefore \frac{1}{C_M} = \frac{1}{C(1-A_V)}$$

$$\therefore \boxed{C_M = (1-A_V)C}$$

Applying KCL we have

$$I_O = I_1 + I_2$$

where $I_1 = V_O/R_O$ & $I_2 = \frac{V_O - V_i}{X_C}$

$$I_o \approx \frac{V_o - V_i}{X_C}.$$

$$\therefore I_o = \frac{V_o - V_o/A_V}{X_C} = \frac{V_o(1-1/A_V)}{X_C}.$$

$$\& \frac{I_o}{V_o} = \frac{1-1/A_V}{X_C}$$

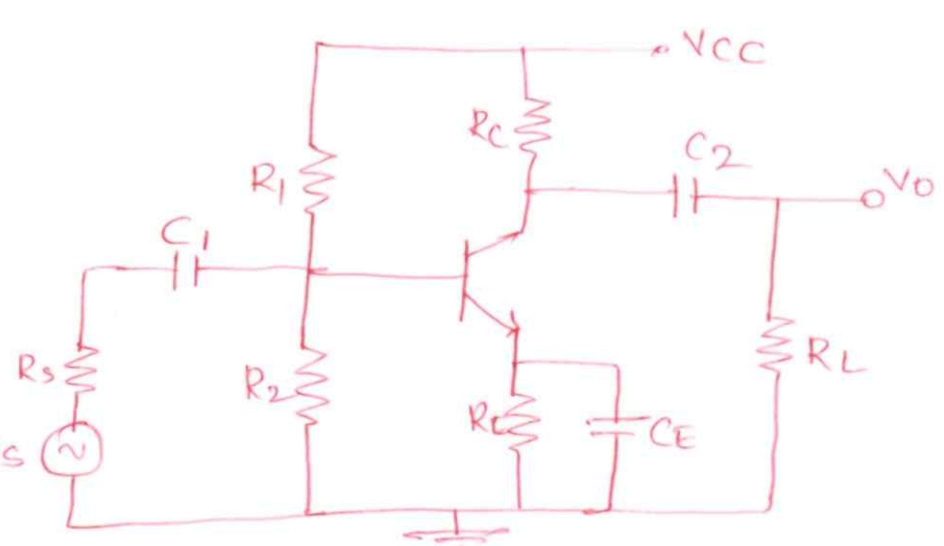
$$\text{or } \frac{V_o}{I_o} = \frac{X_C}{1-1/A_V} = X_{CMO}.$$

$$\therefore X_{CMO} = \frac{X_C}{1-1/A_V}.$$

$$\frac{1}{2\pi f C_{MO}} = \frac{1}{2\pi f C(1-1/A_V)}$$

$$\therefore \boxed{C_{MO} = C(1-1/A_V)}$$

4(b) Consider a single stage amplifier with $R_s = 1K\Omega$, $R_1 = 50K$, $R_2 = 2K$, $R_C = 2K$, $R_L = 2D$, $h_{fe} = 50$, $h_{ie} = 1.1K$, $h_{oe} = 25\,\gamma A/V$ & $h_{re} = 2.5 \times 10^{-4}$ as shown in fig. find A_I, R_i, R_O, A (10M)



Sol^n :→ $R_i = R_1 || R_2 || h_{ie}$.

$$= \left(\frac{1}{50k} + \frac{1}{2k} + \frac{1}{1.1k}\right)^{-1}$$

$$\approx 700\,\Omega$$

(2) Voltage Gain (A_v)

$$A_v = \frac{-h_{fe}(R_C \| R_L)}{h_{ie}}.$$

$$R_C \| R_L = 2K \| 2K = 1K\Omega.$$

$$A_v = \frac{-50 \cdot 1K}{1.1K} \approx -45.45.$$

(3) O/P Resistance (R_O)

$$R_O = R_C \| (1/h_{oe})$$

$$= 2K \| \left(\frac{1}{25\times10^{-6}}\right)$$

$$= 2K \| 40K$$

$$= 1.905 K\Omega$$

(4) Current Gain (A_i)

$$A_i = \frac{I_L}{I_s} = A_v \cdot \frac{R_i}{R_L}$$

$$A_i = -45.45 \times \frac{700}{2000}$$

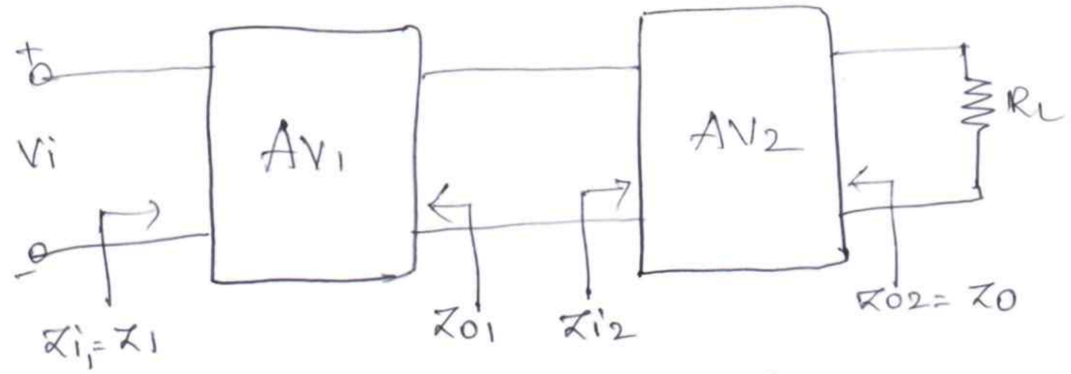
$$\approx -15.9.$$

Module - 3

5(a) Explain the need of a Cascading amplifier. Draw & explain block diagram of 2 stage Cascade Amplifier (8M)

→ When the amplification from a single stage amplifier is not sufficient for a particular purpose, or when the i/p or o/p impedance is not of suitable magnitude, then two or more amplifier stages are connected in

Cascade. The cascade of CE & CB stages is called cascode amplifier.



$Z_i = Z_{i1}$ & $Z_o = Z_{o3}$

$$A_{VT} = \frac{V_o}{V_i}$$

$$A_{VT} = \frac{V_o}{V_{i2}} \cdot \frac{V_{i2}}{V_i}$$

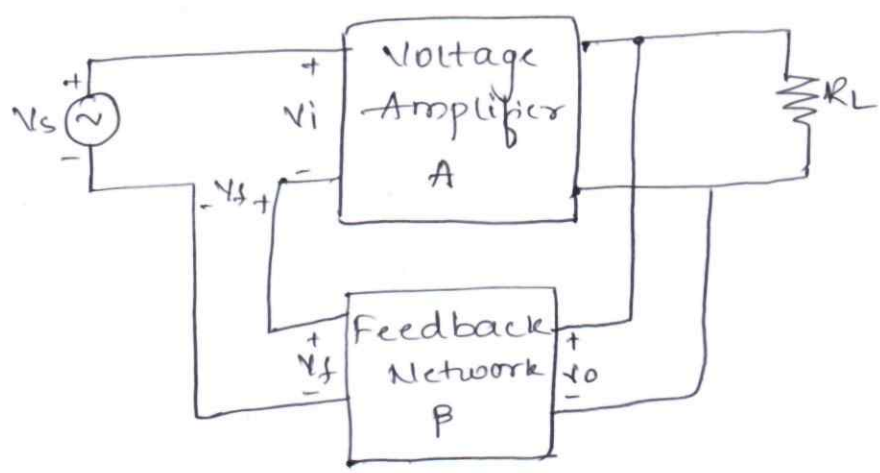
$$\boxed{A_{VT} = \frac{V_o}{V_i}}$$

$$\therefore \boxed{A_{VT} = A_{V1} \cdot A_{V2}}$$

$$A_{IT} = -A_{VT} \cdot \frac{Z_i}{R_L}$$

5b) For voltage series feedback Amplifier. derive an expression for i/p & o/p impd (8M)

→



Transfer gain without f/b

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

Transfer gain with f/b $A_f = \frac{V_o}{V_s}$.

$A = A_v$ & $A_f = A_{vf}$.

$$\therefore \beta = \frac{V_f}{V_o}$$

or $\boxed{V_f = \beta V_o}$

5(c) A f/b amplifier has a gain of 1000 without f/b. Find the gain with f/b for a negative f/b of 10% (gain in dB). (4M)

→ $A = 1000$

$\beta = 10\% = 0.1$

$$A_f = \frac{A}{1 + A\beta}.$$

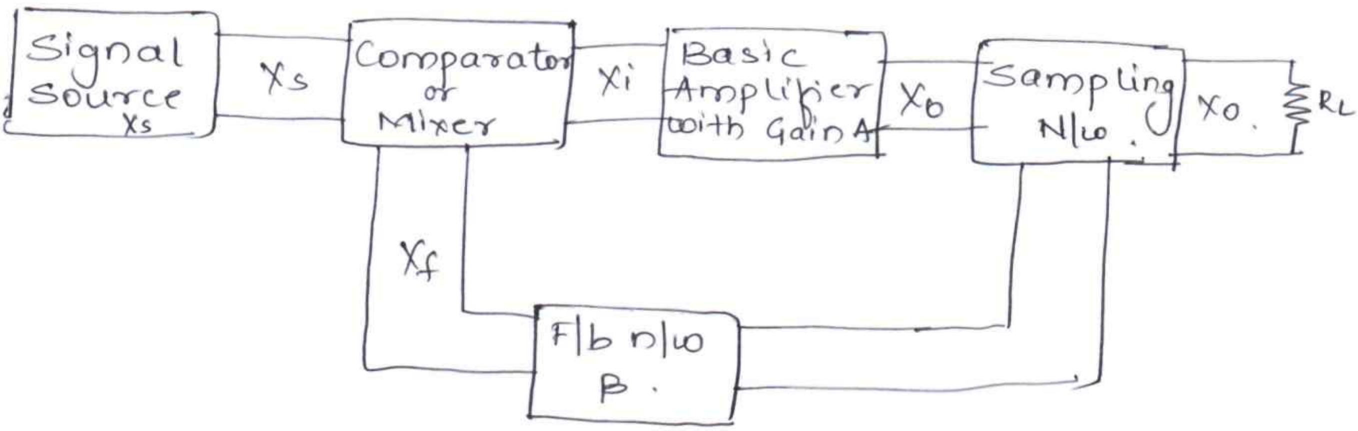
$$A_f = \frac{1000}{1 + 1000(0.1)} \approx 9.90$$

$$\text{Gain (dB)} = 20 \log_{10}(A_f)$$

$$= 20 \log_{10}(9.90)$$

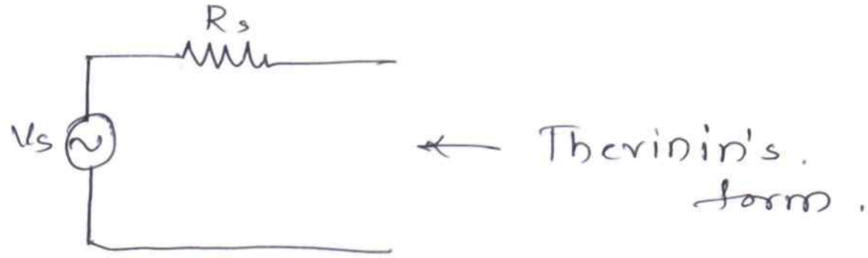
$$= 19.91 \text{ dB}.$$

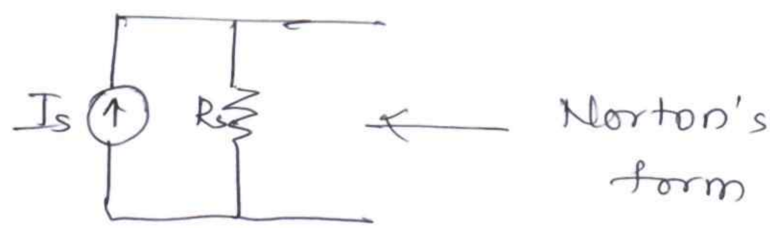
6a) Draw a f/b amplifier in block diagram form. Identify each block & explain its functions (10M)



* Signal Source :-

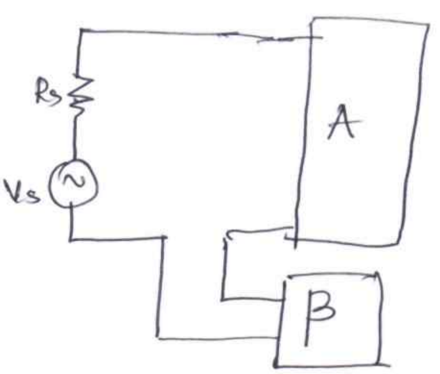
It may be either a Vltg source or a Current source. Vltg source is represented by Therinin's Representation & Current source by Norton's form.



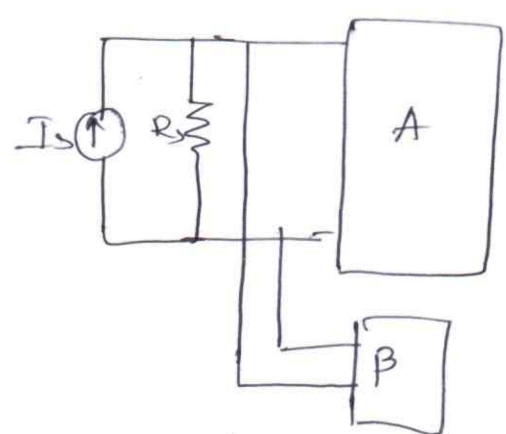


* Comparator or Mixer :-

There are of 2 types of mixing possible, either series mixing or shunt mixing.



series mixing



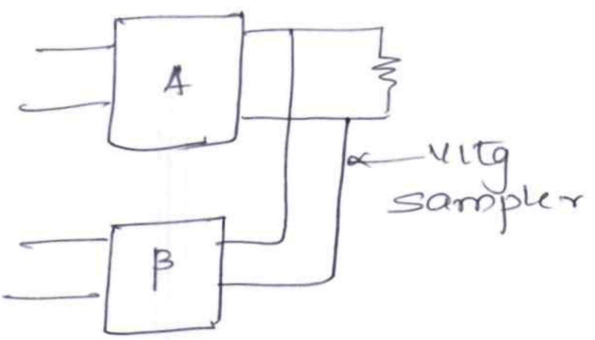
Shunt mixing

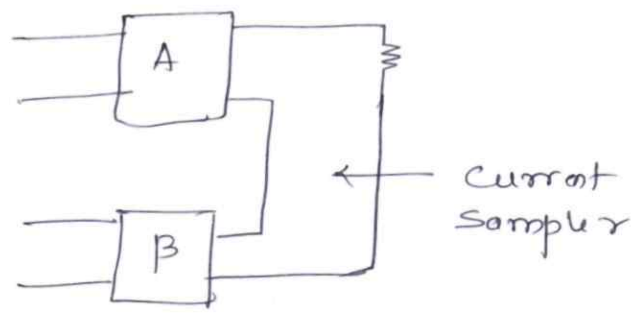
* **Amplifier :-** $A_V = \frac{V_o}{V_i}$ $A_I = \frac{I_o}{I_i}$

$A_{VS} = \frac{V_o}{V_s}$. $A_{Is} = \frac{I_o}{I_s}$.

* **Sampling N/w:**

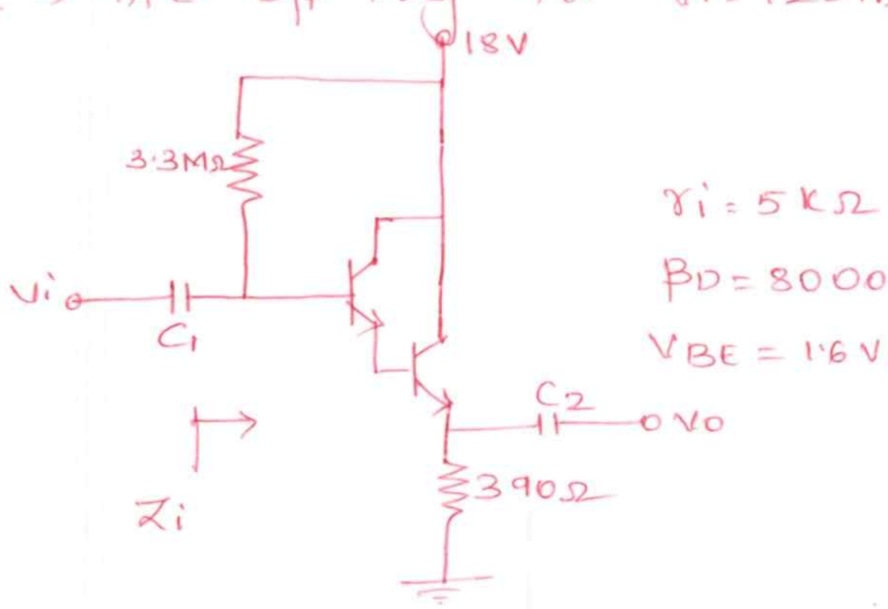
Depending upon the o/p, it may be either voltage or current sampling.





* feedback n/w β, consists of all passive elements. In many cases 'R' only is used.

6(b) For the Darlington Emitter follower shown in fig, calculate
(i) DC bias vltg V_B, V_C & V_E & Current I_B & I_C
(ii) I/p & O/p impedances
(iii) vltg & current Gains.
(iv) AC o/p vltg for $V_i = 120mV$ (10M)



(i)
$$I_B = \frac{V_{CC} - V_{BE}}{R_B + \beta_D R_E}$$

$$= \frac{18 - 1.6}{3.3M + (8000)(390)} = 2.55\mu A$$

$$I_E = I_{E2} \approx I_{C2} = \beta_D I_B.$$

$$= (8000)(2.55\mu) = 20.4mA.$$

$$V_E = I_E R_E = (20.4mA)(390) = 7.96V$$

$$V_B = V_{BE} + V_E = 1.6 + 7.96 = 9.56V$$

$$\therefore V_C = V_{CC} = 18V.$$

ii)
$$Z_b = r_i + (1+\beta_D) R_E$$

$$= 5k + (8001)(390)$$

$$= 3.13 m\Omega.$$

$$Z_i = R_B || Z_b = 3.3m\Omega || 3.13m\Omega$$

$$= 1.6m\Omega.$$

$$Z_o = r_i || R_E || \frac{r_i}{\beta_D}$$

$$= 5k || 390 || \frac{5k}{8000} = 0.625\Omega.$$

(3)
$$A_v = \frac{R_E(1+\beta_D)}{r_i + R_E(1+\beta_D)}$$

$$= \frac{390(8001)}{5k + 390(8001)}$$

$$= 0.998$$

(4)
$$A_I = \frac{\beta_D R_B}{R_B + \beta_D R_E}$$

$$= \frac{8000(3.3m)}{3.3m + (8000)(390)} = 4112.15.$$

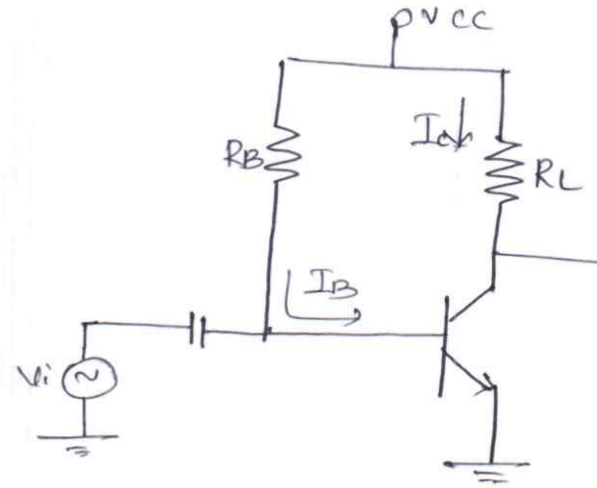
(5)
$$V_o = A_v V_i = (0.998)(120mV)$$

$$= 119.76mV$$

7(a) Analyze the working of series fed directly coupled Class A power Amplifier wrt efficiency (8m)

→ The simple fixed bias ckt can be used to discuss. Class A Series fed amplifier.

* DC Analysis.



Applying KVL to base loop, we get.

$$V_{CC} - I_B R_B - V_{BE} = 0.$$

$$I_B = \frac{V_{CC} - V_{BE}}{R_B} \quad \text{—— (1)}$$

$$I_C = \beta I_B. \quad \text{—— (2)}$$

Applying KVL to CE loop.

$$V_{CC} - I_C R_L - V_{CE} = 0.$$

$$I_C = \frac{V_{CC} - V_{CE}}{R_L} \quad \text{—— (3)}$$

∴ Equ^n (3) can be written as.

$$I_C = \left(-\frac{1}{R_L}\right) V_{CE} + \frac{V_{CC}}{R_L}$$

where slope of line is $(-1/R_L)$.

* AC Analysis

$$P_{o(ac)} = \frac{V_{CE(p-p)} \cdot I_{C(p-p)}}{8}$$

$\therefore \% \eta = \frac{P_{o(ac)}}{P_{i(dc)}} \times 100.$

$V_{max} = V_{CC}$, $V_{min} = 0$.

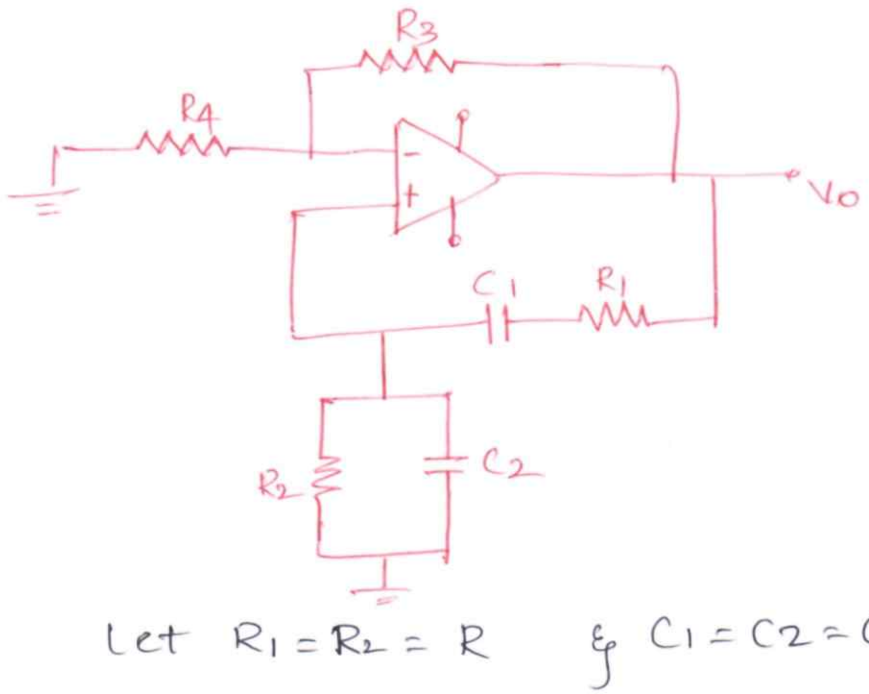
$I_{max} = 2I_C$, $I_{min} = 0$.

$\therefore \% \eta = \frac{(V_{max} - V_{min})(I_{max} - I_{min})}{8 V_{CC} \cdot I_C} \times 100$

$= \frac{(V_{CC} - 0)(2I_C - 0)}{8 V_{CC} I_C} \times 100$

$\boxed{\% \eta = 25\%}$

7(b) Design the component values of Wein bridge oscillator for freq of oscillations of 4KHz. (4m)



Sol^n: Let $R_1 = R_2 = R$ & $C_1 = C_2 = C$.

$f = 1/2\pi RC$.

let $C = 0.01\mu F$

$R = \frac{1}{2\pi f C} = \frac{1}{2\pi (4KHz)(0.01\mu)} = 3.97 K\Omega.$

for sustained oscillations $\frac{R_3}{R_4} \geq 2$

$R_3 \geq 2R_4$

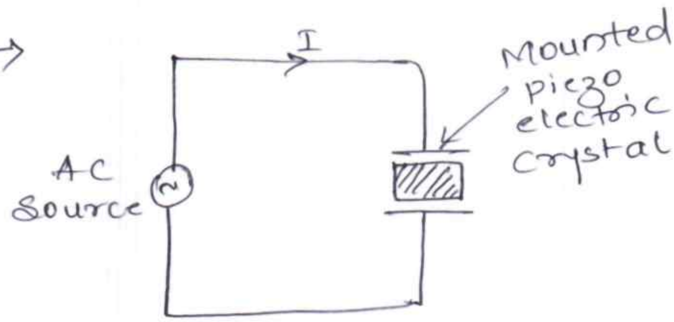
let $R_4 = 10k\Omega$.

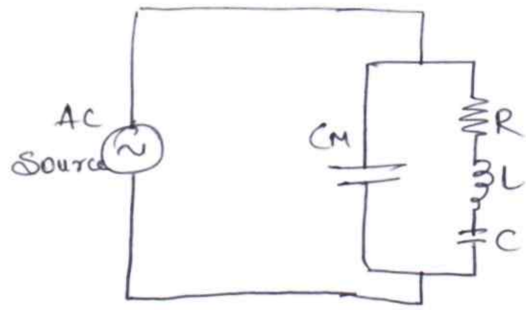
then, $R_3 \geq 20k\Omega$.

& select $R_3 = 30k\Omega$.

7(c) explain the characteristics of crystal with neat diagram, explain crystal oscillations in series resonance ckt. (8m)

→



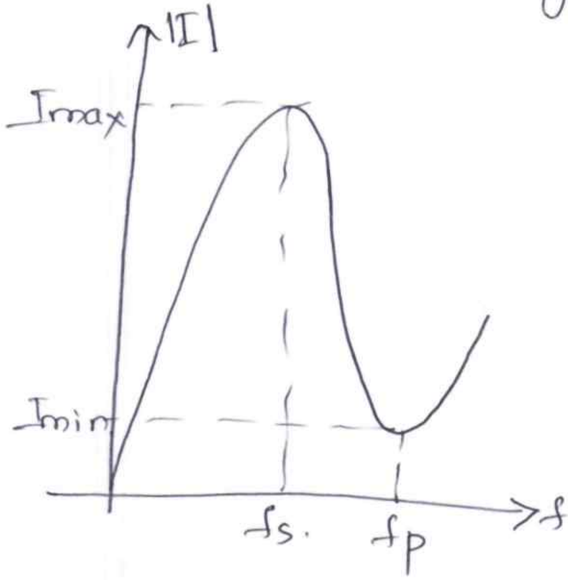


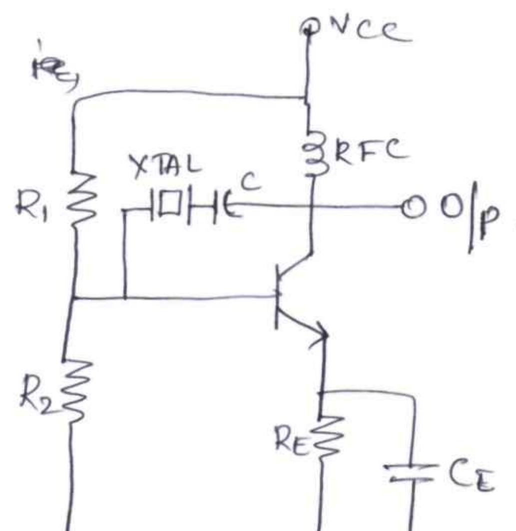
Here, L = Elect. equivalent inductance of crystal

C = " " capacitance " "

R = " " resistance " "

CM = Mounting capacitance.





ie, $\omega L = 1/\omega C$

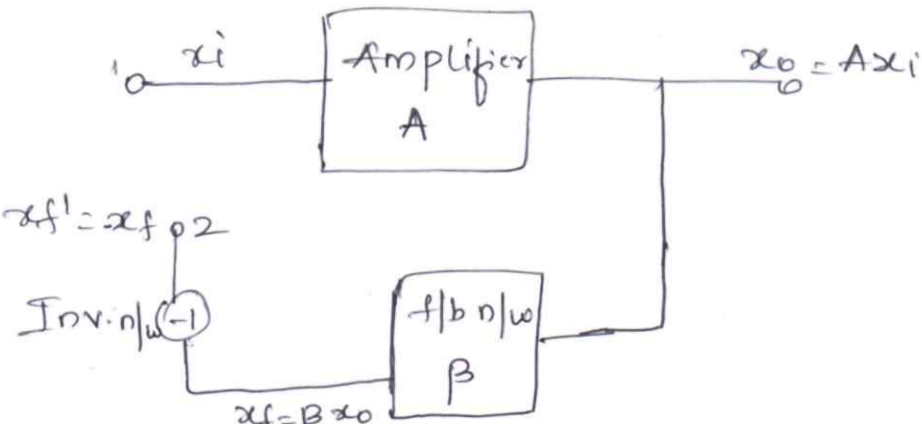
$\omega^2 = 1/LC$

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

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

8(a) Explain the basic principle of Oscillators (6m)

→ An Oscillator is a ckt, designed to provide periodic o/p with no i/p signal. It requires only DC power. It is basically an amplifier with positive feedback.



$x_f = \beta x_o = A\beta x_i$

& o/p inv n/w is $x_f' = -x_f = -A\beta x_i$.

Now, loop gain $= \frac{x_f'}{x_i} = \frac{-A\beta x_i}{x_i}$

$= -A\beta$

loop gain $= -A\beta = 1$

$-A\beta = 1 + j0$

$-A\beta = 1\angle 0 \text{ or } 360$.

$-A\beta = |-A\beta| \angle \theta$.

& $\theta = \angle -A\beta = 0^\circ$ or 360°.

8(b) An ideal Class B push pull amplifier with i/p is o/p transformers has $V_{CC} = 20V$, $N_2 = 2N_1$ & $R_L = 20\Omega$. The transistor has $h_{fe} = 20$. Let i/p be sinusoidal. for max. o/p signal at $V_{CE(p)} = V_{CC}$

Determine (i) o/p signal power.

(ii) collector dessipation in each transistor.

(iii) Conversion η — (6m)

→ Given: $V_{CC} = 20V$

$R_L = 20\Omega$

$N_2 = 2N_1$

or $\frac{N_1}{N_2} = 0.5$

$V_{CE(p)} = V_{CC} = 20V$

(i) $P_{O(ac)} = \frac{V_{CE}^2(p)}{2R_L'}$

$R_L' = \left(\frac{N_1}{N_2}\right)^2 R_L = 0.5^2 \times 20$

$= 5\Omega.$

$\therefore P_{O(ac)} = \frac{20^2}{(2)(5)} = 40W.$

(ii) $P_{2(Q)} = P_{i(dc)} - P_{O(ac)}$

$P_{i(dc)} = \frac{2}{\pi} V_{CC} I_{C(p)}$

$\therefore I_{C(p)} = \frac{V_{CE(p)}}{R_L'} = \frac{V_{CC}}{R_L'}$

we get $P_{i(dc)} = \frac{2}{\pi}\frac{V_{CC}^2}{R_L'} = \frac{2}{\pi}\frac{(20V)^2}{5} = 50.93W.$

$P_{2(Q)} = 50.93 - 40 = 10.93W.$

$P_Q = \frac{P_{2Q}}{2} = \frac{10.93}{2} = 5.46W.$

(iii) $\% \eta = \frac{P_{O(ac)}}{P_{i(dc)}} \times 100.$

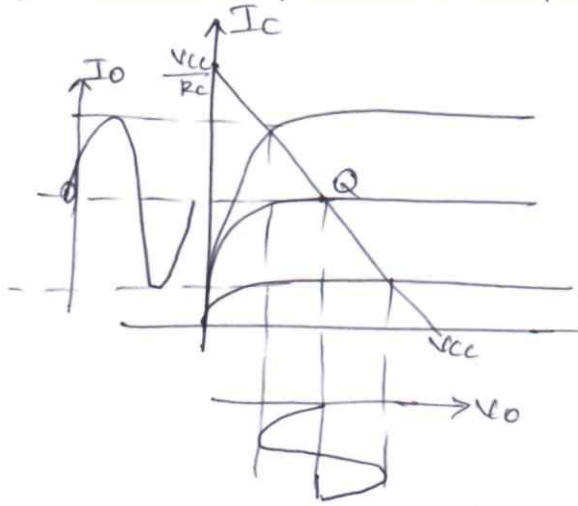
$= \frac{40}{50.93} \times 100$

$= 78.4\%.$

8(c) Discuss the different types of power Amplifiers -- (8M)

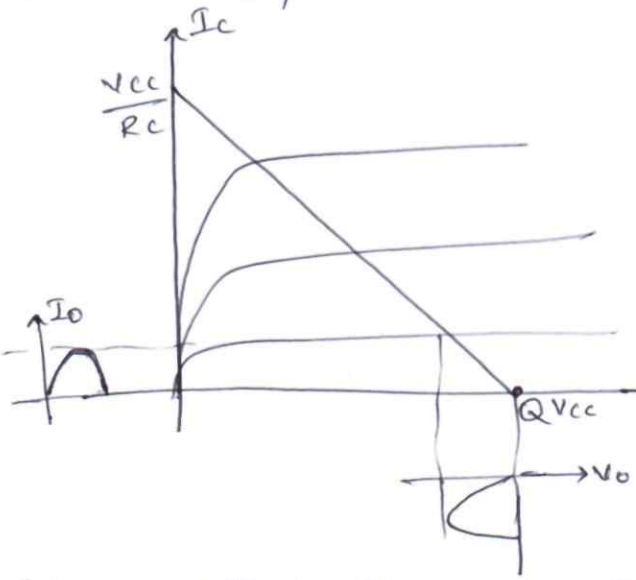
→ 1) Class A power Amplifier
2) Class B power Amplifier
3) Class C power Amplifier
4) Class AB power Amplifier
5) Class D power Amplifier

1) Class A power Amplifier



In, Class A power amp Q.pt is located at centre of load line. So o/p varies for 360° cycle of i/p signal

2) Class B power Amplifier



In class B, power amplifier, Q.pt is located at the Cutoff region of load.
So, o/p varies for 180° of the i/p signal

3) Class AB: In class AB power amp, Q pt is selected such that o/p signal obtained is more than 180° but less than 360° of the i/p signal.

4) Class C: In class C, amplifier Q pt is located below the cutoff region. So o/p signal varies for less than a half cycle i/p.

5) Class D: In Class D power amplifier, o/p is designed to operate with digital signals ON/OFF.

Module 5

9a) Explain the basic operation & Characteristics of n-channel depletion type MOSFET? (10M)

→ WKT, $I_D = I_{DSS}\left[1 - \frac{V_{GS}}{V_P}\right]^2$ ——(1)

$$g_m = g_{mo}\left[1 - \frac{V_{GS}}{V_P}\right] \quad \text{——(2)}$$

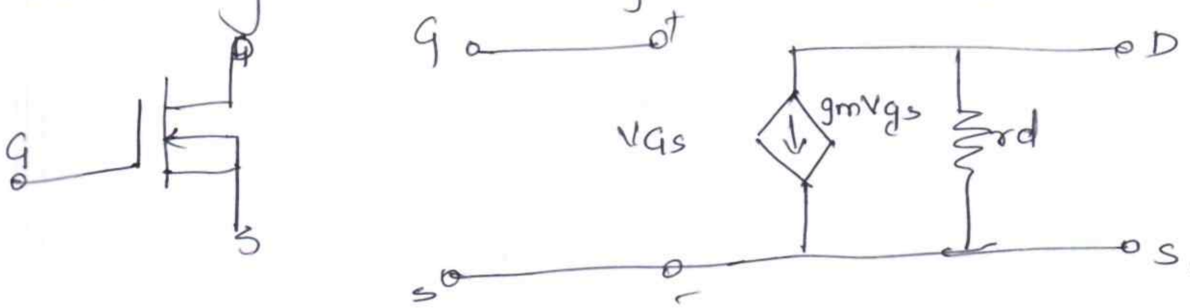
where $g_{mo} = \frac{2 I_{DSS}}{|V_P|}$ ——(3)

Note! 1) In JFET, V_{GS} can be negative for n channel devices & positive for p channel.
Hence, g_m is always less than g_{mo}.
But for DMOSFET, V_{GSQ} can be of either polarity.

(2) for ex: if V_{GSQ} is -ve for an n-channel device, the device operates in depletion mode device, the ie, $g_m < g_{mo}$ & $I_D < I_{DSS}$ from (1) & (2)

(3) On other hand, if V_{GSQ} is +ve, the device operates in enhancement mode.
In this mode, $g_m > g_{mo}$ & $I_D > I_{DSS}$.

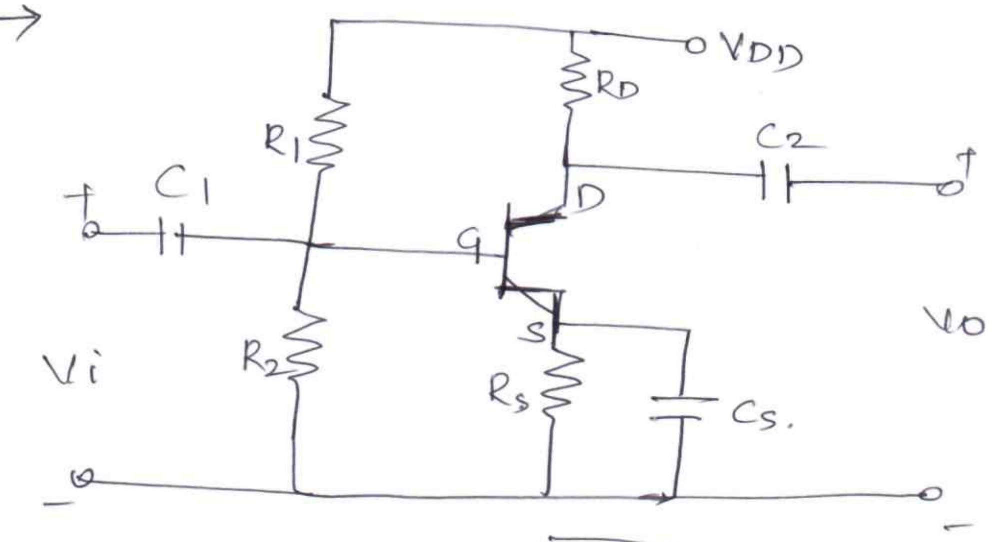
* small signal model & symbol of DMOSFET

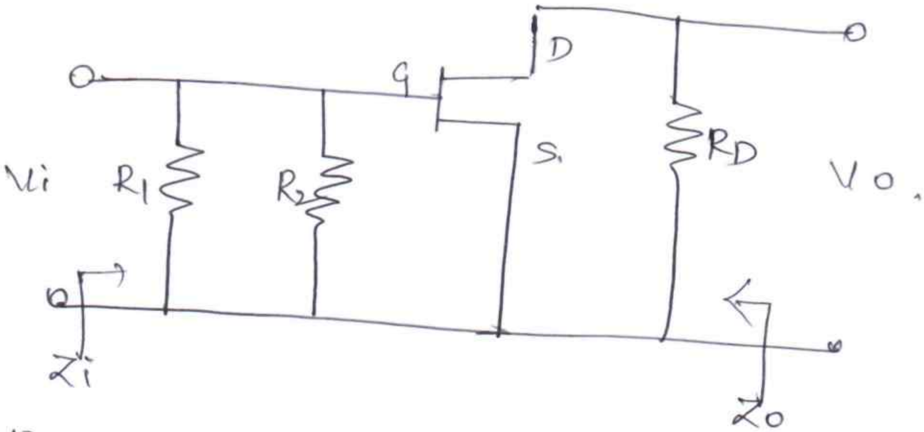


i) It is exactly same as JFET
ii) only difference is value of g_m.

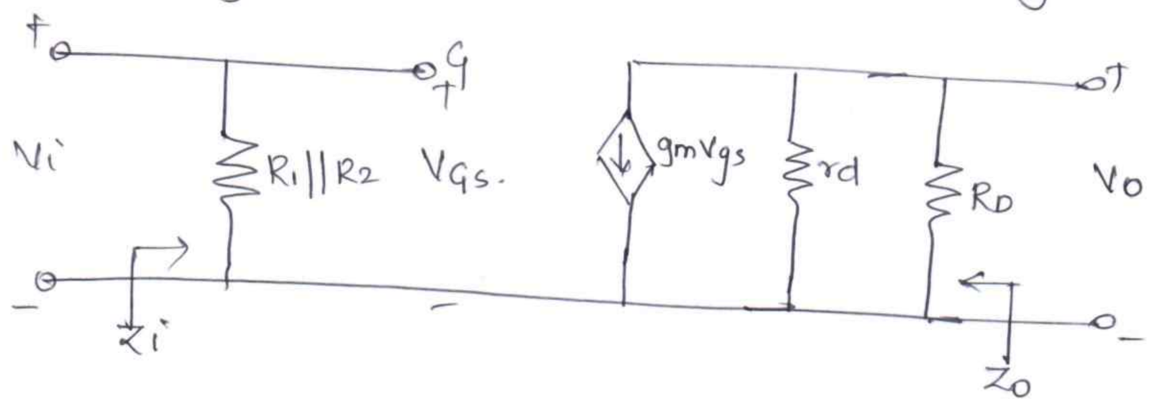
9b) Derive expression for Z_i, Z_o & A_v for vltg divider Biasing ckt using JFET --- (10m).

→





Replacing JFET with small signal ac model



$$\therefore Z_i = R_1 || R_2$$

$$Z_o = r_d || R_D$$

$$\& \; A_v = -g_m (r_d || R_D).$$

for $r_d \geq 10 R_D$.

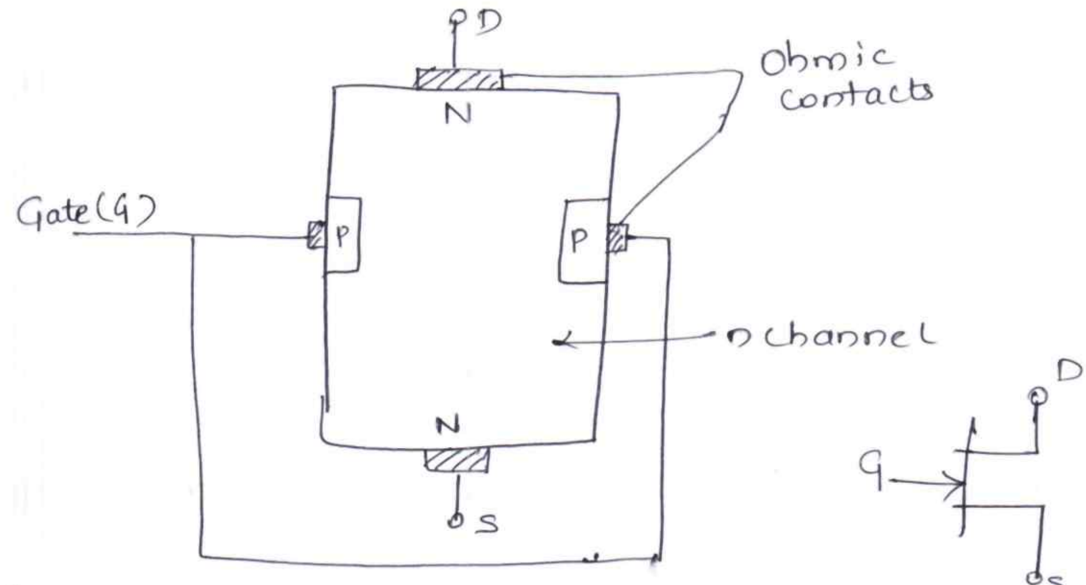
$$Z_i = R_1 || R_2$$

$$Z_o = R_D$$

$$A_v \simeq -g_m R_D.$$

10(a) With neat diagram explain construction of n channel JFET. — (10M)

→



* A piece of n type material is referred to as channel.
* It has 2 smaller pieces of p-type material forming a pn junction.
* The channel ends are designated as Drain & source.
* The 2 pieces of p-type material are connected together & their terminal is called as Gate.
* since the channel is of n-type it is called as n channel JFET.

1(b). Data sheet for a JFET indicates that $I_{DSS} = 10mA$ & $V_{GS(off)} = -4V$. Determine the drain current for $V_{GS} = 0V, -1V$ & $-4V$ (6m)

→ $$I_D = I_{DSS}\left(1 - \frac{V_{GS}}{V_{GS(off)}}\right)^2$$

$I_{DSS} = 10mA$

$V_{GS(off)} = -4V$

Case 1:→ $V_{GS} = 0V$

$$I_D = 10\left(1 - \frac{0}{-4}\right)^2 = 10 \times 1^2 = 10mA$$

Case 2: $V_{GS} = -1V$

$$I_D = 10\left(1 - \frac{-1}{-4}\right)^2 = 10(1-0.25)^2$$
$$= 10 \times 0.75^2$$
$$= 10 \times 0.5625$$
$$= 5.625 mA$$

Case 3: $V_{GS} = -4V$

$$I_D = 10\left(1 - \frac{-4}{-4}\right)^2 = 10(1-1)^2$$
$$= 0 mA$$

10 c) Discuss the difference b/w JFET & MOSFET. (4M).

→

JFET	MOSFET.
1) Junction Field Effect Transistor.	1) Metal Oxide Semiconductor field effect transistor.
2) PN junction b/w gate & channel	2) Gate insulated by SiO_2 layer
3) High i/p impedance	3) very high.
4) Operates in Depletion mode	4) Both Depletion & Enhancement mode
5) slow speed	5) Faster switching speed.

6/6/25