Assignment
Date: 14/04/2020

Course Details

Course Title:	Electronic Circuit Design	**Module:**	04
Instructor:	ENGINEER MUJTABA	**Total Marks:**	30

Student Details

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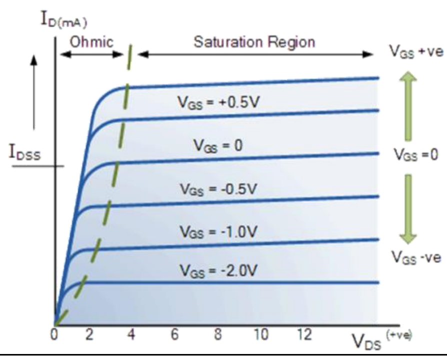
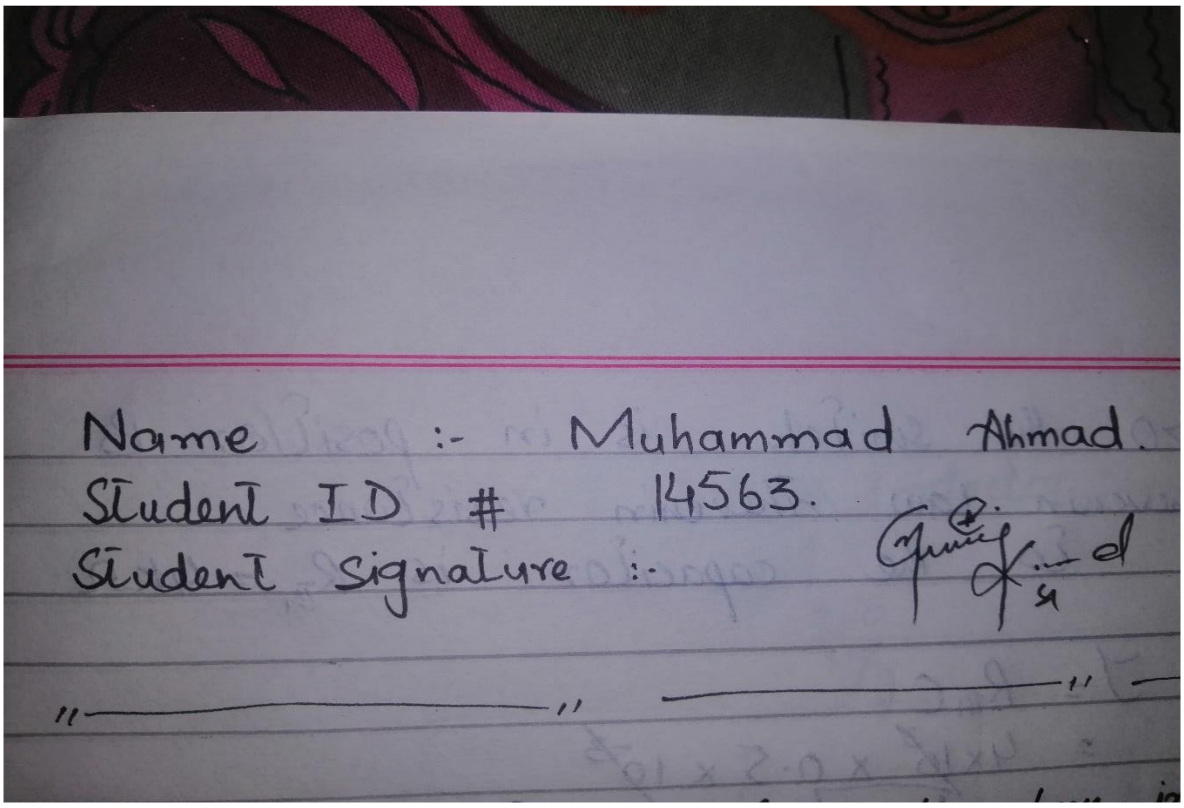
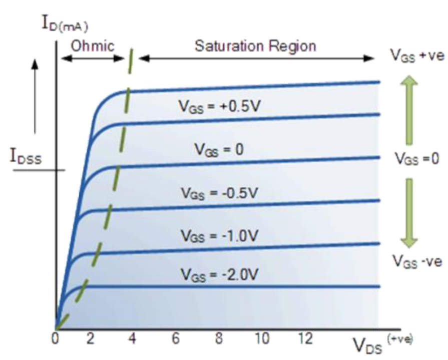
Q1.	(a)	**Explain** the drain characteristic curve of D-MOSFET given below. 	Marks 07 CLO 1
	(b)	**Sketch** the hybrid model and write equations for the transistor in common emitter configuration.	Marks 06 CLO 1
Q2.		A certain operational amplifier has a common mode gain of 0.6 and an open loop differential voltage gain of 400,000. **Evaluate** the CMRR & express it in decibels.	Marks 05 CLO 2
Q3.	(a)	**Explain** the concept behind negative feedback in operational amplifiers.	Marks 06 CLO 2
	(b)	**State** the following statement as **True** or **False** and also give the reason for your answer: “The output of a summing amplifier is positive”	Marks 06 CLO 2



QNO 1(a): Explain the drain characteristic curve of D-MOSFET given below.

Answer :



- The characteristics curve between the drain current I_d and the voltage V_{ds} for various voltage V_{gs} let see the fig I_d , V_{ds} and V_{gs} we know that the I_d is the output current .
- V_{ds} is the output voltage and V_{gs} is the input voltage.
- At Y axis we have drain current I_d in (mA) and X axis we have voltage V_{ds} in volts.
- When V_{ds}=0 , I_d is also zero (because of no potential difference)
- As we know V_{ds} and I_d is proportional to each other. When we increase V_{ds} the I_d will increase uniformly. But after some time the drain current I_d become constant and its because of the pinch off ($V_{ds} = V_{gs} - V_p$)boundary between ohmic and active region (the dotted line from origin). Here V_{ds} is 0 volts the pinch off start .
- We can either increase or decrease the value of V_{gs}. Its our choice -0.5 volt or +0.5 as shown in the figure. Let take V_{gs} +0.5 the terminal is positive. When terminal becomes positive it attracts almost all electrons, now the terminal will have maximum electrons and as the number of electrons increase the current will also increase. So, for V_{ds} the I_d will be greater when V_{gs} is positive. As we can see the gap between the V_{gs} =0 to V_{gs} =+0.5 curve. This shows that the I_d will increase constantly with same value of V_{ds} if we make V_{gs} more positive. Same with negative it will decrease as V_{gs} decreases.
- When V_{gs} is equal to pinch off then the I_d will be zero at any point.

<u>QNO 1(b) :</u> Sketch the hybrid model and write equations for the transistor in common emitter configuration.

Answer: In common emitter transistor configuration the input signal is applied between the base and emitter terminals of the transistor &output appears between the collector &emitter terminals. The input voltage (V_{be}) and the output current I_c are given by the following equations: equations:

$$V_{be} = h_{ie}.i_b + h_{re}.V_c$$

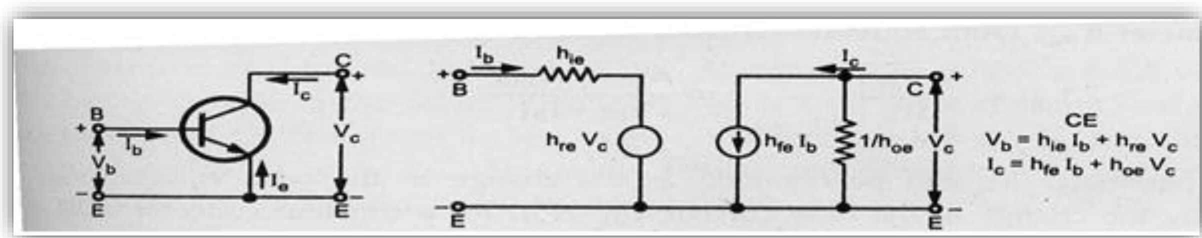
$$i_e = h_{fe}.i_b + h_{oe}.V_c$$

Also if V_{ce} is held constant (V_{ce} =0) then hie and hfe can be solved:

$$hie = V_{be} / i_b \mid V_{ce} = 0$$

$$hfe = I_c / i_b \mid V_{ce} = 0$$

These are the four basic parameters for a BJT in common emitter. Typical values are $h_{re} = 1 \times 10^{-4}$, h_{oe} typical value 20µS, h_{ie} typically 1k to 20k ohm and h_{fe} can be 50 - 750. The H-parameters can often be found on the transistor datasheets.



h_{ie}= input impedance (ohm)

$h_{re=}$reserve voltage ratio (dimensionless)

h_{fe} =forward current transfer ratio (dimensionless)

h_{oe} =output admittance (siemen)

Where $h_{ie} =(\partial f_1/\partial i_B)V_c = (\partial v_B/\partial i_B)V_c = (\Delta v_B /\Delta i_B)V_c = (v_b / i_b)V_c$

$h_{re} =(\partial f_1/\partial v_c)I_B = (\partial v_B/\partial v_c) I_B = (\Delta v_B /\Delta v_c) I_B = (v_b /v_c) I_B$

$h_{fe} =(\partial f_2/\partial i_B)V_c = (\partial i_c /\partial i_B)V_c = (\Delta i_c /\Delta i_B)V_c = (i_c / i_b)V_c$

$h_{oe}= (\partial f_2/\partial v_c)I_B = (\partial i_c /\partial v_c) I_B = (\Delta i_c /\Delta v_c) I_B = (i_c /v_c) I_B$

Current gain $A_I = \frac{-h_{fe} \times I_b}{I_b} = -h_{fe}$ .....(2)

Input resistance $R_i = h_{ie}$

Voltage gain $A_V = A_I \times \frac{R_L}{R_i} = \frac{-h_{fe} \times R_L}{h_{ie}}$ ......(3)

<u>QNO 2:</u> A certain operational amplifier has a common mode gain of 0.6 and an open loop differential voltage gain of 400,000. Evaluate the CMRR & express it in decibels.

<u>Answer :</u>

<u>Given:</u>

Differential voltage gain=A=400,000

Common mode gain=0.6

Find CMRR=?

Solution:

As we the formula of CMRR

CMRR = (Differential Mode Gain)/(Common Mode Gain)

$$CMRR=(Aol/Acm)$$

$$CMRR=400000/0.6$$

CMRR =666666.666

CMRR in decibels:

CMRR(db)=20*log(CMRR)

=20*log(666666.666)

=20*5.8239

=116.47 dB Answer

QNO 3(a): Explain the concept behind negative feedback in operational amplifiers.

Answer: Negative feedback is the process whereby a portion of the output voltage of an amplifier is returned to the input with a phase angle that opposes (or subtracts from) the input signal. Inverting (-) input effectively makes the feedback signal 180’ out of phase with the input signal. A negative feedback amplifier is an amplifier that subtracts a fraction of its output from its input, so that the negative feedback opposes the original signal, the applied negative feedback can improve its performance (gain stability, linearly, frequency response, step response) and reduces sensitivity to the parameter variations due to malfunctioning or environment. Because of these advantages, many amplifiers and control system use negative feedback.

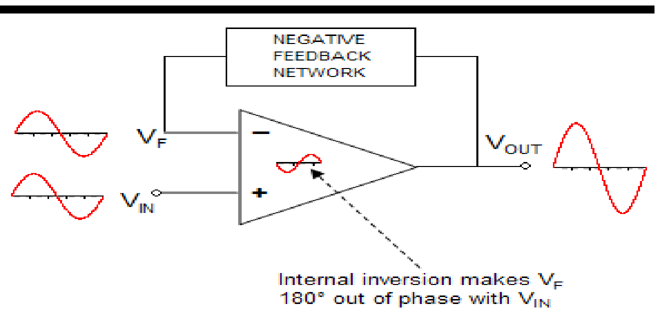
Advantage of Negative Feedback in Op-Amps

One major benefit of using an op-amp with negative feedback is that the op-amp's actual voltage gain doesn't matter, as long as it's really high. Improves the stability in gain. Reduces the distortion. Reduces the noise level at the output. If the differential gain of the op-amp was 250,000 instead of 200,000, what this would mean is that the output voltage would stay only a little closer to Vin (less differential voltage needed between inputs to produce the necessary output). The output voltage will always (for all practical purposes) be equal to the non-inverting input voltage in the circuit just demonstrated. Op-amp gains, therefore, do not have to be precisely set by the factory in order for the circuit designer to build an amplifier circuit with precise gain. Negative feedback is making the machine auto-correct. The above circuit as a whole will simply follow the input voltage with a stable gain of 1.

Disadvantage of negative feed back

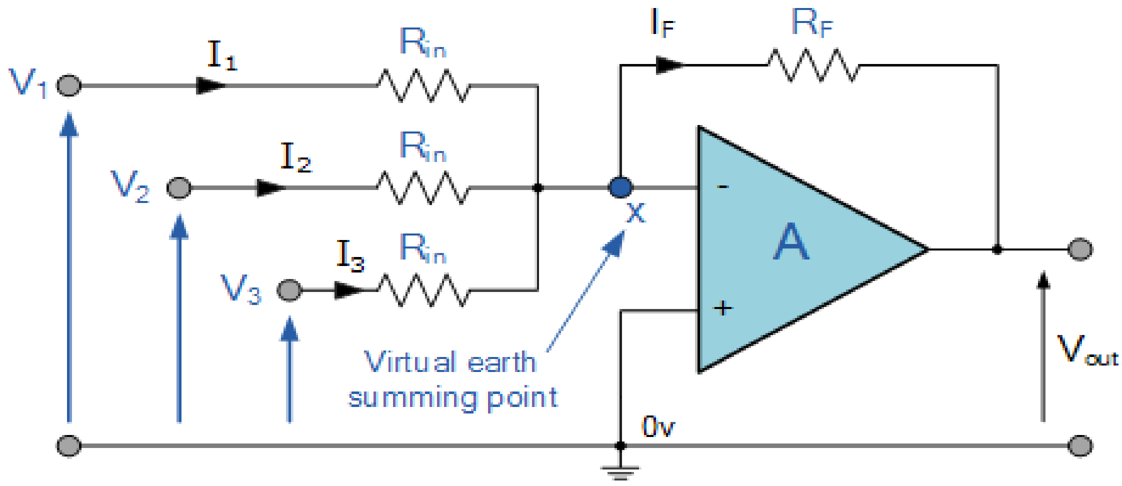
- Decreases the gain
- Decreases the distortion
- Decreases the noise

Due to this it is used amplifiers



QNO # 3(b): State the following statement as True or False and also give the reason for your answer:
“The output of a summing amplifier is positive”

Answer : This statement is false because of “Summing amplifier is an application of inverting op-amp configuration that has two or more inputs & its output voltage is proportional to the negative of the algebraic sum of its input voltage”. Likewise, when the summing input is connected to the non-inverting input of the om-amp, it will produce the positive sum of the input voltages. When we have gain greater than unity Rf is greater than input resistors, the amplifier has a gain of Rf/R, where R is the value of each equal value input resistor.



The output voltage, (Vout) is now proportional to the number of input voltages, V1, V2, V3, etc. in this basic summing amplifier circuit. We can then modify the original equation for the inverting amplifier so that these new inputs are taken into account:

$$I_F = I_1 + I_2 + I_3 = -\left[\frac{V1}{Rin} + \frac{V2}{Rin} + \frac{V3}{Rin}\right]$$

$$\text{Inverting Equation: } Vout = -\frac{Rf}{Rin} \times Vin$$

$$\text{then, } -Vout = \left[\frac{R_F}{Rin}V1 + \frac{R_F}{Rin}V2 + \frac{R_F}{Rin}V3\right]$$

However, if all the input impedances, (R_{IN}) are equal in value, we can simplify the above

Summing Amplifier Equation

$$-Vout = \frac{R_F}{R_{IN}}\left(V1 + V2 + V3 \ldots .etc\right)$$