Department of Electrical Engineering
Assignment
Date: 14/04/2020

Course Details

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

Student Details

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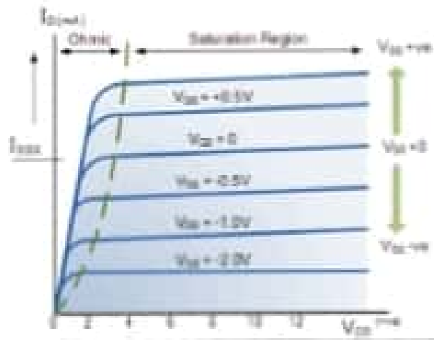
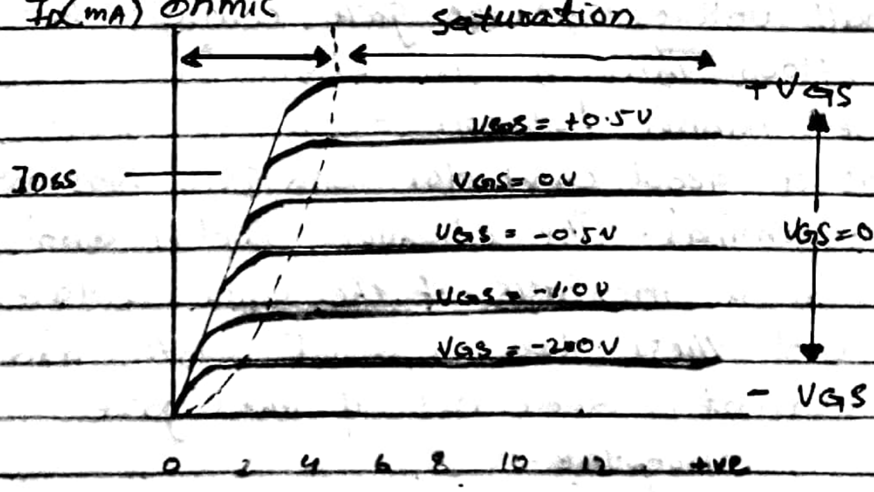
Q1.	(a)	**Explain** the drain characteristic curve of D-MOSFET given below. 	Marks 07 CLO 1
	(b)	**Sketch** the hybrid model and write equations for the transistor in common emitter configuration.	Marks 06 CLO 1
Q2.		A certain operational amplifier has a common mode gain of 0.6 and an open loop differential 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

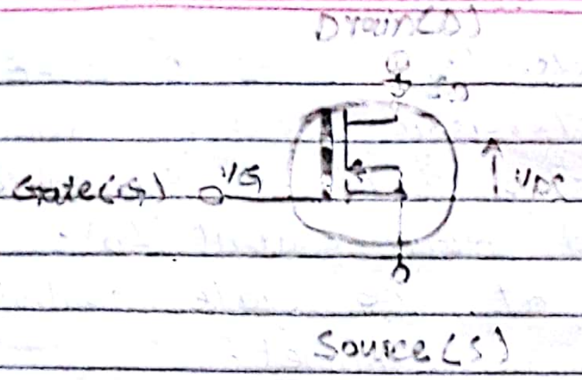
Q1 (a) Explain the drain characteristic curve of D-MOSFET.

This characteristic curve mainly gives the relationship between drain-source voltage (V_{DS}) and drain current (I_D). The small voltage at the gate controls the flow through the channel.

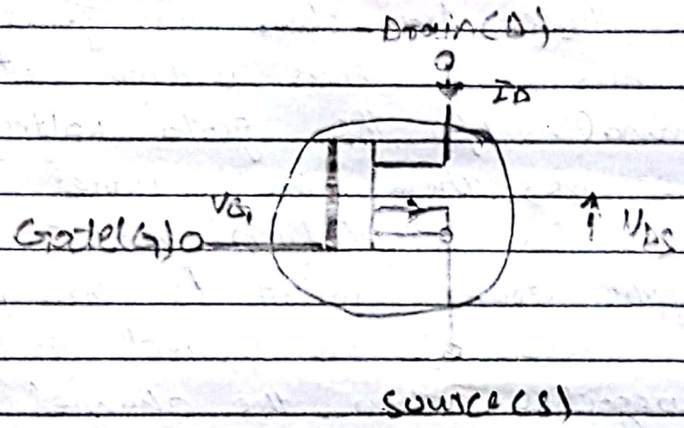
The depletion mode MOSFETs are generally known as 'switched ON' devices, because these transistors are generally closed when there is no bias voltage at the gate terminal. If the gate voltage increases in positive, then the channel width increases in depletion mode. As a result the drain current I_D through the channel increases. If the applied gate voltage more negative, then the channel width is very less and MOSFET may enter into the cutoff region. The depletion mode MOSFET is rarely used type of transistor in the electronic circuits.



characteristic curve of Depletion mode MOSFET



N- Channel

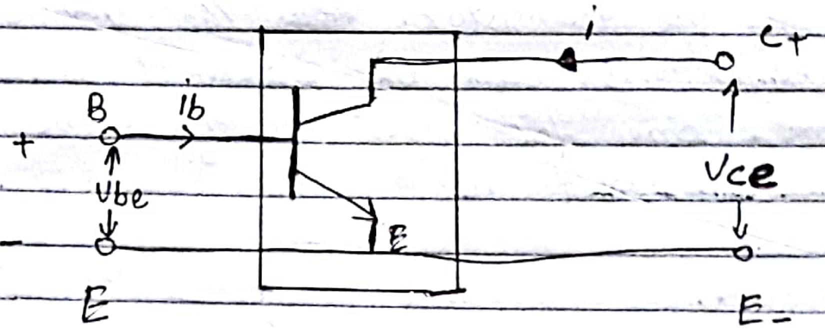


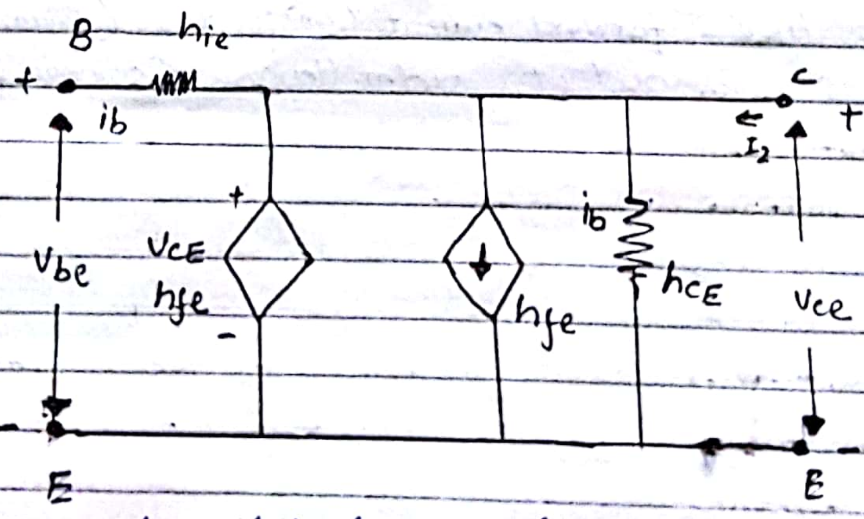
P- channel

The V-I characteristics of the depletion mode MOSFET transistor are given above. This characteristic mainly gives the relationship b/w drain-source voltage (VDS) and drain current (I_D). The small voltage at the gate controls the current flow through the channel.

The channel between drain and source acts as a good conductor with zero bias voltage at gate terminal. The channel width and drain current increases if the gate voltage is positive and these two (channel width and drain current) decreases if the gate voltage is negative.

Q1. (b) Sketch the hybrid model and write equations for the transistor in common emitter configuration.





Transistor Hybrid Model CE Configuration

In common emitter transistor configuration, the input signal is applied between the base and emitter terminals of transistor and output appears between the collector and emitter terminals. The input voltage (Vbe) and the output current (ie) are given by the following equations.

$$V_{be} = h_{ie} \cdot i_b + h_{re} \cdot V_{ce}$$

$$i_e = h_{fe} \cdot i_b + h_{oe} \cdot V_{ce}$$

The hybrid model is suitable for small signals at mid band and describes the action of the transistor. The above two equations can be derived from the diagram, one for input voltage V_{be} and one for the out i_c

h_{ie} = input impedance (Ω)
h_{re} = reverse voltage ratio (dimensionless)
h_{fe} = forward current transfer ratio (dimensionless)
h_{oe} = output admittance (siemen)

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 and express it in decibels.

Given data:

$A_{cm} = 0.6$ ∴ A_{cm} = common mode gain

$A_{ol} = 400,000$ ∴ A_{ol} = (open loop differential voltage gain)

Required data:

CMRR = ?

Solution:

As we know that

$$CMRR = A_{ol} / A_{cm}$$

Puts values in the above formula

Therefore we get.

$$CMRR = 400,000 / 0.6 = 6,66,666.667$$

$$CMRR = 6,66,666.667$$

Now we expressed in decibels;

also we know that

$$CMRR = 20 \log (A_d / A_{cm})$$

$$CMRR = 20 \log (666,666.667)$$

$$= 116.478 \text{ dB}$$

Q3 (a) Explain the concept behind negative feedback in operational amplifiers.

Negative feedback is one of the most useful concepts in electronics, particularly in operational amplifiers. 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.

Negative feedback is illustrated in figure below. The inverting (−) input effectively makes the feed-back signal 180° out of phase with the input signal.

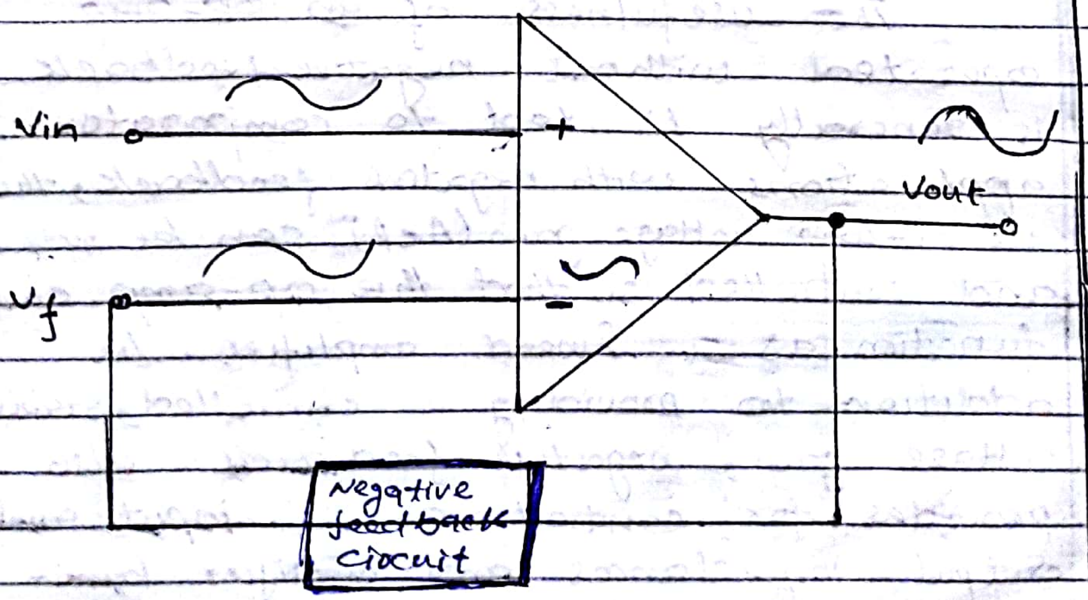


Illustration of negative feedback

Why use Negative feedback?

The inherent open-loop voltage gain of a typical op-amp is very high (usually greater than 100,000). Therefore, an extremely small input voltage drives the op-amp into its saturated output states. In fact, even the input offset voltage of the op-amp can drive it into saturation. For example, assume V_{IN} = 1mV and A_{ol} = 100,000. Then,

$$V_{IN} A_{ol} = (1mV)(100{,}000) = 100V$$

Since the output level of an op-amp can never reach 100V, it is driven deep into saturation and the output is limited to its maximum output levels.

The usefulness of an op-amp operated without negative feedback is generally limited to comparator applications. With negative feedback, the closed-loop voltage gain (A_{cl}) can be reduced and controlled so that the op-amp can function as a linear amplifier. In addition to providing a controlled, stable voltage gain, negative feedback also provides for control of the input and output impedances and amplifier band-width. The below Table summarizes the general effects of negative feedback on op-amp performance.

(a)

	Voltage Gain	Input Z	output Z	Bandwidth
without negative feedback	Aol is too high for linear amplifier application	Relatively high	Relatively Low	Relatively narrow (because the gain is so high)
with negative feedback	Acl is set to desired value by the feed back circuit	can be increased or reduced to a desired value depending on type of circuit	can be reduced to a desired value	significantly wider

Q3
(b) state the following statement as True or Flase and also give the reason for your answer:
" The out put of a summing amplifier is positive "

sol:- " The output of a summing amplifier is positive "

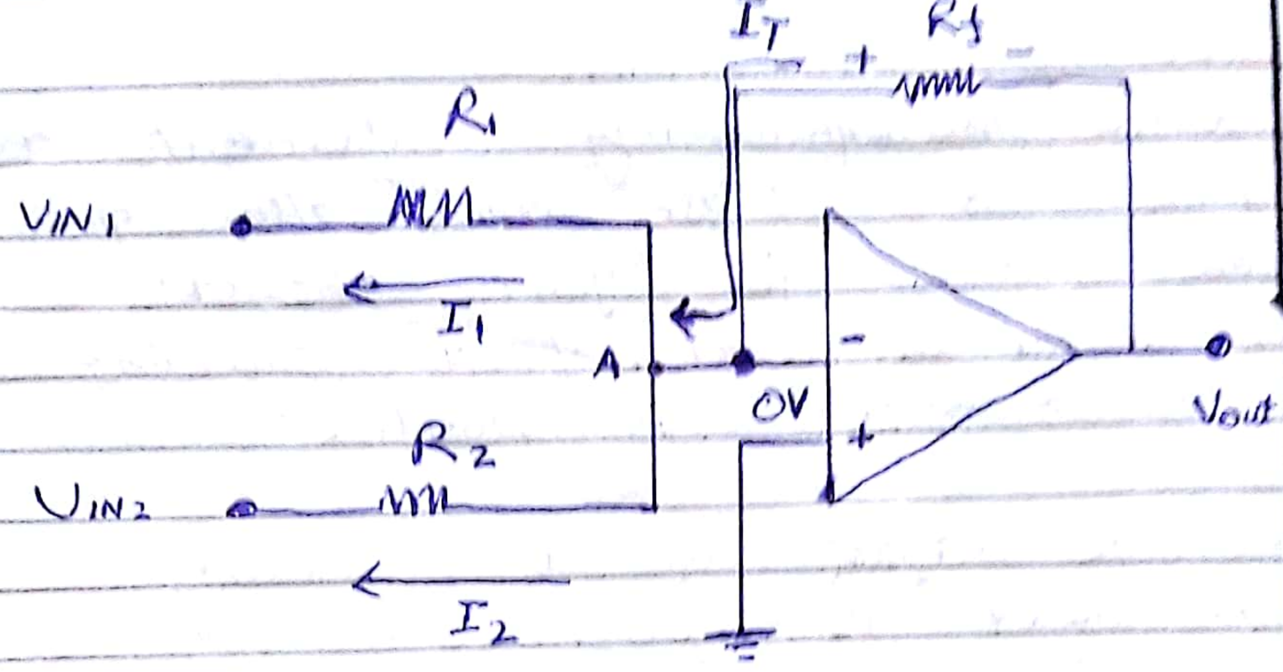
The above given statement is false

Reason:
The summing amplifier in its basic structure is also called inverted op-Amp.

The equation for output voltage "Vout" of a summing amplifier is

$$V_{out} = -\frac{R_f}{R}(V_{IN_1} + V_{IN_2} + \cdots + V_{IN_n})$$

summing amplifier using op-amp have two or more inputs connected to the inverting terminal and non inverting terminal is grounded (**Inverting amplifie configuration**). Its output will be negative of the algebraic sum of inputs. Hence the name summing amplifier.
It have a negative feedback.



Summing amplifier with two inputs