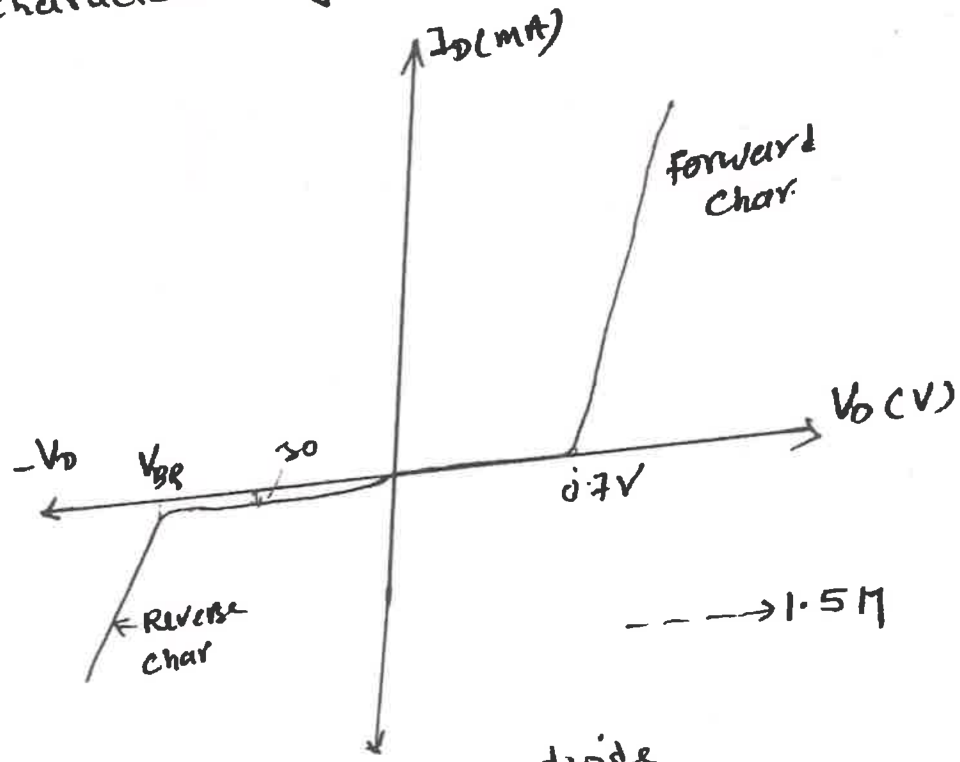
ECAD - Sol^n of 40502

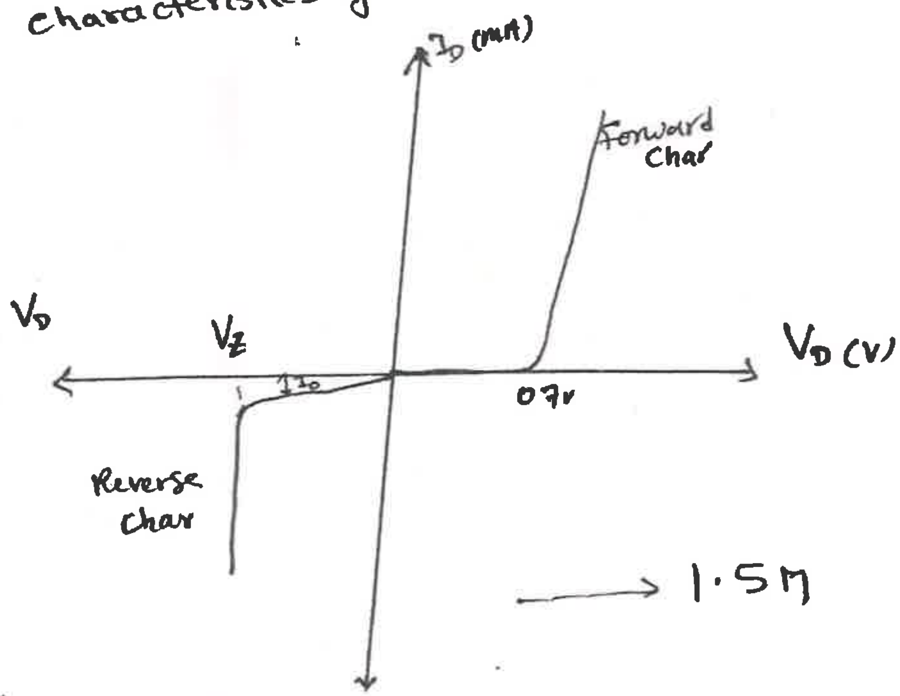
S.E_ Biomedical_ Sem-III
(Paper solution)
Q.P. cod. 40502

Q.1 (a) Characteristics of P-N junction diode



----> 1.5M

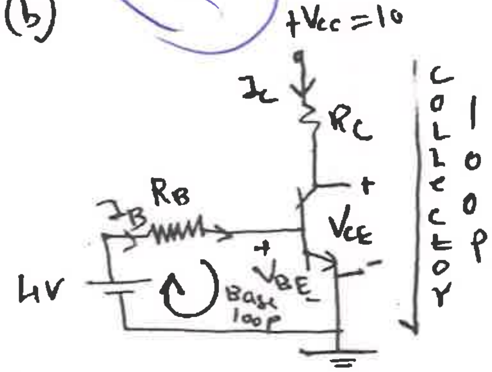
Characteristics of Zener diode



→ 1.5M

Discription ----> 2M

Q.1(b) Q2



KVL to collector loop

$V_{cc} - I_c R_c - V_{CE} = 0$

$V_{cc} - I_c R_c = V_{CE}$

$V_{CE} = 10 - 3.3\,mA \times 2k\Omega$

$\boxed{V_{CE} = 3.4V}$

KVL to base loop

$4 - I_B R_B - V_{BE} = 0$

$4 - 0.7 = I_B R_B$

$I_B = \dfrac{3.3}{220K} = 15\,\mu A$

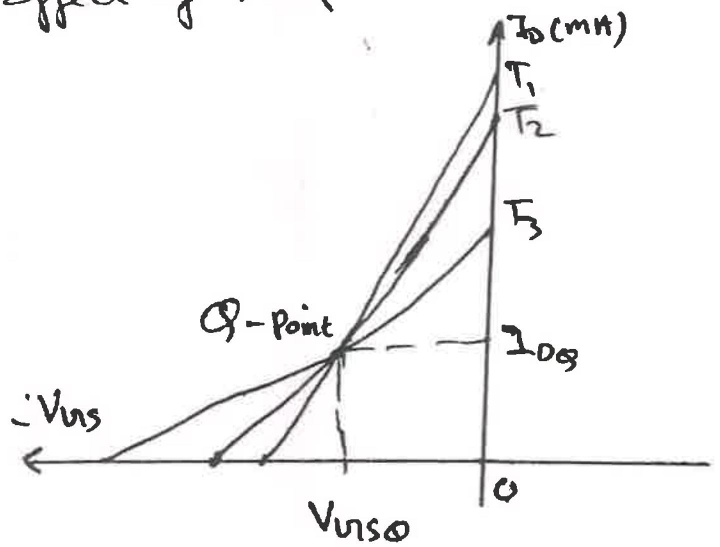
$\boxed{I_B = 15\,\mu A}$

$I_c = \beta \cdot I_B = 220 \cdot 15\,\mu A$

$\boxed{I_c = 3.3\,mA}$

Q.1 (c) → Point to be covered
feedback capacitance
→ Effect of miller theorem
→ Parasitic and inter electrode capacitance at high freq.

Q.1 (d) Effect of temperature on JFET



— — — 2M

Increase in I_D with temp = Decrease in I_D with Temp

$\Delta I_D = (0.7\%/°C)|I_D|$

$\boxed{|V_P| - |V_{GS}| = 0.63V}$ — — — 3M

Q3

1(d) Need of cascaded amplifier

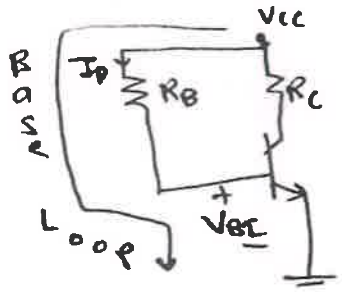
- To increase overall Voltage gain
- To Control input impedance and output impedance → 2M

Types of cascaded configurations

(i) CE − CE amplifier
(ii) CS − CE amplifier
(iii) CS − CS amplifier

} 3M

Q.2 (a) For Fixed bias



$\therefore$ $S = 1+\beta$

For current stability factor

$\because$ $S = \dfrac{1+\beta}{1-\beta\left(\dfrac{dI_B}{dI_C}\right)}$

From base loop

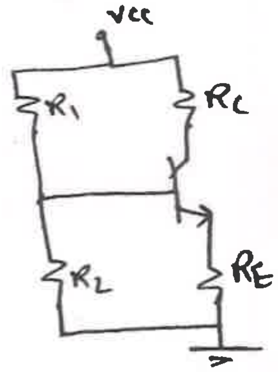
$V_{CC} - I_B R_B - V_{BE} = 0$

diff. w.r.t. I_C

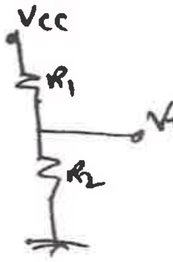
$\dfrac{d}{dI_C}(V_{CC} - I_B R_B - V_{BE}) = 0$

$\therefore$ $\dfrac{dI_B}{dI_C} = 0$

For Voltage divider Bias



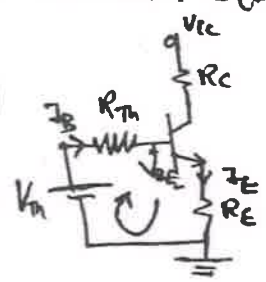
Using Voltage divider rule



$V_{Th} = \dfrac{R_2 V_{CC}}{R_1 + R_2}$

& $R_{Th} = R_1 \| R_2$

Thevenin's equivalent ckt



From base loop

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

$V_{Th} - I_B R_{Th} - V_{BE} - (I_C + I_B) R_E = 0$

$V_{Th} - V_{BE} - I_B R_{Th} - I_C R_E - I_B R_E = 0$

$V_{Th} - V_{BE} - I_B (R_{Th} + R_E) - I_C R_E = 0$

diff w.r.t. I_C

$0 - (R_{Th} + R_E)\dfrac{dI_B}{dI_C} - R_E \dfrac{dI_C}{dI_C} \Rightarrow$

$-(R_{Th} + R_E)\dfrac{dI_B}{dI_C} = R_E$

$\dfrac{dI_B}{dI_C} = \dfrac{-R_E}{R_{Th} + R_E}$

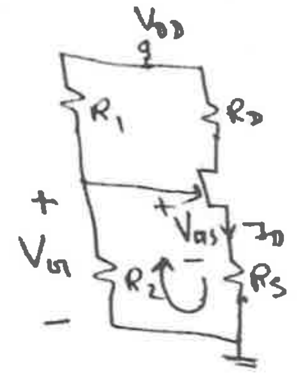
$S = \dfrac{1+\beta}{1-\beta\left(\dfrac{-R_E}{R_{Th}+R_E}\right)}$

$S = \dfrac{1+\beta}{1+\beta\left(\dfrac{R_E}{R_{Th}+R_E}\right)}$

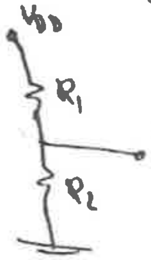
(04)

Q. 2 (b)

DC equivalent ckt



Using voltage divider rule



$V_{GT} = \frac{R_2}{R_1+R_2} V_{DD}$

$= \frac{180K}{420K+180K} \times 20$

$= 6V$

From gate loop

$V_{GT} - V_{GS} - I_D R_S = 0$

$6 - V_{GS} - I_D \times 2.7k = 0$

$\boxed{6 - I_D \times 2.7k = V_{GS}}$ — (1)

For JFET

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

$\therefore I_D = 12m\left(1 - \frac{(6 - I_D \times 2.7k)}{-4}\right)^2$

$I_D = 12m\left[1 + \frac{6 - I_D \times 2.7k}{4}\right]^2$

on solving

$\boxed{I_D = 2.967\ mA}$

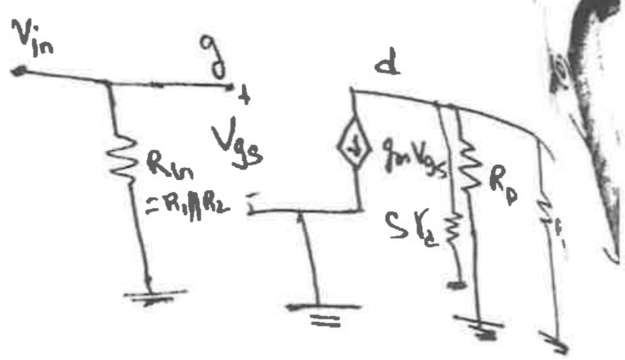
~~from equation~~

from eq (1)

$V_{GS} = 6 - 2.967m \times 2.7K$

(ii) $\boxed{V_{GS} = -2.01V}$

ac equivalent ckt



$g_m = \frac{2 I_{DSS}}{|V_P|}\left(1 - \frac{V_{GS}}{V_P}\right)$

$= \frac{2 \times 12m}{4}\left(1 - \frac{-2.01}{-4}\right)$

$\boxed{g_m = 2.985\ m℧}$

$Z_i = R_{in} = R_1 \| R_2$

$Z_i = 420k \| 180K = 126\ k\Omega$

$\boxed{Z_i = 126\ k\Omega}$

$Z_o = R_L \| R_D \| r_d = 4k \| 2.7k \| 50k$

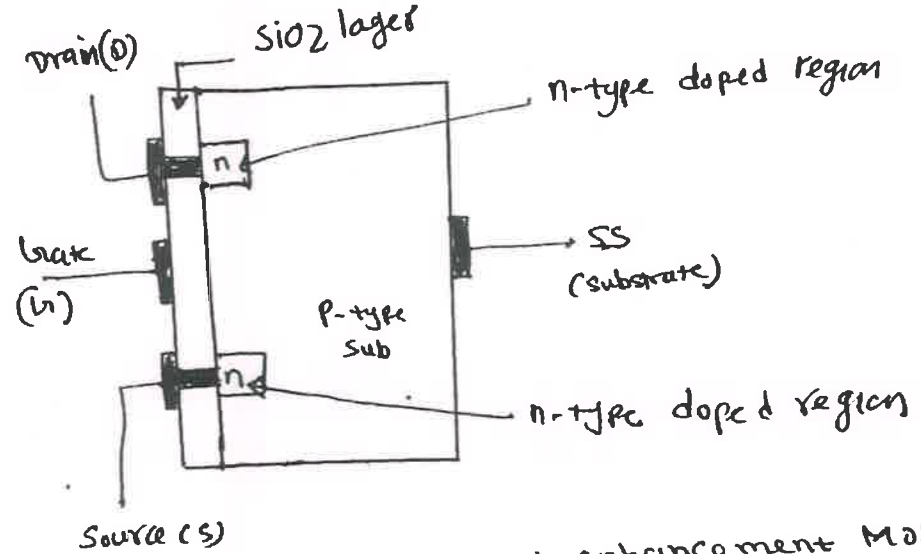
$\boxed{Z_o = 1.561\ k\Omega}$

$A_V = -g_m (R_L \| R_D \| r_d)$

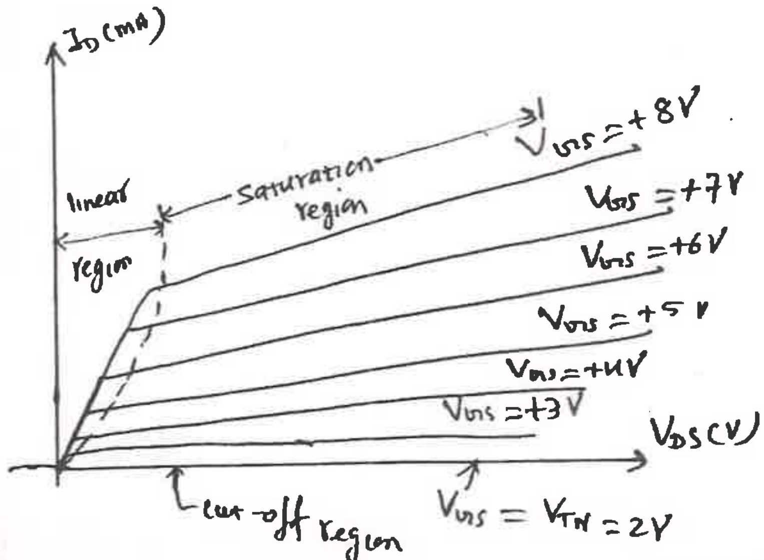
$= -2.98m\,(1.561k)$

$\boxed{A_V = -4.653}$

3 (a)



construction of n-channel enhancement MOSFET → 2M



→ 3M

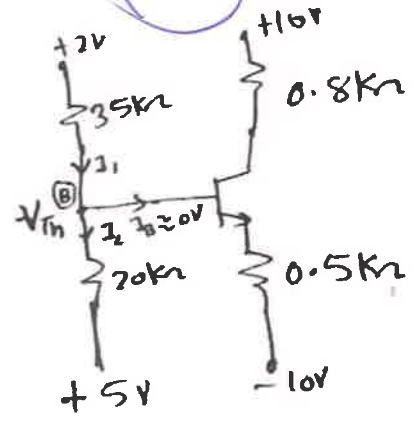
$I_D = K_n [V_{GS} - V_{TN}]^2$ → In ~~Saturat~~ region → 1M

$I_D = K_n [2(V_{GS}-V_{TN}) V_{DS} - V_{DS}^2]$ → linea region → 1M

Discription --- 3M

06

Q.3 (b)



KCl at node (B)

$$\frac{2-V_{Th}}{35k} = \frac{V_{Th}-5V}{20K}$$

on solving

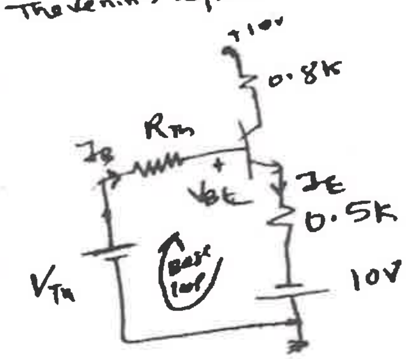
$V_{Th} = 3.90V$

$R_{Th} = R_1 \| R_2$

$= 35k \| 20k$

$R_{Th} = 12.72k\Omega$

Thevenin's equivalent ckt



KVL to base loop

$V_{Th} - I_B R_{Th} - V_{BE} - I_E(0.5K) + 10 = 0$

$3.90 - 0.7 + 10 = I_B R_{Th} + (1+\beta) I_B (0.5K)$

$I_B = \frac{13.20}{R_{Th} + (1+\beta)(0.5K)} = 208.79\mu A$

$I_C = \beta \cdot I_B = 100 \times 208.79\mu$

$I_C = 20.87 mA$

from collector loop

$10 - I_C(0.8K) - V_{CE} - I_E(0.5K) + 10 = 0$

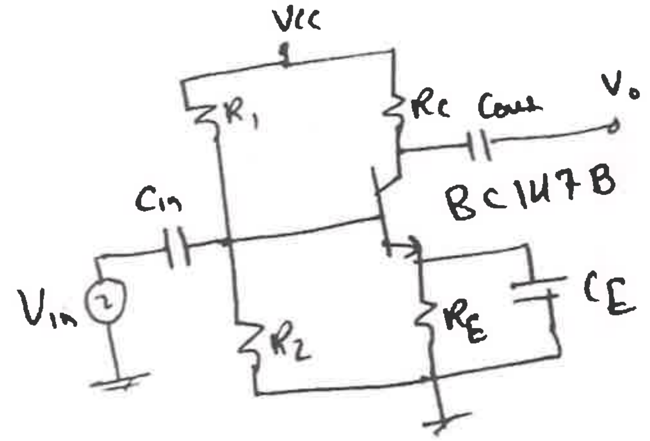
$V_{CE} = 20 - 20.87mA \times 0.8K - 20.87mA \times 0.5K$

$V_{CE} = -7.131V$

Q.4 (a) (i) Selection of Transistor

→ BC147B having $h_{ie} = 4.5k\Omega$ → 1M

(ii) selection of biasing ckt → 1M.

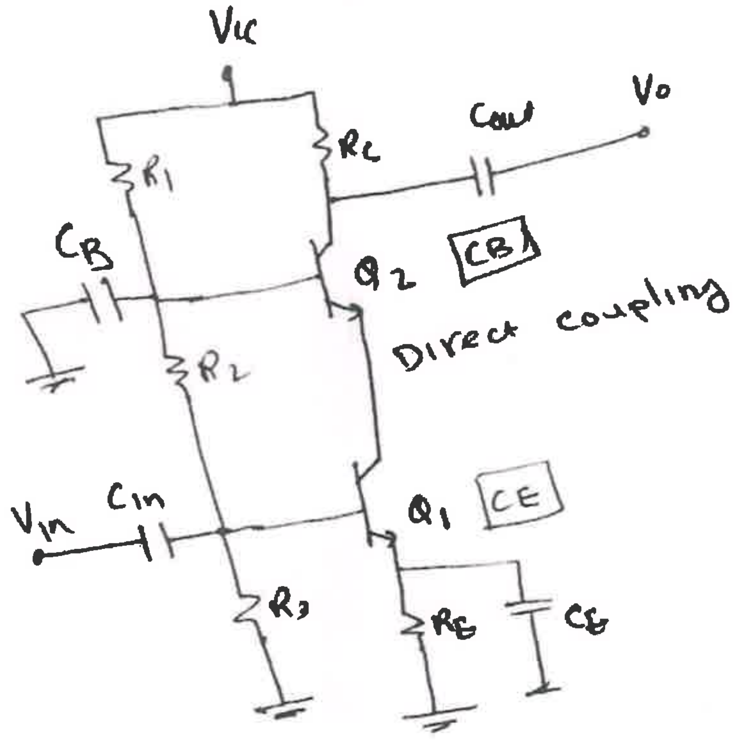


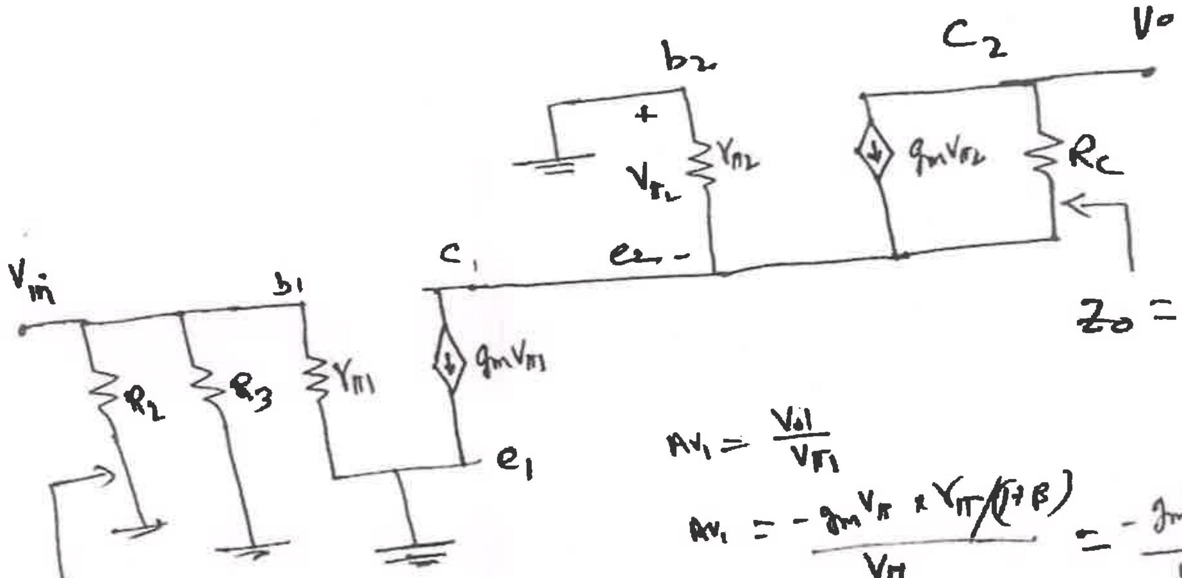
Selection of each component 1M/each

Selection of Vcc → 1M

07

1.5 (a) Cascode amplifier





$Z_o = R_C$

$Z_i = R_2 \| R_3 \| r_{\pi 1}$

$A_{V_1} = \frac{V_{o1}}{V_{\pi 1}}$

$A_{V_1} = -\frac{g_m V_\pi \times r_\pi/(1+\beta)}{V_\pi} = -\frac{g_m r_\pi}{1+\beta}$

$A_{V_1} = \frac{-\beta}{1+\beta} = -1$

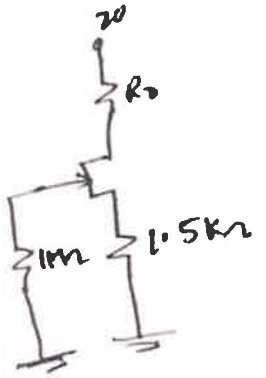
$A_{V_2} = g_m R_C$

$A_{VT} = A_{V_1} \times A_{V_2}$

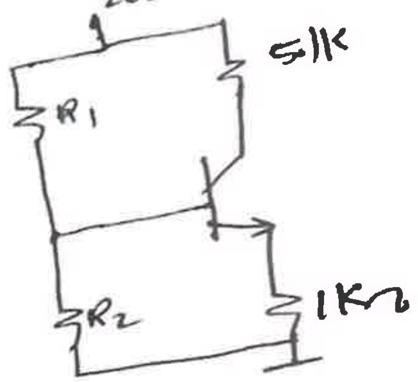
$\boxed{A_{VT} = g_m R_C}$

Q 5 (b) DC equivalent ckt

(i) JFET



BJT



For JFET, $I_G = 0$

∴ R_G can be replaced by short

∴ $V_{GS} = -I_D R_S = -I_D \times 1.5K$

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

$I_D = 10mA\left[1 - \frac{-I_D \times 1.5K}{-4}\right]^2$

$I_D = 10mA\left[1 - \frac{I_D \times 1.5K}{4}\right]^2$

on solving

$I_D = 1.6\ mA$

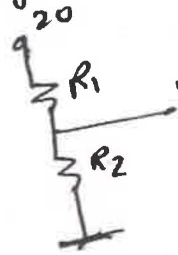
$V_{GS} = -1.6mA \times 1.5K$

$V_{GS} = -2.4V$

$g_m = \frac{2 I_{DSS}}{|V_P|}\left(1 - \frac{V_{GS}}{V_P}\right) = \frac{20m}{4}\left(1 - \frac{-2.4}{-4}\right)$

$g_m = 2m℧$

Voltage divider rule

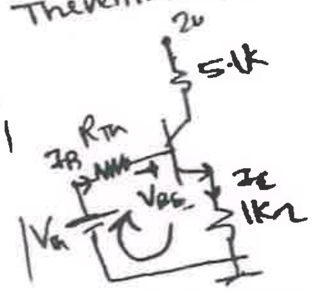


$V_{Th} = \frac{R_2}{R_1 + R_2} \times 20$

$= \frac{33K}{120K + 33K} \times 20 = 4.31$

$R_{Th} = R_1 \| R_2 = 120K \| 33K = 25.88kΩ$

Thevenin's equivalent ckt



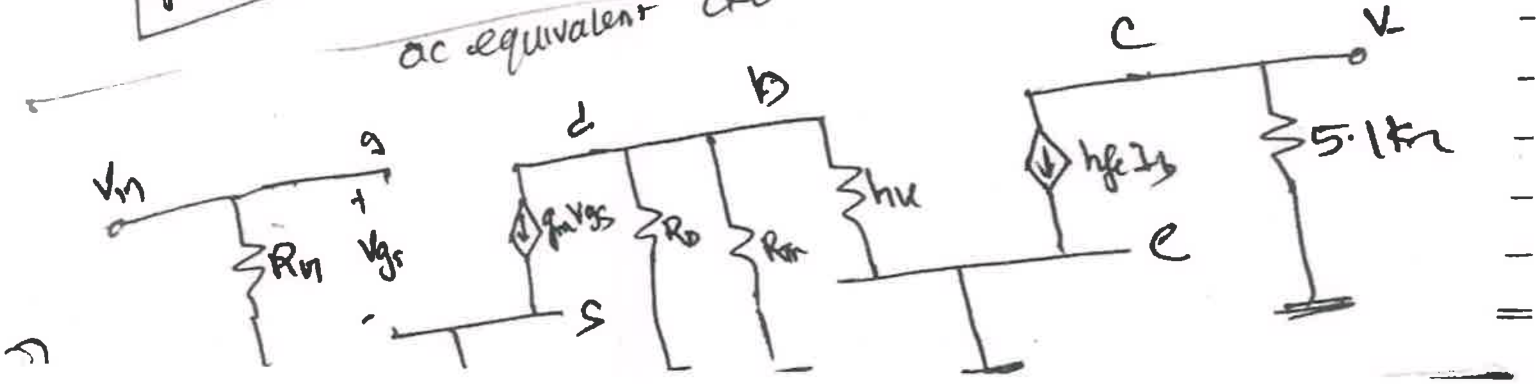
From Base loop

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

$I_B = \frac{4.31 - 0.7}{25.88K + 181 \times 1K} = 17.44\mu A$

$I_E = 3.14\ mA$

ac equivalent ckt



(8)

$$A_{V_1} = \frac{-g_m (R_D || R_{in} || h_{ie})}{1 + g_m R_S}$$

$$= \frac{-2m (3K || 25.88K || 4.5K)}{1 + 2m \times 1.5K}$$

$$= \frac{-3.36}{1+3} = -0.84$$

$$A_{V_2} = \frac{-h_{fe} R_L}{h_{ie}} = \frac{-180 \times 5.1K}{4.5K} = -204$$

Total (overall voltage gain), $A_{V_T} = A_{V_1} \times A_{V_2}$

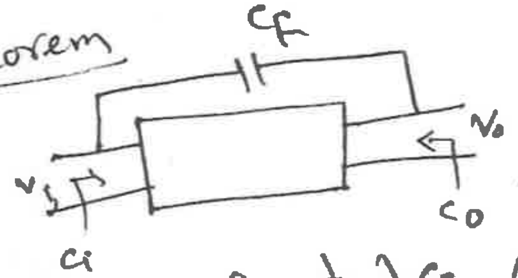
$$A_{V_T} = (-0.84)(-204)$$

$$\boxed{A_{V_T} = +171.36}$$

Q.6 (a) Self biasing for JFET

- zero temp-drift condition
- Circuit diagram
- Transfer char. with Q-point

(b) Miller Theorem



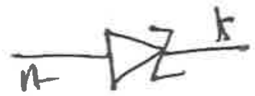
$C_i = (1 - A_V) C_f$ & $C_o = \left(1 - \frac{1}{A_V}\right) C_f$ (Derivations)

(9)

Q.6 (c) MOSFET applications

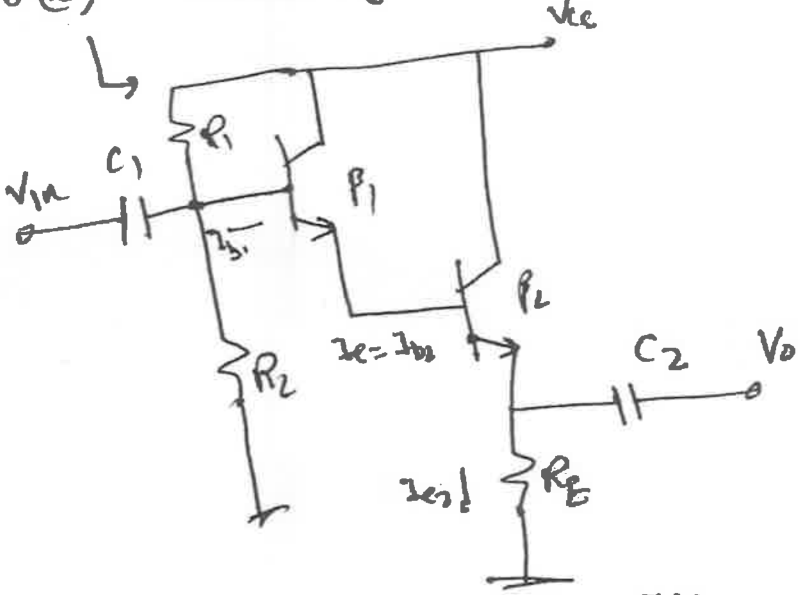
- → CS amplifier
- → Inverter / Not gate using CMOS

Q.6 (d) Zener diode

- → symbol 

- → Characteristics
- → Zener breakdown
- → Zener voltage regulator

Q.6 (e) Darlington Amplifier



- → ckt diagram.
- → $\beta_T = \beta_1 \times \beta_2$
- → Need
- → Applications