DEPT OF COMPUTER SCIENCE
MLITARY COLLEGE OF SIGNALS, NUST
ELECTRONIC CIRCUIT AND DEVICES
BESE 15 A&B

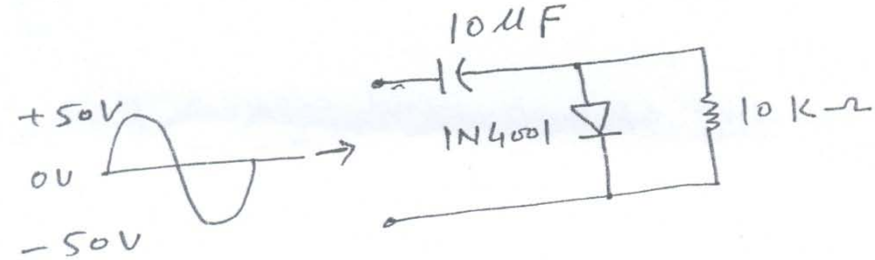
Exam: Final Term
Paper Type: (Regular)
Semester: Spring

Instructor: Lt Col (R) Saleem
Max Marks: 50
Time Allowed: 2 hrs 30 mins

Note:
1) Make neat and clean diagram
2) Attempt all questions
3) Attach question paper with answer sheet

Question No-1

a. Compute voltage across R_L in the circuit. Assume R_E is large enough to prevent significant capacitor discharge. (5)

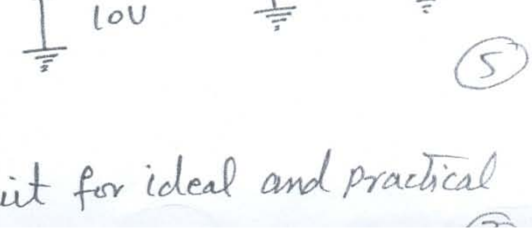


b. Find the Maximum value to which Vcc can be adjusted without exceeding the ratings. maximum rating are as under.

$P_{D(max)} = 1000\ mW$

$V_{CE(max)} = 20\ V$

$I_{C(max)} = 150\ mA$



(5)

Question No-2

a. Sketch ac equivalent circuit for ideal and practical

c. Explain and draw comparison of pinch-off and cutoff voltage (FET). (5)

Question No-3

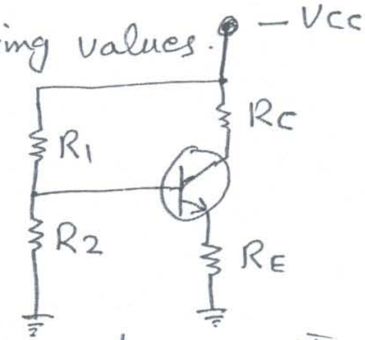
a. Find Ic and VCE for following values.

$R_1 = 68\ K\Omega$ $\quad V_{CC} = -6V$

$R_2 = 47\ K\Omega$ $\quad \beta_{DC} = 75$

$R_C = 1.8\ K\Omega$

$R_E = 2.2\ K\Omega$



(5)

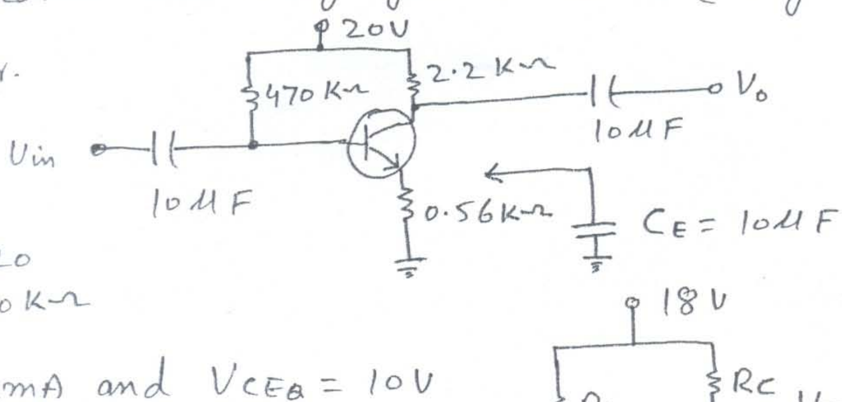
b. The I/p to a device is 10,000 W at the voltage of 1000V, The o/p power is 500 W and o/p impedance is 20 Ω. Find voltage and power gain in decibels. (5)

Question No-4

Derived expression for close loop voltage gain for Non-inverting op-amp. Find close loop gain (Av) if open loop gain of op-amp is 100,000, $R_f = 100\ K\Omega$ and $R_{in} = 4.7\ K\Omega$. (10)

Question No-5.

a. Find Internal ac resistance of Emitter Junction, I/p impedance, o/p impedance and voltage gain without C_E (unbypass) capacitor.



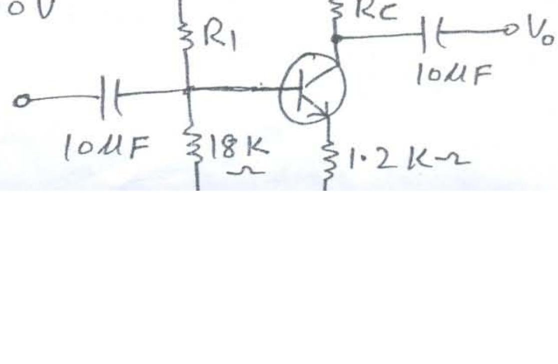
(5)

$\beta = 120$

$r_o = 40\ K\Omega$

b. $I_{CQ} = 2mA$ and $V_{CEQ} = 10V$

calculate R_1 & R_C.



Dept of CS-(MCS) NUST

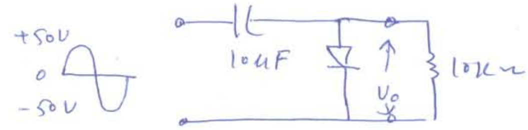
Subj : Electronic Devices and cct : Instr: Saleem.

Course : BESE 15-A & B : Final paper soln

Question No. 1 :-

a. This is a clamping cct. A negative DC value equal to the I/p peak less the diode drop is inserted by the clamping cct.

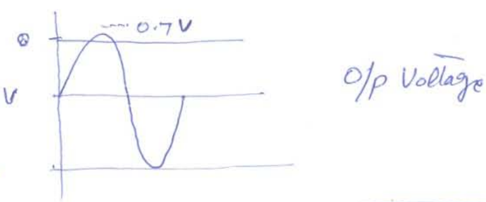
$V_{DC} \cong -(V_{p\,in} - 0.7)$



$= -(50V - 0.7)$

$= -49.3V$

· capacitor discharges a little bit and average value will be slightly less than That i.e -49.3 V



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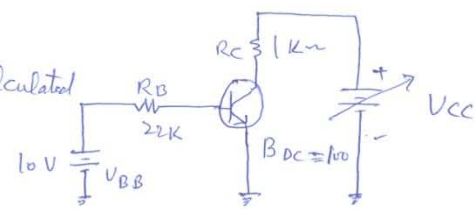
b. First find I_B so That I_C be calculated



$I_B = \dfrac{V_{BB} - V_{BE}}{R_B}$

$= \dfrac{10V - 0.7V}{22K\Omega} = 423\ \mu A$

I_C

$I_C = B_{DC} I_B = (100)(423\ \mu A) = .0423\ A = \boxed{42.3\ mA}$

$I_{C(max)} = 150\ mA$ so I_C calculated is very very less Than $I_{C(max)}$ and

Question No - 2

a. Ideal OP-amp

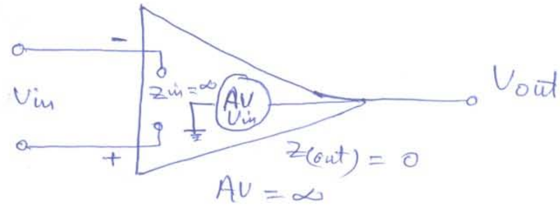
$Z_{in} = \alpha$

$Z_{out} = 0$

$A_v (gain) = \alpha$

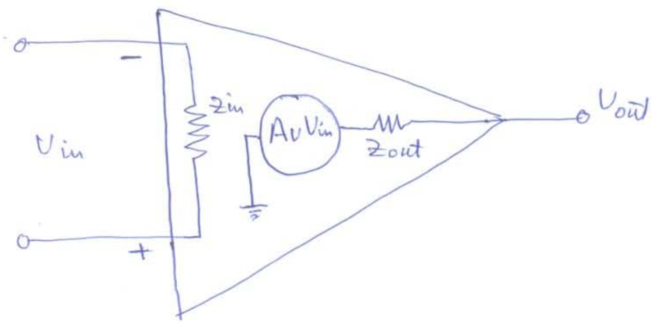
$BW = \infty$

V_{in} & V_{out}



2x Terminal -ve & +ve

practical OP-amp



Z_{in} = very High

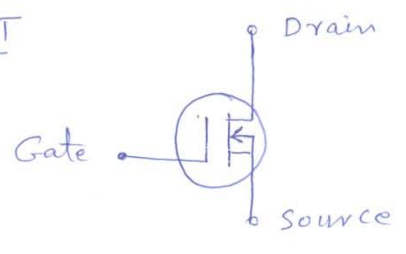
Z_{out} = " Low

Gain = very. v. High

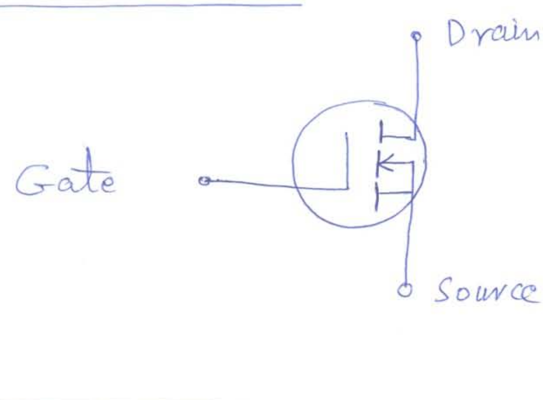
BW = " High.

b. N-channel - D-MOSFET

symbol sketch



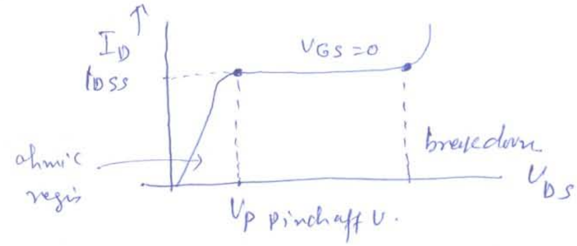
N - Channel . E - MOSFET



C. pinch off voltage

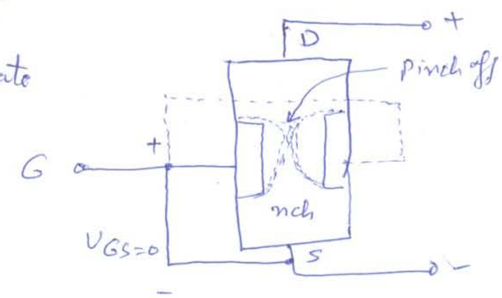
- when $V_{GS} = 0V$, it's always measured at $V_{GS} = 0$

  The value of V_{DS} at which I_D become constant is known as pinch off voltage



- pinch off occurs for V_{DS} value less than V_p when $V_{GS} \neq 0$

- $V_{GS(off)}$ and V_p are always equal in magnitude but opposite in sign.

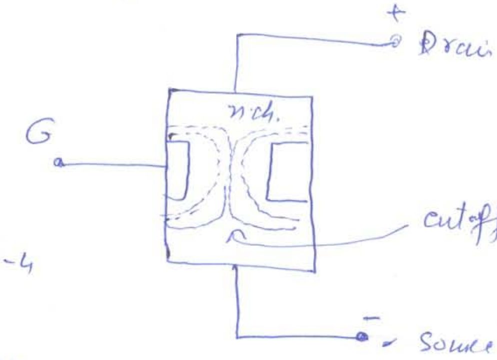


- V_p is measured by shorting the gate to source lead i.e I_D increase up to its max value then levels off.
- mfr provides this value.

- cutoff voltage

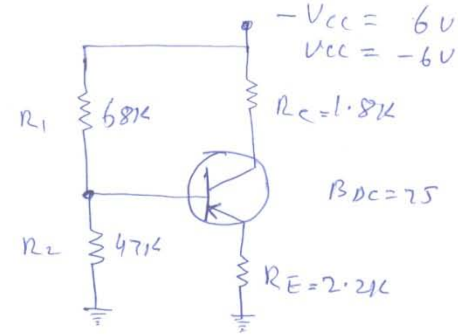
- The value of V_{GS} that makes I_D approximately zero is cut off voltage $V_{GS} = off$.

- JFET to be operated b/w $V_{GS} = 0$ & $V_{GS(off)}$, for this range V_{DS} & I_D will vary b/w max (I_{DSS}) to minimum i.e channel is completely closed.



- $V_{GS(off)}$ and V_p are always equal in magnitude but opposite in ~~direction~~ sign i.e if $V_{GS(off)} = -4$ then V_p will be $+4$.
- Mfr provide one of these value.

Question No. 3



a. $R_{in\,base} = B_{DC} R_E$

$= 75(2.2K\Omega) = 165K\Omega$

As R_{in} is not more 10 time R_2

i.e (R_2) 10 = (47) 10 = 470KΩ

so

- $V_B = \left(\dfrac{R_2 \| R_{in\,base}}{R_1 + R_2 \| R_{in\,base}}\right) V_{cc} = \left(\dfrac{(47K\Omega)\|(165K\Omega)}{68K\Omega + 47K\Omega\|165K\Omega}\right) - 6V$

$= -2.1V$

- $V_E = V_B + V_{BE} = -2.1V + 0.7V = -1.4V$

$I_E = \dfrac{V_E}{R_E} = \dfrac{-1.4V}{2.2K\Omega} = -636\,uA$

- $I_C = I_E = \boxed{-636\,uA}$

$V_C = V_{cc} - I_C R_C = -6V - (-636\,uA)(1.8K\Omega) = -4.86V$

$V_{CE} = V_C - V_E = -4.86V - (-1.4) = -3.46V$

$\boxed{-636\,uA,\ -3.46V}$
$-1.27mA,\ 5.94$

b. Power gain in dbs i.e $G_{dB} = 10\log_{10}\dfrac{P_o}{P_{in}} = 10\log_{10}\dfrac{500W}{10KW}$

$= 10\log_{10}\dfrac{1}{20} = -10\log_{10} 20$

$-10(1.301) = \boxed{-13.01dB}$

- Voltage gain $= 20\log_{10}\dfrac{V_o}{V_i} = 20\log_{10}\dfrac{\sqrt{PR}}{1000}$

$= 20\log_{10}\dfrac{\sqrt{(500W)(20\Omega)}}{1000}$

$= 20\log_{10} 100/1000 = 20\log_{10}\dfrac{1}{10} = -20\log_{10}10 = \boxed{-20dB}$

will not change with V_{CC}. It depend upon I_B & β_{DC}

<u>V_{RC}</u>

- Now voltage drop across R_C is

$$V_{RC} = I_C R_C = (42.3\,mA)(1\,k\Omega) = \boxed{42.3\,V}$$

- <u>$V_{CC(max)}$</u>

- Now Find the value of V_{CC} when $V_{CE} = V_{CE(max)}$ which is 20V

$$V_{RC} = V_{CC} - V_{CE}$$

So
$$V_{CC(max)} = V_{CE(max)} + V_{RC}$$
$$= 20V + 42.3V = \boxed{62.3\,V}$$

V_{CC} can be increased up to 62.3V before $V_{CE(max)}$ is exceeded.

- <u>P_D</u>

- $$P_D = (V_{CE(max)})\,I_C = (20V)(42.3\,mA) = \boxed{846\,mW}$$

As $P_{D(max)} = 1000\,mW$ so it's not exceeded when

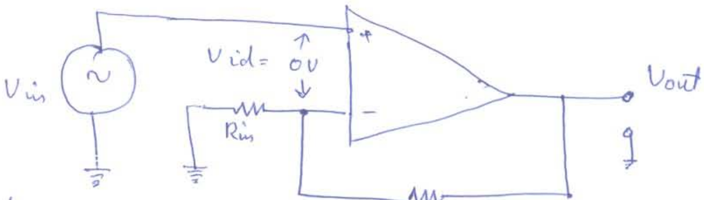
$V_{CC} = 62.3\,V$

So $V_{CE(max)} = 20V$ is the limiting rating

- If transistor is turned off then $V_{CE(max)}$ will exceed as the whole supply voltage V_{CC} will drop across transistor.

Question No-4

Non. Inverting Amp close loop gain



- It is non inverting as the I/p signal drives the non-inverting I/p Terminal. O/p signal is applied to inverting I/p terminal Through FB Nw.
- Rf & Rin form -ive FB path and are voltage divider which reduces Vout

FB voltage $V_f = \left(\frac{R_i}{R_i+R_f}\right) V_{out}$ | $\frac{R_i}{R_i+R_f}$ is atten of FBNW

$V_f = B V_{out}$ —— (1)

The difference of I/p and o/p voltage i.e $V_{in} - V_f$ is applied which is the cause of o/p voltage.

$$V_{out} = A_{OL}(V_{in} - V_f)$$

$$V_{out} = A_{OL}(V_{in} - B V_{out})$$

$$V_{out} = A_{OL} V_{in} - A_{OL} B V_{out}$$

$$A_{OL} V_{in} = V_{out} + A_{OL} B V_{out}$$

$$\text{"} = V_{out}(1 + A_{OL} B)$$

overall voltage gain of Amp = V_{out}/V_{in}

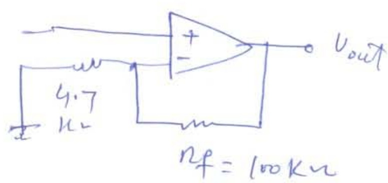
$$\boxed{A_{cl NI} = 1 + \frac{R_f}{R_{in}}}$$

$$\frac{V_{out}}{V_{in}} = \frac{A_{ol}}{1 + A_{ol} B}$$ | $A_{ol}B$ is $>>1$

$$\frac{V_{out}}{V_{in}} = \frac{A_{ol}}{A_{ol} B} = \frac{1}{B}$$

So it is the reciprocal of FB atten

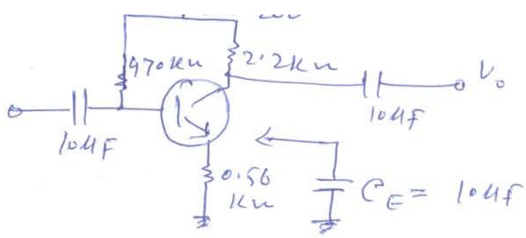
$$A_{cl(NI)} = \frac{R_i + R_f}{R_i} = \left(1 + \frac{R_f}{R_{in}}\right)$$



$$A_{v(cl)} = 1 + \frac{R_f}{R_i}$$

$$= 1 + \frac{100\,k\Omega}{4.7\,k\Omega} = 22.3 \text{ voltage}$$

Question-5



$\beta = 120$
$r_o = 40k\Omega$

a. DC:

r'_e

$$I_B = \frac{V_{CC} - V_{BE}}{R_B + (\beta+1)R_E} = \frac{20V - 0.7V}{470k\Omega + (121)0.56k\Omega} = 35.89\mu A$$

$$I_E = (\beta+1)I_B = (121)(35.89\mu A) = 4.34\,mA$$

and

$$r'_e = \frac{26mV}{I_E} = \frac{26mV}{4.34mA} = \boxed{5.99\Omega}$$

$\frac{25mV}{4.34} = 5.76\Omega$

I/p Z.

Test the condition $r_o \geq 10(R_C + R_E)$

$40k\Omega \geq 10(2.2k\Omega + 0.56k\Omega)$

" condition satisfied " $40k\Omega \geq 10(2.76k\Omega) = 27.6k\Omega$

so

$$Z_{base} = \beta(r'_e + R_E) = 120(5.99\Omega + 560\Omega)$$

$$= \boxed{67.92\,k\Omega}$$

$$Z_{in} = R_B \| Z_b = 470k\Omega \| 67.92k\Omega$$

$$\frac{470 \times 67.92}{470 + 67.92} = \boxed{59.34\,k\Omega}$$

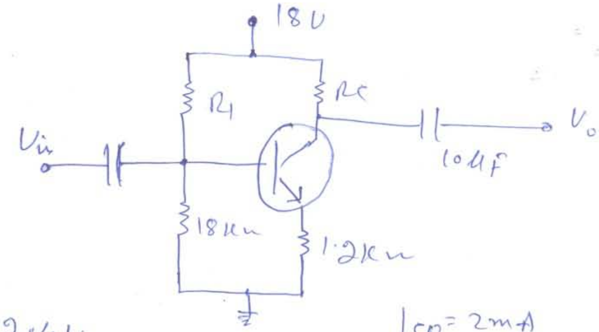
O/p Z

$$Z_o = R_C = 2.2k\Omega$$

voltage gain $r_o \geq 10R_C$ is satisfied so

$$A_V = \frac{V_o}{V_{in}} = -\frac{\beta R_C}{Z_b} = \frac{(120)(2.2k\Omega)}{67.92k\Omega} = \boxed{-3.89}$$

B



$I_{CQ} = 2mA$

$V_{CEQ} = 10V$

$V_E = I_E R_E \cong I_C R_E$

$= (2mA)(1.2k\Omega) = 2.4V$

$V_B = V_{BE} + V_E = 0.7V + 2.4V = 3.1V$

$$V_B = \frac{R_2 V_{CC}}{R_1 + R_2}$$

$$= \frac{(18k\Omega)(18V)}{R_1 + 18k\Omega} = 3.1V$$

$324k\Omega = 3.1V(R_1) + (3.1V)(18k\Omega)$

$324k\Omega = 3.1R_1 + 55.8k\Omega$

$$R_1 = \frac{324 - 55.8}{3.1} = \frac{268.2k\Omega}{3.1} = \boxed{86.52k\Omega}$$

$$R_C = \frac{V_{RC}}{I_C} = \frac{V_{CC} - V_C}{I_C}$$

$V_C = V_{CE} + V_E$

$10V + 2.4V = 12.4V$

$$R_C = \frac{18V - 12.4V}{2mA} = \boxed{2.8k\Omega}$$