Department of Electrical Engineering

Assignment

Date: 20/04/2020

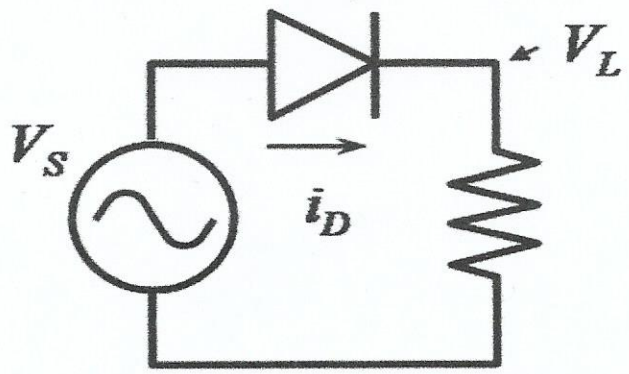
Course Details

Course Title: Power Electronics **Module:** 4rth

Instructor: Aamir Aman **Total Marks:** 30

Student Details

Name: Nehad muhammad **Student ID:** 14912

Q1.	(a)	In some applications, power semiconductor diodes are required to conduct several kilo amperes of current in the forward direction with very little power loss while blocking several kilo volts in the reverse direction. Explain the main differences of constructional features of a power diode and a signal diode. Illustrate your answer with the help of sketches to make a clear difference between the two.	Marks 10 CLO 1
Q2.	(a)	Explain operational features of the power MOSFET. Support your explanation using MOSFET operation as a switch. Also, illustrate the conditions to derive power MOSFET in the different regions of operation.	Marks 10 CLO 1
Q3.	(a)	 Consider Vs = 220Sin2wt, R = 1000kΩ and 1N4004 uncontrolled rectifier diode for the circuit shown above. Find i) V_{avg} ii) I_{oavg} iii) V_{rms} iv) I_{orms} v) Output Power vi) Input Power Factor vii) Conduction angle of a diode	Marks 10 CLO 2

		viii) Extension angle of diode ix) Comparison of both conduction angle and extension angle of diode x) Peak Inverse Voltage xi) Circuit turnoff time, t_c xii) By putting inductor of your own choice repeat all the findings and compare both circuits result and comment.	

****

☺GOOD LUCK☺

Question 1

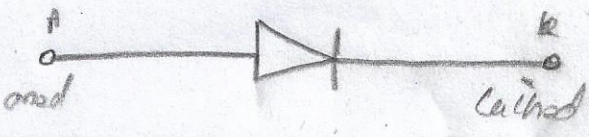
Ans

Main difference between Power and Signal diode

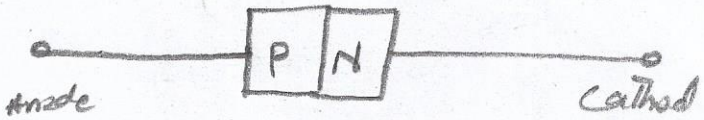
Power diode	Signal diode
Power diode is constructed with n-Layer called drift region between p^+ Layer and n^+ Layer.	In Signal diode the drift region is not present.
The voltage current and power ratings are higher in power diode	the voltage current and power rating are Lower in Signal diode
Power diode have more thickness	Signal diode is less thickness
Power diode operate at high Speeds.	Signal diode operates at higher Switching Speed.

Sketches to make a clear difference between the two

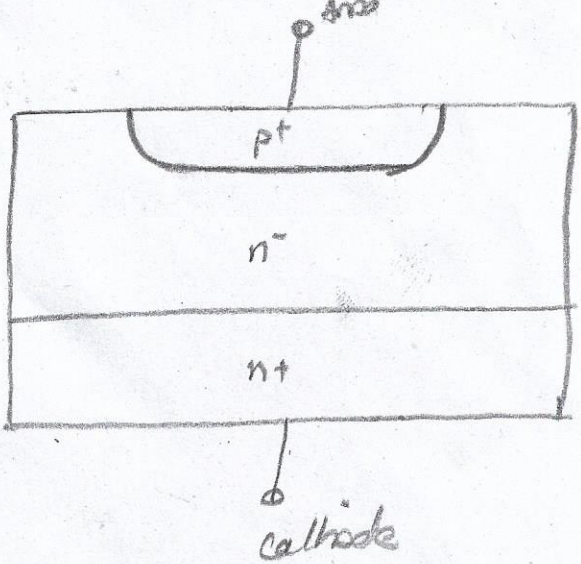
the Signal diode and power diode has the same Symbol



Signal diode is a two terminal, two layer, PN junction device, two layer, PN junction device



whereas power diode is a two terminal PN junction diod which has p, n, n-layers.



* Signal diod are made up of Silicon and germinum.
* Power diod are made up of Silicon material only.

Question 2

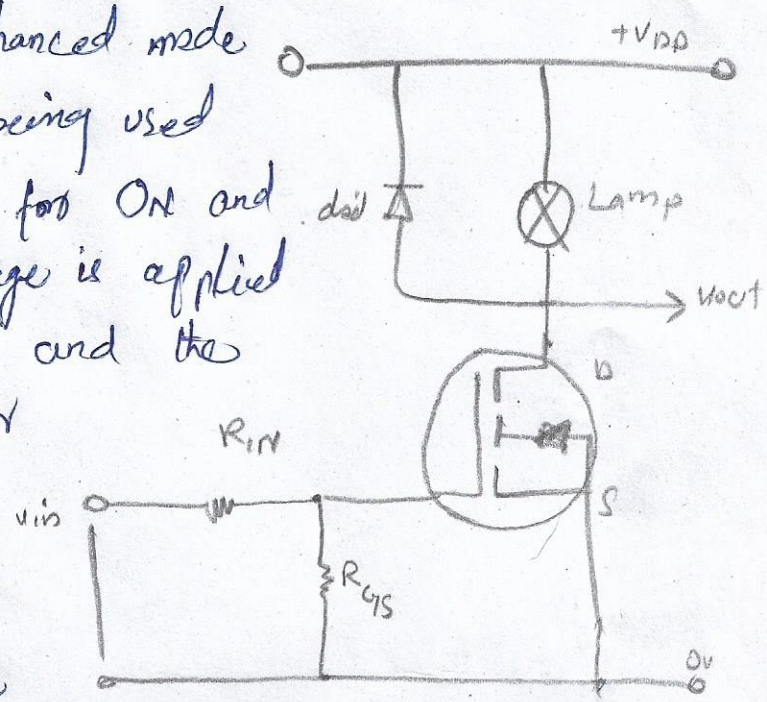
Operational features of power MOSFET

The following are features of MOSFET

* Basically low voltage device
* Can be paralleled quite easily for higher current capability
* High voltage device are available up to 600V but with limited current
* High losses especially for high voltage device due to R
* Dominant in high frequency application (> 100 kHz)
* Biggest application is in switched mode power supplies.

MOSFET Used As A Switch.

In this circuit using enhanced mode n channel MOSFET is being used to switch the Lamp for ON and OFF. The positive voltage is applied as the gate of MOSFET and the Lamp is ON (V_{GS} = +V) or at the zero voltage level the device turn off (V_{GS} = 0) if the resistive load is to be replaced by inductive load and connected to relay to protect the load. It is a very simple circuit for switching a resistive load such as LED's or Lamp. But when using MOSFET to switch either inductive load or capacitive load protection. If we are not giving the protection than MOSFET will be damaged. For the MOSFET to operate as an switch device that needs to be switched between its cutoff region where V_{GS} = 0 and saturation region where V_{GS} = +V.



Power MOSFET in the different regions of operation.

The three operating regions of MOSFET is

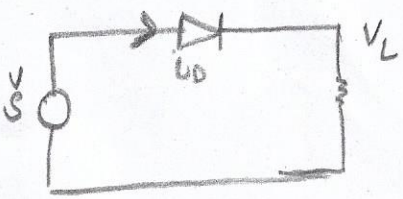
* Ohmic region at Low voltage V_{ds} - here the current is proportional to v_{ds} for given V_{gs}
* The knee region at slightly higher value V_{ds}. Here the current is not in V_{ds} value at all.
* Breakdown region at very high value of V_{ds}. The device breaks down.

Question 3

Given data

$V_s = 220 \sin 2\omega t$

$R = 1000\ k\Omega$



Required data

i) V_{avg} ii) I_{avg} iii) V_{rms} iv) I_{rms}

v) output power vi) input power vii) Conduction angle of diode viii) Extension angle of diode ix) Comparision of both conduction and extension angle diode x) peak inverse voltage xi) circuit turn off time t_c.

Solution

i) $V_{avg} = ?$

We know that $V_{avg} = \frac{V_m}{\pi}$

So $V_{avg} = 220 / 3.14$ $\quad \pi = 3.14$

$V_{avg} = 70.06\ V$

ii) $I_{avg} = ?$

$$I_{avg} = \frac{V_m}{\pi R}$$

$$= \frac{220}{3.14 \times 1000 \times 10^3\ \Omega}$$

$$I_{avg} = 0.0700 \times 10^{-3}\ A$$

iii) $V_{rms} = ?$

$$V_{rms} = \frac{V_m}{2}$$

$$= \frac{220}{2} = 110\,V$$

$$V_{rms} = 110\,V$$

iv) $I_{rms} = ?$

$$I_{rms} = \frac{V_{rms}}{R}$$

$$I_{rms} = \frac{110}{1000 \times 10^3\,\Omega}$$

$$I_{rms} = 0.11 \times 10^{-3}$$

v) Output power = ?

$$\text{output power} = I_{rms}^2 \times R$$

$$= (0.11 \times 10^{-3})^2 \times (1000 \times 10^3\,\Omega)$$

$$= 0.0121 \times 10^{-6} \times 1000 \times 10^3$$

$$= 12.1 \times 10^{-3}$$

$$\text{Output power} = 0.0121\,W$$

vi) Input power factor = ?.

$$\text{Input power factor} = \frac{V_{rms}}{V_s}$$

$$= \frac{110}{220 \sin 2\omega t}$$

$$= 0.5 \sin 2\omega t$$

vii) peak inverse voltage voltage = ?

$$P_{iv} = V_m$$

$$P_{iv} = 220 \text{ ans}$$

viii) Circuit turnoff time t_c

$$T_c = \frac{\pi}{\omega}$$

$$= \frac{3.14}{}$$