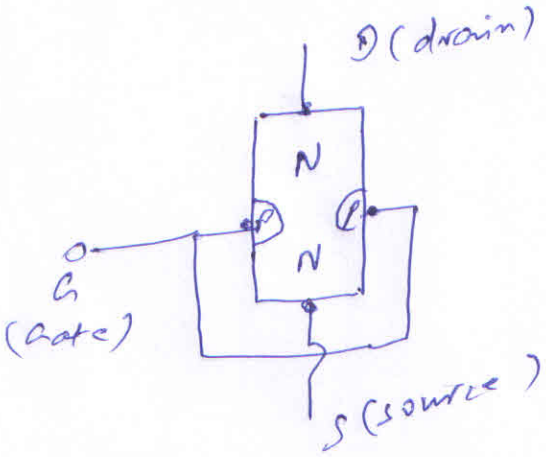
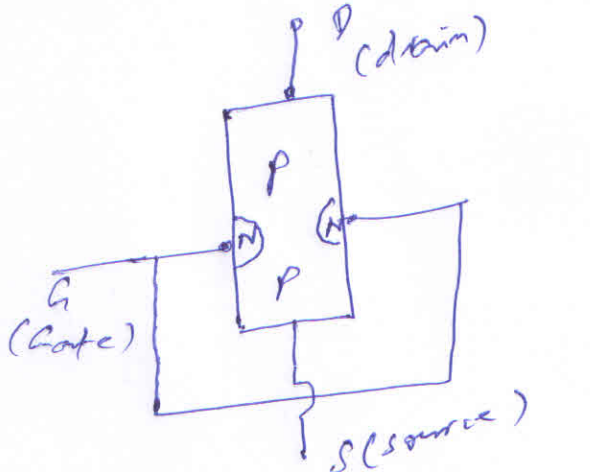
EE-201

Q.(1). Explain construction and working principle of "FET."

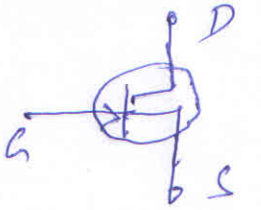
Answer: → In a FET i.e. field effect transistor, the output characteristics are controlled by input voltage i.e. electric field and not by the input current. A JFET is a three terminal semiconductor device in which current conduction is by one type of carrier i.e. electrons or holes.



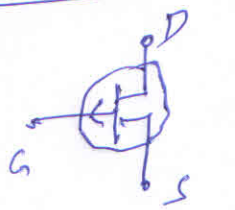
N-channel JFET



P-channel JFET.



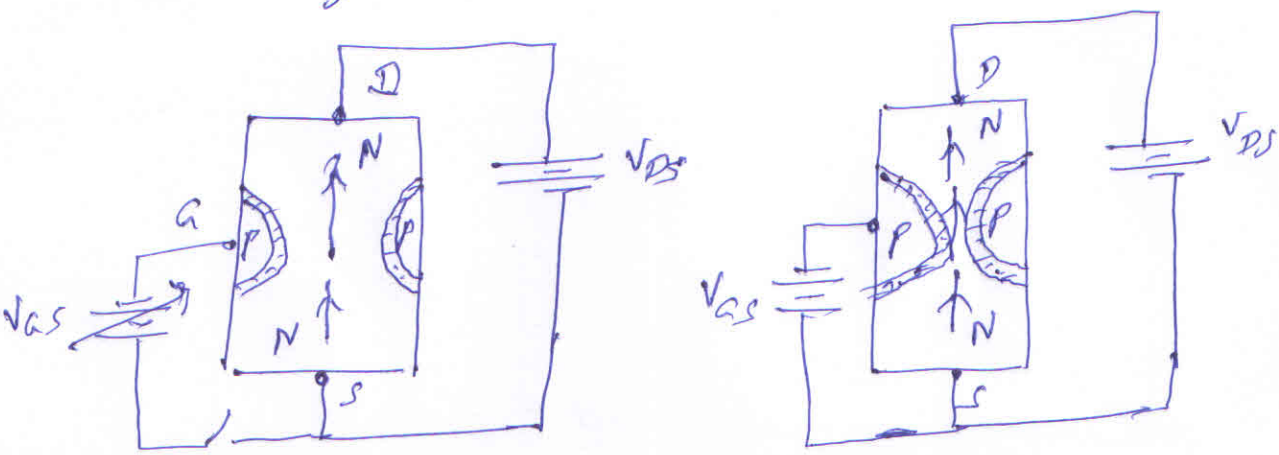
Symbol



Symbol

A FET consist of P-type or N-type silicon bar containing two PN junctions at the sides as shown above. The bar forms the conduction channel for the charge carriers. If bar is of N-type it is called N-channel JFET and if the bar is of P-type it is called P-channel JFET. The two p-n junction forming diodes are connected internally and a common terminal called gate is taken out. Thus JFET has essentially 3-terminals viz: gate(G), source(S) and drain(D).

The two-pn junctions at the sides forms two depletion layers. The current conduction by charge carriers is through the channel between two depletion layers, here it is electrons. The width and hence "resistance of this channel can be controlled by changing the input voltages V_{GS}.



The greater the reverse voltage V_{GS}, the wider will be the depletion layers and narrower will be the conduction channel. The narrower channels becomes greater resistance and hence S to D current decreases. Reverse will happen should V_{GS} decrease. Thus JFET operates on the principle that width and hence resistance of the conduction channel can be varied by changing the reverse voltage V_{GS}. It is clear that from source to drain, the current can be controlled by the application of electric field on the gate (G). So this device is called field effect transistor.

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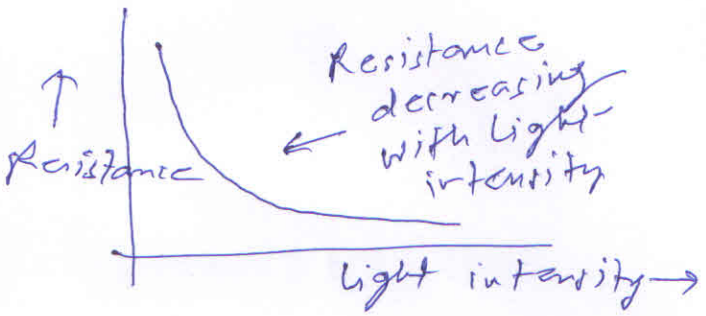
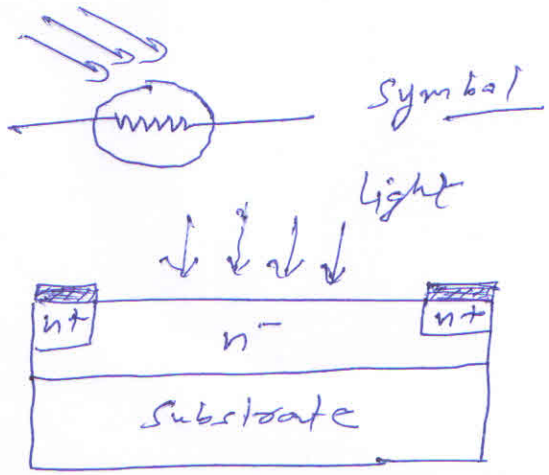
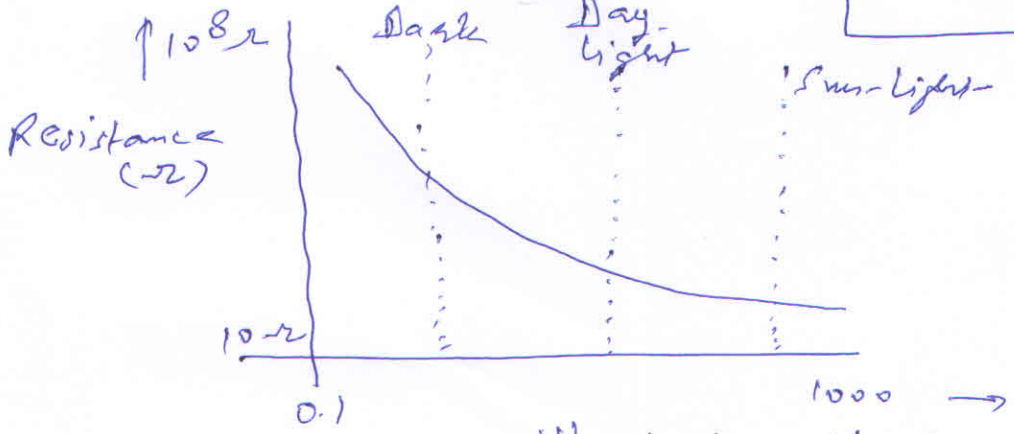
Q. (2) Explain construction and working principle of "LDR".

Answer:→ It is a light controlled variable resistor. The resistance of photoresistor / LDR / photo-cell decreases with increasing incident light intensity. It exhibits photoconductivity. LDR is made of semi-conductor material having high resistance. LDR means "Light-Dependent-Register".





Construction



When photons falls on the device the electrons in the valance band of the semi-conductor material are excited to the conduction band. The photons in the incident light should have energy greater than the band gap of the S/C material to make the electrons jumps from the VB to CB. Hence more and more electrons are excited to the CB, which results a large number of charge carriers, so current start flowing of the device.

Q. (3). Explain construction and working principle of "MOSFET."

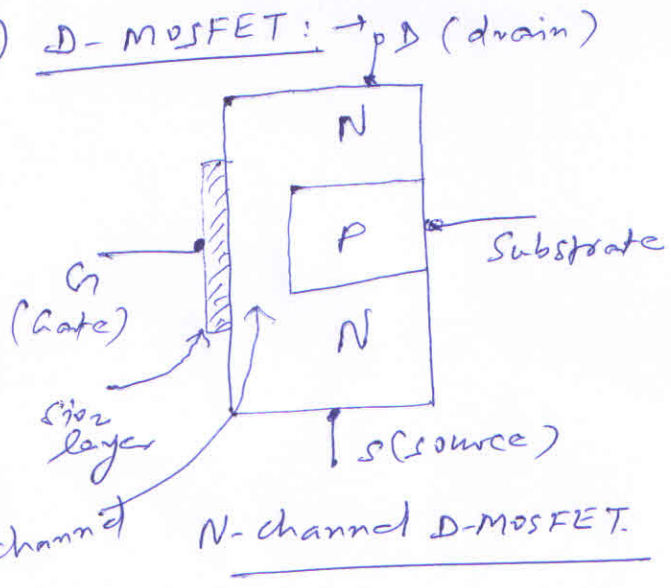
Answer:— 'MOSFET' is 'Metal oxide Semi-conductor FET. The main drawback of JFET is that it's gate must be reverse biased for proper operation of the device i.e. it can only have negative gate operation for n-channel and positive gate operation for p-channel. This means that we can only decrease the width of the channel. This type of operation is referred to as "depletion mode" operation. Therefore, a JFET can only be operated in the depletion-mode. However, there is a field effect transistor (FET) that can be operated to enhance (or increase) the width of the channel i.e. it can have enhancement-mode operation. Such type of FET is called MOSFET.

A field effect transistor that can be operated in the enhancement-mode is called a 'MOSFET.'

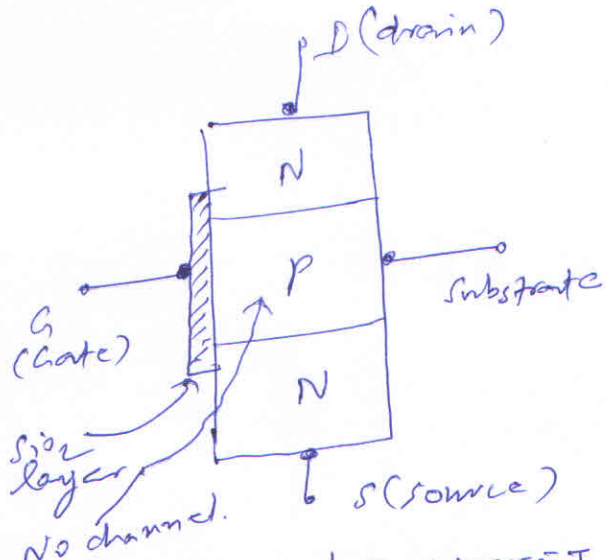
Basically two types of MOSFETs are —

1) D-MOSFET.
2) E-MOSFET

1) D-MOSFET: →



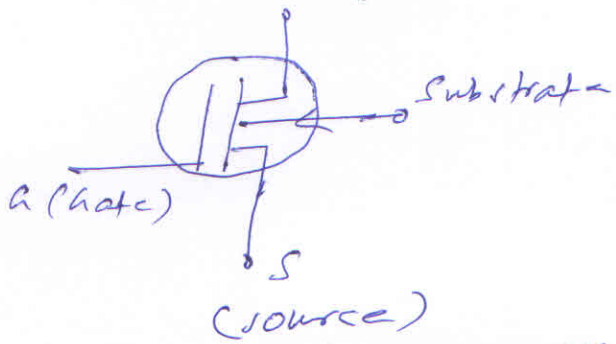
N-channel D-MOSFET.



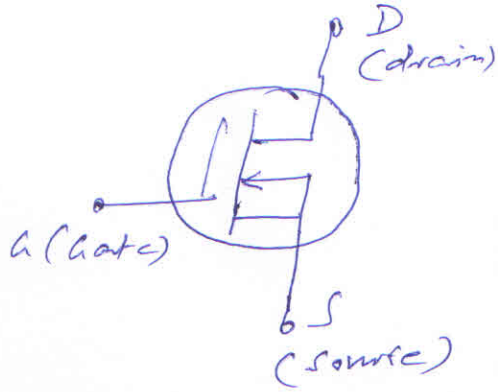
N-channel E-MOSFET

The n-channel D-MOSFET is a piece of N-type material with a p-type region on the right and an insulated gate on the left. The free electrons flowing from source to drain must pass through the narrow channel between the gate and p-type region.

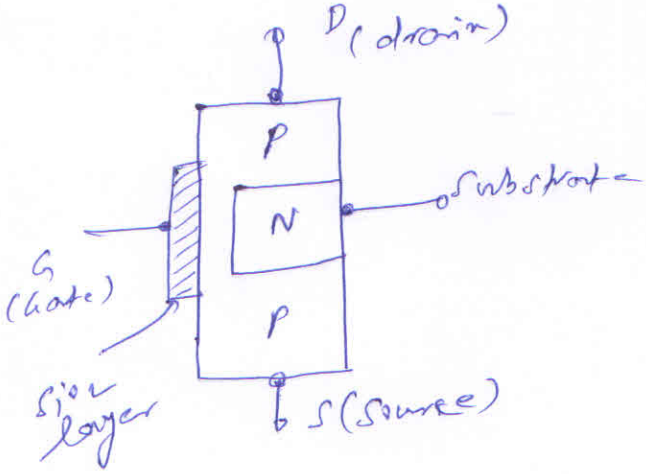
E-MOSFET:— The E-MOSFET has no channel between source and drain unlike the D-MOSFET. The substrate extends completely to the SiO_2 layer so that no channel exists. The construction of E-MOSFET is quite similar to that of the D-MOSFET except for the absence of a channel between the drain and source terminals.



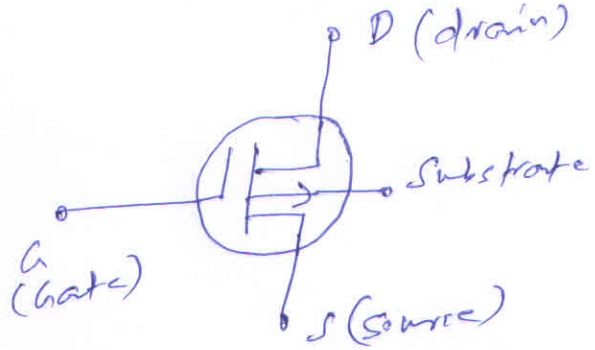
N-channel D-MOSFET

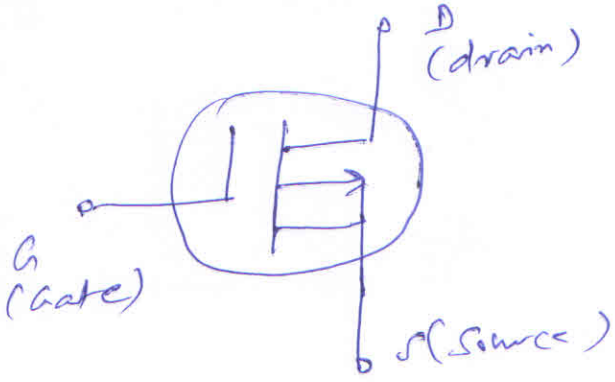


N-channel E-MOSFET



P-channel D-MOSFET ⟶ (symbol)





P-channel E-MOSFET

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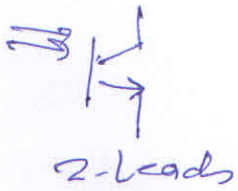
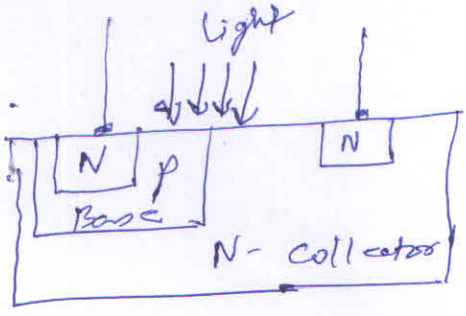
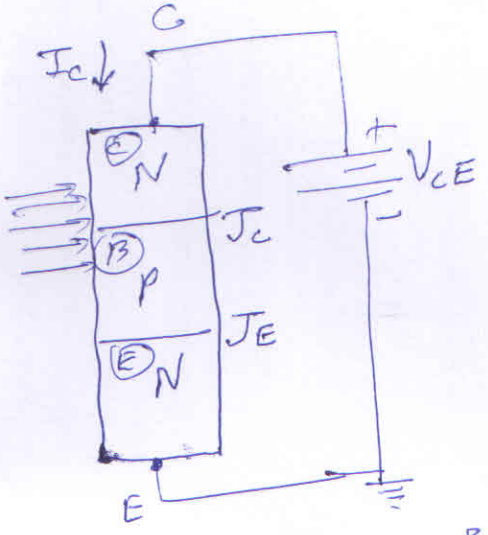
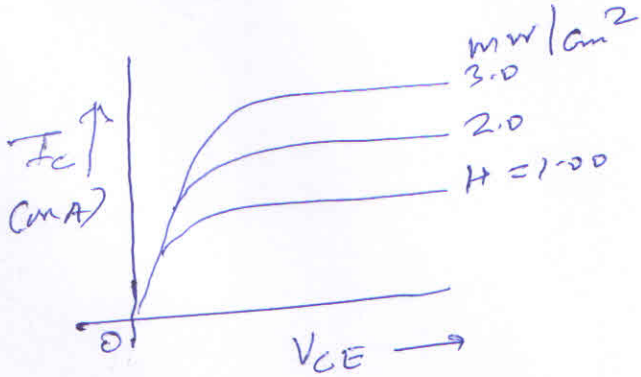
Q(4). Explain construction and working principle of "photo-transistor".

Answer: → A photo-transistor is a light sensitive transistor. The photo-transistor is usually connected in CE configuration with the Base open and the radiation is concentrated on the region near the collector junction.









The characteristics of photo-transistor are similar to those of normal except that they have base current replaced by light intensity.

$$I_c = I_E \sim \beta I_B \sim \beta I_{photon}$$

$$I_B = I_{photo}$$

If we recognize that the J_E is slightly forward bias & J_c is reverse bias. Assumed that there is no radiation excitation, under these condition, minority carriers are generated thermally, and the electrons crossing from the base to collector as well as hole crossing from the collector to base, so constitute the flow of reverse saturation collector current I_{co}.

$$I_c = (1+\beta) I_{co} \quad \text{—— (1)}$$

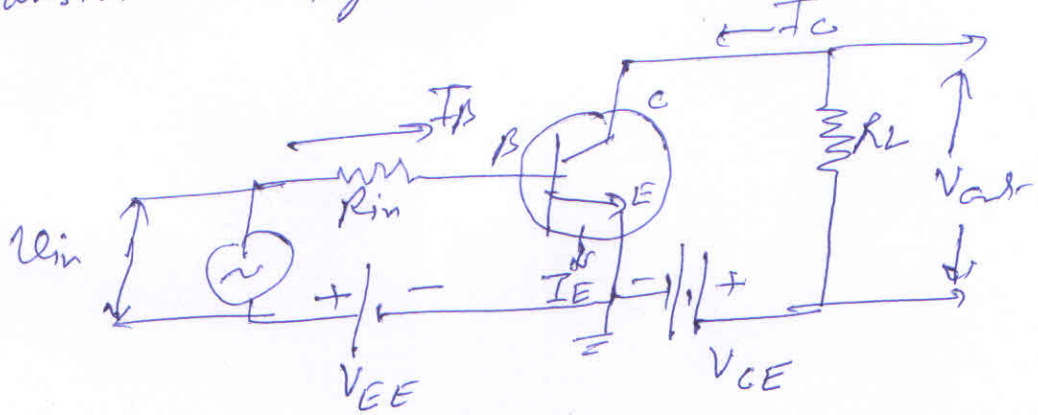
When light turn ON I_L = reverse saturation current due to light

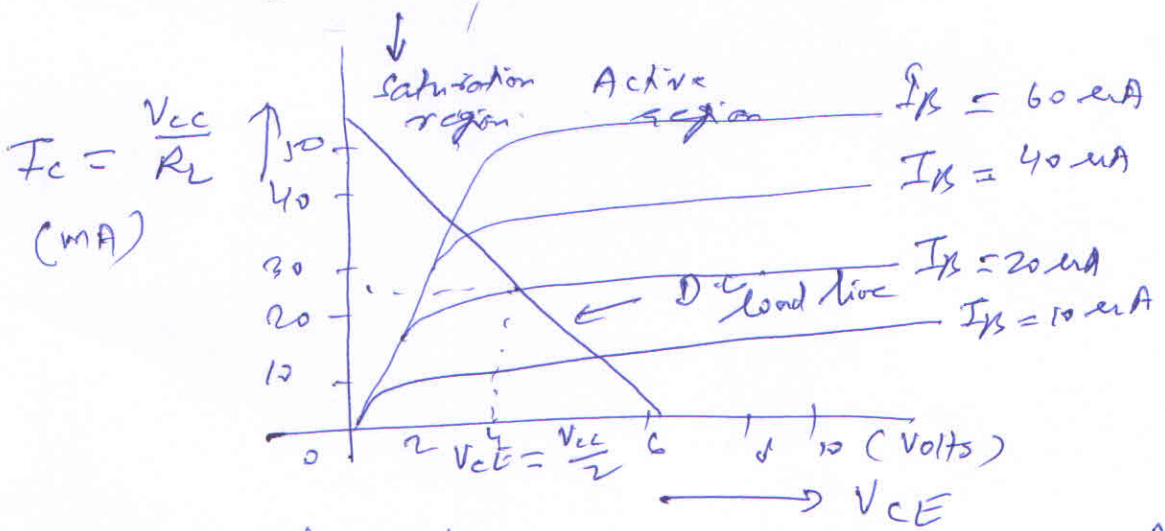
$$I_c = (1+\beta)(I_{co} + I_L) \quad \text{—— (2)}$$

——— xxxx ———

Q(5). Describe the output characteristics of a NPN transistor in CE configuration and also find alpha and beta relation in it.

Answer:- In Common Emitter or grounded emitter configuration, the input signal is applied between the base, while the output is taken from between the collector and the emitter. The CE amplifier configuration produces the highest current and power gain of all the three bipolar transistor configurations.





$$I_C = \frac{V_{CC} - V_{CE}}{R_L}$$

When $V_{CE} = 0$, $I_C = \frac{V_{CC}}{R_L}$

When $I_C = 0$, $V_{CC} = V_{CE}$

$$\text{Alpha } (\alpha) = \frac{I_C}{I_E} \qquad \text{Beta } (\beta) = \frac{I_C}{I_B}$$

$$\therefore I_C = \beta I_B = \alpha I_E$$

$$\boxed{\alpha = \frac{\beta}{1+\beta}} \qquad \therefore \boxed{\beta = \frac{\alpha}{1-\alpha}}$$

$$\boxed{I_E = I_C + I_B}$$