Ajay Kumar Garg Engineering College, Ghaziabad

Department of ECE

Model Solution of Sessional Test-2

Course:	B.Tech	Semester:	I
Session:	2017-18	Section:	EN, CS, EI, IT
Subject:	Basic Electronics Engineering	Sub. Code:	REC 101
Max Marks:	50	Time:	2 hour

Note : Answer **all** the sections.

Section A

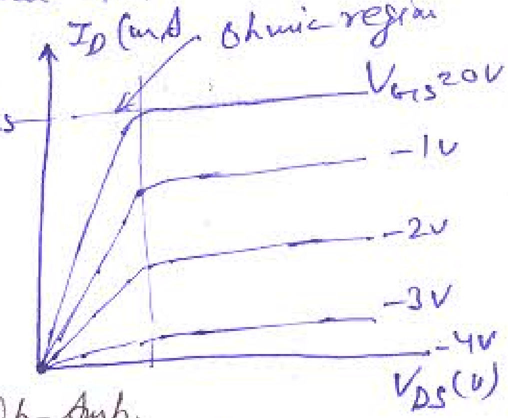
Q.1. Explain why BJT is a Bipolar device?

Ans. In BJT, both minority and majority will take part for the conduction and both carriers will be responsible for the flow of current. that, why BJT is a bipolar device.

Q.2. Explain FET as a Voltage Variable Register.

Ans. In Ohmic region JFET can be emplyed as a variable resistor whose resistance is controlled by gate to source voltage. As V_{gs} between gate and source becomes more and more negative the shape of each curve becomes more and more horizontal corresponding to increasing resistance. This is defind as.

$$r_d = \frac{r_o}{(1 - V_{GS}/V_P)^2}$$



Q.3. List the Ideal Characteristics of an Op-Amp.

Ans.

Characteristics	Range
Voltage Gain A_V	∞
Input Impedance Z_{in}	∞
Output Impedance Z_o	0

Characteristics	Range
Bandwidth	∞ Hz
CMRR	∞
Slew Rate	∞

Q.4. The BJT has $I_C = 10\,mA$ and $\alpha = .98$. Determine the value of β and I_B.

Ans. Given $I_C = 10\,mA$ $\quad \alpha = .98$ $\quad$ find β & I_B

formula used $\quad \beta = \dfrac{\alpha}{1-\alpha}$, $I_B = \dfrac{I_C}{\beta}$

$$\beta = \frac{.98}{1-.98} = 49 \text{ Ans.}$$

$$I_B = \frac{I_C}{\beta} = \frac{10\,mA}{49} = .204\,mA = 204\,\mu A$$

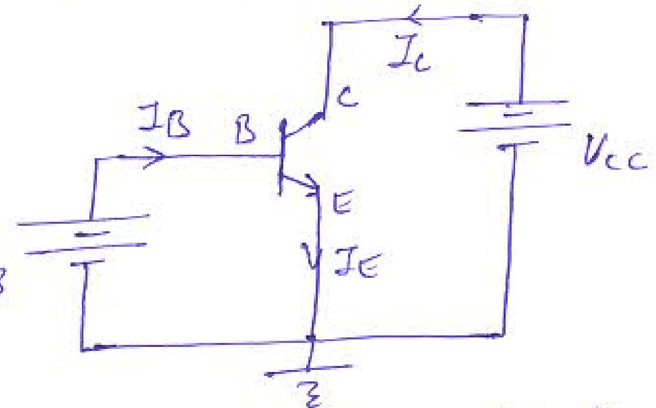
Q.5. List the primary difference between JFET and MOSFET.

Ans.

JFET	MOSFET
I. It works in depletion mode.	I. It works in both enhancement and depletion mode.
2. Channel is already depleted in the JFET as construction.	2. Channel should be enhanced in MOSFET.
3. JFET has lower input impedance as compared to MOSFET	3. Higher Input impedance
4. Normally on device	4. Normally off device.

Q.6 Draw the CE Configuration circuit of BJT and explain its input and output characteristics.

Ans. <u>Common Emitter Configuration:</u> In this type of configuration emitter is common in both circuits. it means emitter is connected to ground. This configuration is mostly used for amplification circuits.



In this configuration as per the current direction –

$$I_C = \alpha I_E + I_{CBO}$$

where $\alpha = \frac{I_C}{I_E}$

and I_{CBO} = reverse leakage current.

$$\Rightarrow I_C = \alpha(I_C + I_B) + I_{CBO}$$

and $I_E = (I_C + I_B)$

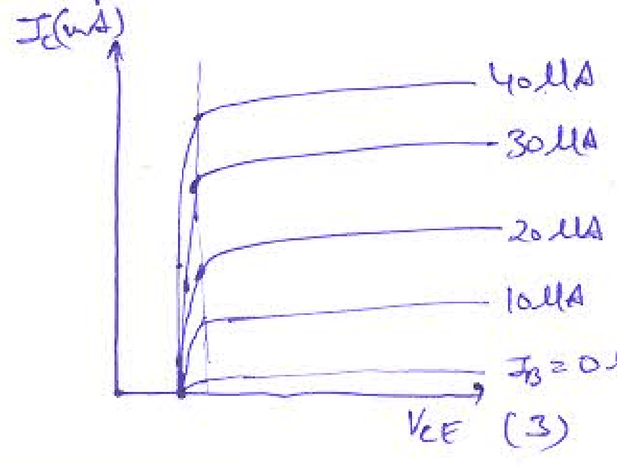
$$I_C = \frac{\alpha I_B}{1-\alpha} + \frac{I_{CBO}}{1-\alpha}$$

<u>Beta(β):</u> Common emitter forward current amplification factor that relates the level of I_C and I_B.

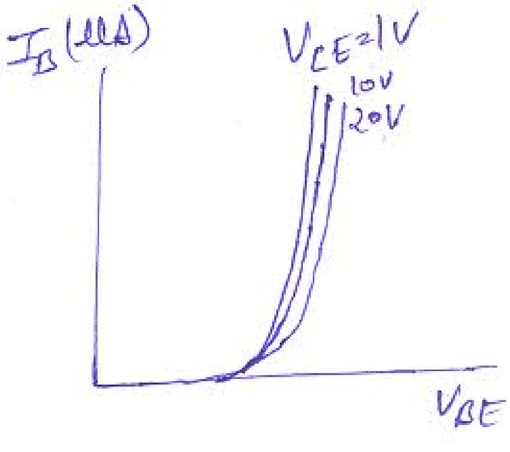
$$\beta_{dc} = \frac{I_C}{I_B}$$

$\beta \Rightarrow 50$ to 400

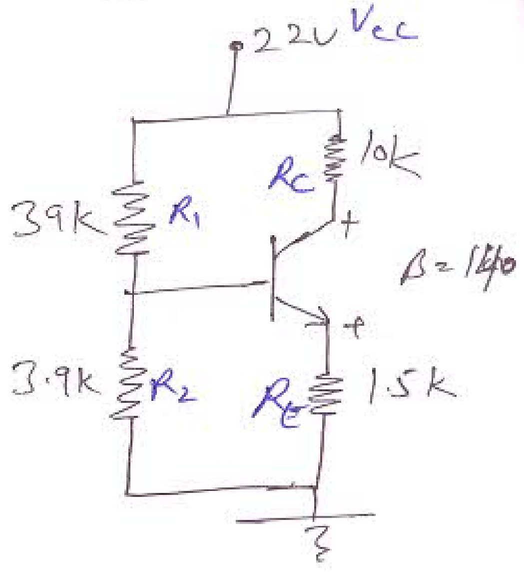
~~Input~~ Characteristics Output



~~Output~~ Characteristics Input



Q.7 Determine V_{CE} and I_C for the voltage divider bias.



Ans. Approximate analysis.

$\beta R_E \geq 10 R_2$

$\beta = 140$ $R_E = 1.5K$ $R_2 = 3.9K$

$R_1 = 39K$ $V_{cc} = 22V$

so $\beta R_E \geq 10 R_2$

$140 \times 1.5K \geq 10 \times 3.9K$

$210K \geq 39K$

condition satisfied so

$$V_B = \frac{R_2 V_{cc}}{R_1 + R_2} = \frac{3.9K \times 22}{3.9K + 39K} = 2V$$

$$V_E = V_B - V_{BE} = 2 - .7V = 1.3V$$

$$I_c = I_E = \frac{V_E}{R_E} = \frac{1.3V}{1.5K\Omega} = .867mA$$

$$V_{CE} = V_{CC} - I_c (R_c + R_E)$$

$$= 22 - (.867m)(10 + 1.5K)$$

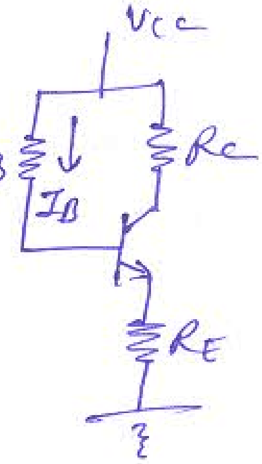
$$= 12.03V$$

Q.8. Derive the stability factor $S(I_{co})$ for the emitter bias configuration.

Ans. $S(I_{co})$ is defined as the change in collector ~~cuttee~~ current with the change in collector leakage current.

$$S(I_{co}) = \left.\frac{\Delta I_c}{\Delta I_{co}}\right|_{\text{Constant } \beta,\ V_{BE}}$$

S(I_{co}) for emitter bias :-



Apply KVL in ckt

$$V_{cc} - I_B R_B - V_{BE} - I_E R_E = 0$$

$$V_{cc} - I_B R_B - V_{BE} - (I_c + I_B) R_E = 0$$

differentiate w.r.t. I_c

$$-R_B \frac{\partial I_B}{\partial I_c} - \left(1 + \frac{\partial I_B}{\partial I_c}\right) R_E = 0$$

$$-\frac{\partial I_B}{\partial I_c} \cdot (R_B + R_E) - R_E = 0$$

$$R_E = -\frac{\partial I_B}{\partial I_c}(R_B + R_E)$$

$$\frac{\partial I_B}{\partial I_c} = -\frac{R_E}{R_B + R_E}$$

put this in general eqⁿ

$$S(I_{co}) = \frac{1+\beta}{1-\beta \frac{\partial I_B}{\partial I_c}}$$

$$S(I_{co}) = \frac{1+\beta}{1-\beta \frac{R_E}{(R_B + R_E)}} = (1+\beta)\frac{1+\frac{R_B}{R_E}}{(1+\beta)+\frac{R_B}{R_E}}$$

Q.9. Define Slew Rate and determine the output voltage of a differential amplifier for the input voltages of 300 mV and 240 mV. The Ad is 5000 and CMRR is 100.

Ans. Slew Rate (SR) : It shows the op-amp's ability to handle varying signals. It is defined as the ratio of change in output voltage with time.

$$SR = \frac{\Delta V_o}{\Delta t} \ V/\mu s \quad (t \text{ is in } \mu s)$$

Numerical.

Given $V_1 = 300\mu V$ $\quad$ CMRR = 100

$V_2 = 240\mu V$ $\quad$ $A_d = 5000$

so $V_d = V_1 - V_2 = 300 - 240 = 60\mu V$

$V_c = \frac{V_1 + V_2}{2} = 270\mu V$

$CMRR = \frac{A_d}{A_c} \Rightarrow \frac{5000}{A_c} = 100$

so $A_c = 50$

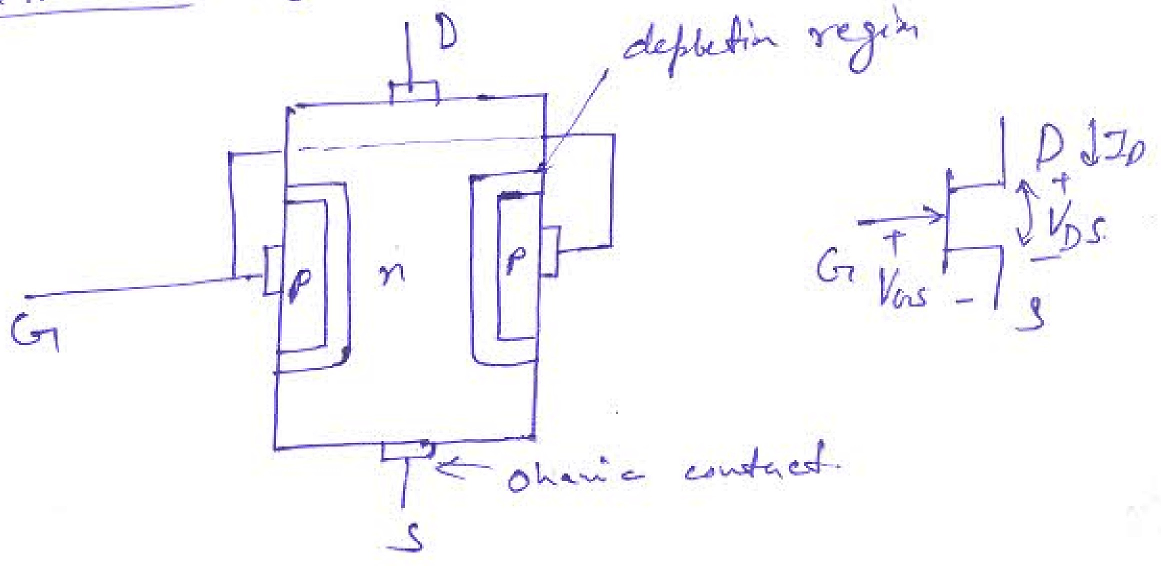
$V_o = A_d V_d + A_c V_c$

$= 5000 \times 60\mu + 50 \times 270\mu$

$= \underline{\underline{313.5 mV}}$

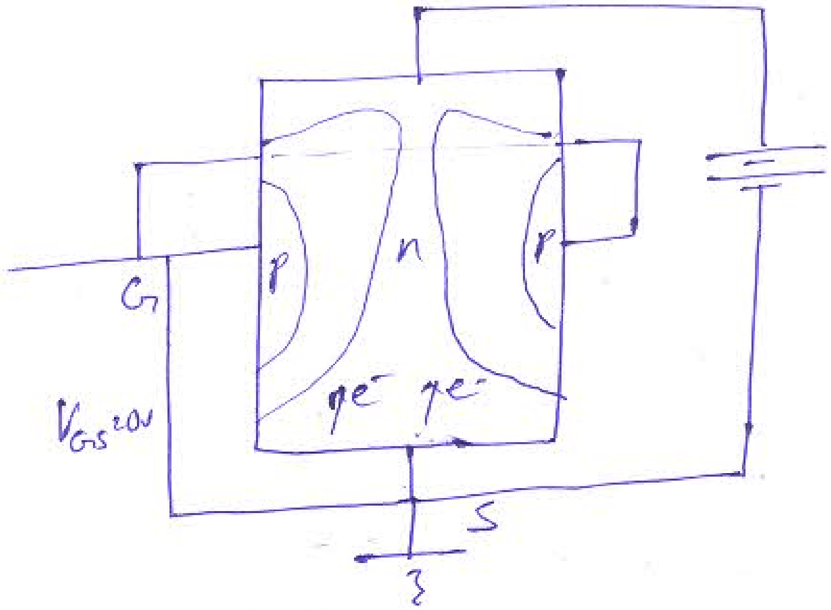
Q.10 Draw the structure of n-channel JFET and explain its principle of operation with its V-I characteristics.

Ans. Construction :- (n-channel JFET)

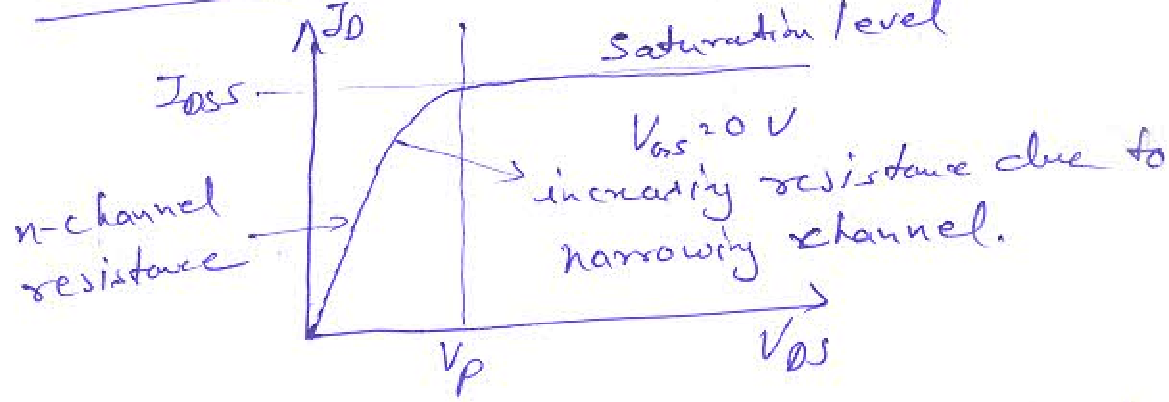


Working :-

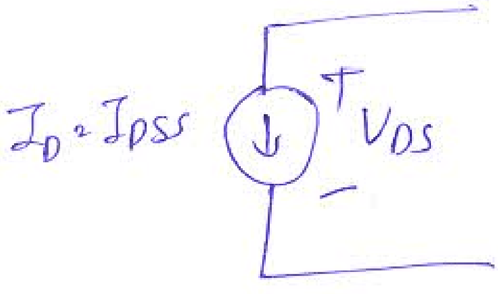
(i) When $V_{GS} = 0V$, V_{DS} = some positive value.

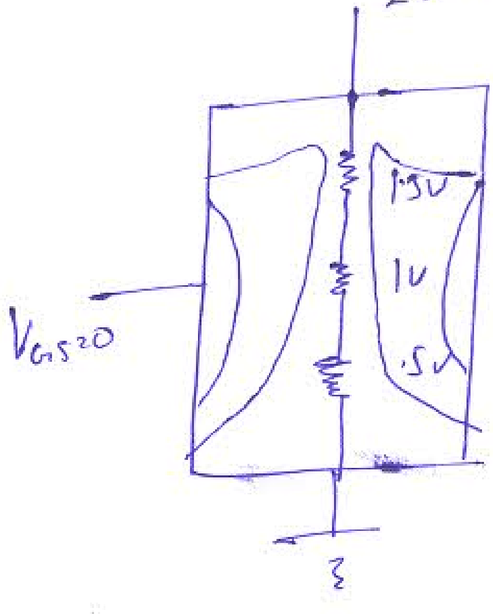


V-I Characteristics



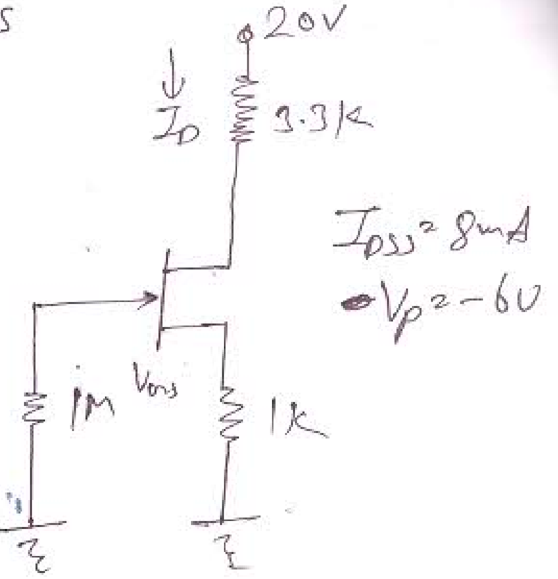
at $V_{GS} = 0$ $V_{DS} > V_P$ FET as a current source





for −ve V_{GS} it works as voltage variable resistor.

Q.11 (b) Determine ~~V_{GS}~~ V_{GS}, I_D and V_{DS}



Given $V_{DD} = 20V$

$I_{DSS} = 8mA$

$V_p = -6V$

so $V_{GS} = -I_D R_S = -I_D$

because $R_S = 1M$

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

$= 8m\left(1 - \frac{-I_D}{-6}\right)^2$

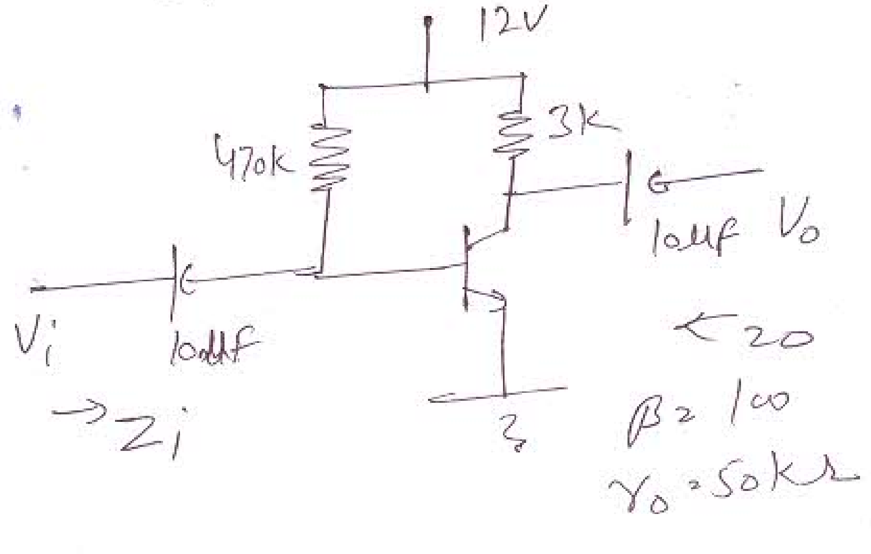
by solving equation for I_D we get 2.6mA and 13.01mA for I_D but $I_D = 2.6mA$ is suitable so

$I_D = 2.6mA$

$V_{DS} = V_{DD} - I_D(R_S + R_D) = 20 - (2.6)mA(1k + 3.3k)$

$= 8.82V$

Q.11 (C) Determine r_e, Z_i, Z_o, A_v and A_i



Ans. First find r_e by using DC analysis.

For given configuration

$$I_B = \frac{V_{CC} - V_{BE}}{R_B} = \frac{20 - .7}{470k} = 24.04\,\mu A$$

$$I_E = (1+\beta)\, I_B = (1+100)\, 24.04\mu = 2.424\, mA$$

So $$r_e = \frac{26mV}{I_E}$$

$$= \frac{26\,mV}{2.4\,m} = 10.83\,\Omega$$

Now $$Z_i = R_B \,||\, \beta r_e$$

$$\beta r_e = 100 \times 10.83\Omega = 1083\,\Omega = 1.083\,k\Omega$$

$$Z_i = 470k \,||\, 1.083k = \frac{470 \times 1.083}{470 + 1.083}\,k$$

$$= 1080.5\,\Omega$$

$$Z_o = R_C = 3\,k\Omega$$

$$A_v = -\frac{R_C}{r_e} = -\frac{3k}{10.83} = -277.01$$

when $r_o = 50\,k\Omega$

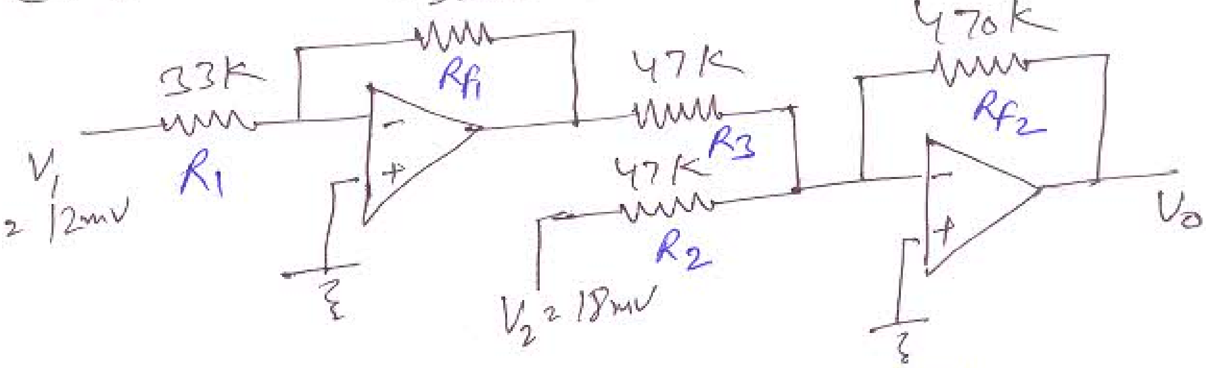
$$Z_o = R_C \,||\, r_o = 50k \,||\, 3k = 2.83k$$

$$A_v = -\frac{r_o \,||\, R_C}{r_e} = \frac{2.83k}{10.83} = -261.31$$

$$A_i = -A_v \frac{Z_i}{R_C} = -\frac{1080.5}{3000}(-277.01) = 99.7$$

$\cong \beta = 100$

Q.12 (a) Determine V_o



$$V_o = -\left[\frac{R_{f_2}}{R_3}\left(-\frac{R_{f_1}}{R_1}V_1\right) + \frac{R_{f_2}}{R_2}V_2\right]$$

$$= -\left[\left(\frac{470K}{47K}\right)\left(-\frac{330k}{33K}\times 12m\right) + \frac{470k}{47K}18m\right]$$

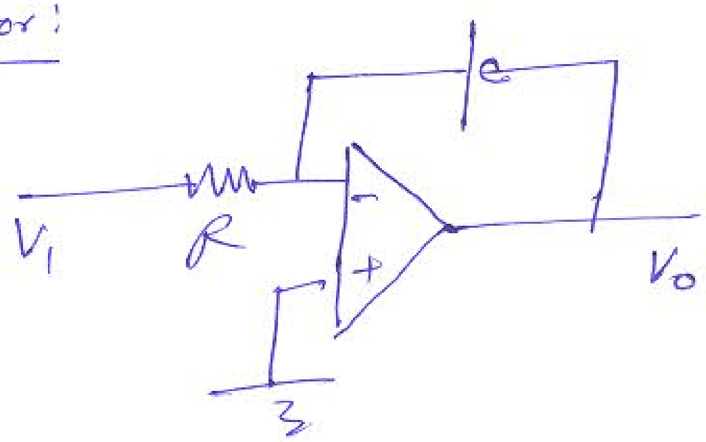
$$= -\left[-1200m + 180m\right]$$

$$= 1020m = 1.02V$$

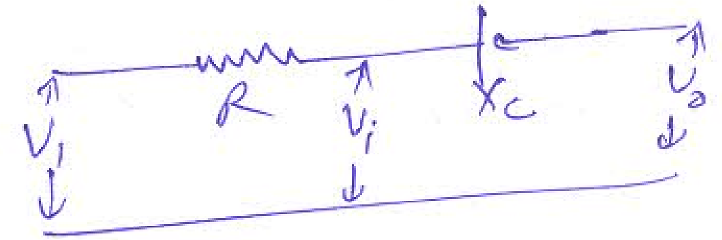
Q.12 (b) Explain Integrator and differentiator using Op-amp

Ans. There are the application of op-amp in inverting mode.

(a) Integrator:



equivalent ckt. is



apply current value

$$\frac{V_1 - 0}{R} = \frac{0 - V_o}{X_C}$$

$$\frac{V_1}{R} = -\frac{V_o}{X_C}$$

when $X_C = \frac{1}{sC}$

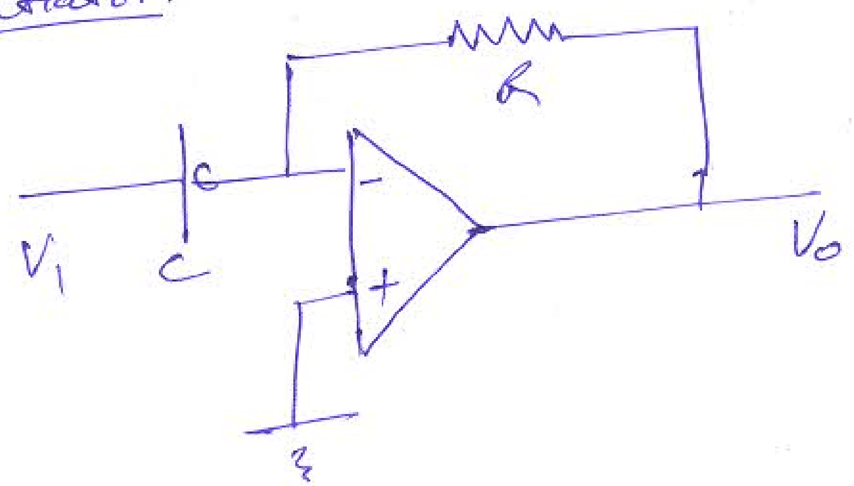
so $$\frac{V_o}{V_1} = -\frac{1}{sCR}$$

by taking its inverse laplace

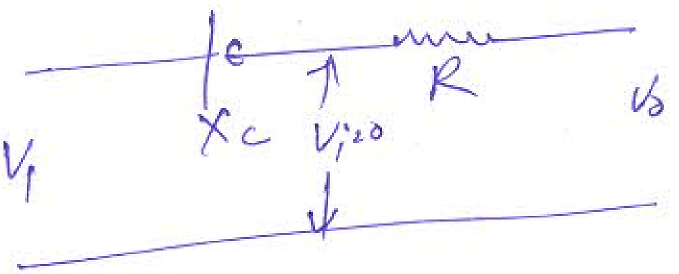
$$V_o(t) = -\frac{1}{RC}\int V_1(t)\,dt$$

which is function of integrator

(b) Differentiator:



equivalent circuit



$$\frac{V_1 - 0}{X_C} = \frac{0 - V_o}{R}$$

$$\frac{V_1}{X_C} = \frac{-V_o}{R} \qquad \text{where } X_C = \frac{1}{sC}$$

so $$\frac{V_o}{V_1} = -sCR$$

by taking inverse laplace

$$V_o(t) = -RC\frac{d}{dt}V_1(t)$$

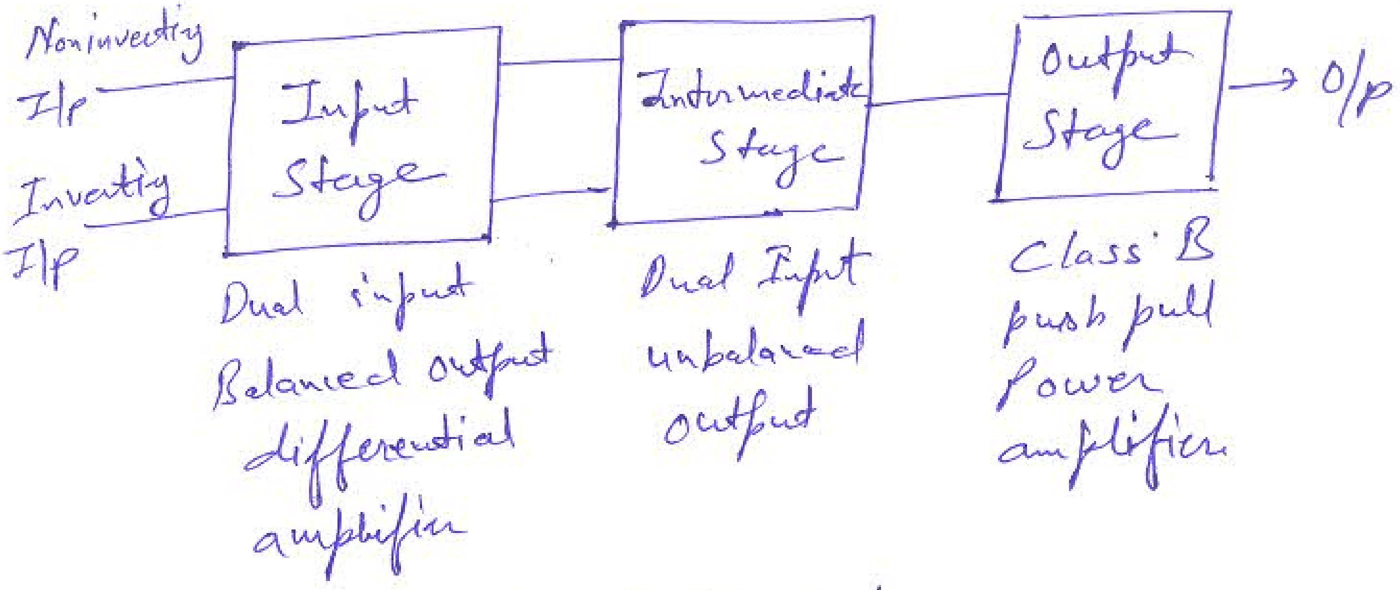
which is the function of differentiator

Q.12 (c) Draw the block diagram of Op-amp and equivalent circuit of op-amp.

Ans. <u>Block Diagram of Op-Amp:—</u>

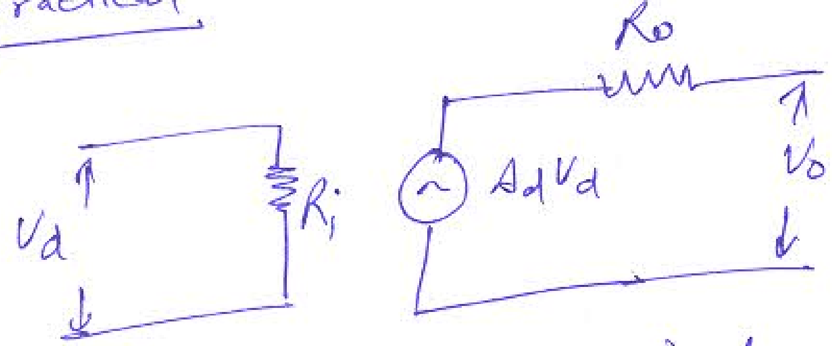
Op-amp has three stages.

1. Input stages.
2. Intermediate stage
3. Output stage



Equivalent circuit of Op-amp.

Practical



where V_d = difference signal
R_i = input impedance
A_d = differential gain
R_o = output impedance
V_o = output voltage

Ideal: