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

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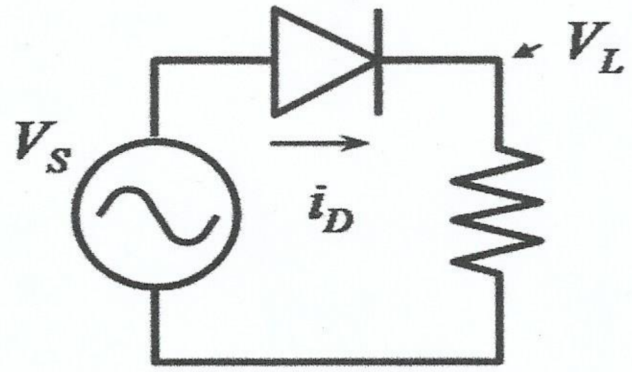
Q1.	(a)	In some applications, power semiconductor diodes are required to conduct several kilo amperes of current in the forward direction with very little power loss while blocking several kilo volts in the reverse direction. Explain the main differences of constructional features of a power diode and 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.	

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☺GOOD LUCK☺

Question (1)

Answer: Difference B/w power Diode and signal diode:.

* power diodes.

* Power diode is a two terminal p-n junction semiconductor ~~device~~ device.

* The two terminal are anod and cathod.

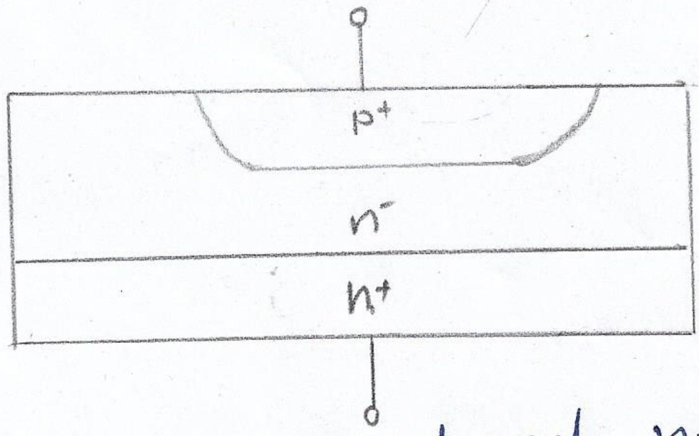
* the voltage current and power ratings are higher in power diode.

* power diode is operate at very high speed.

* power diode have more thickness

* The structure of power diode is different from a signal diode.

* power Diode structure:. The structure of power diode is



* There is heavily doped n+ substrate (Cathode) with doping level of $10^{19}/cm^3$
* Lightly doped n- epitaxial layer is grown, also known as drift region
* Anode is formed by the heavily doped p+ region.
* The breakdown voltage depends on the thickness of the n- layer.
* power diode are made up of silicon material only.

* Signal Diode:.

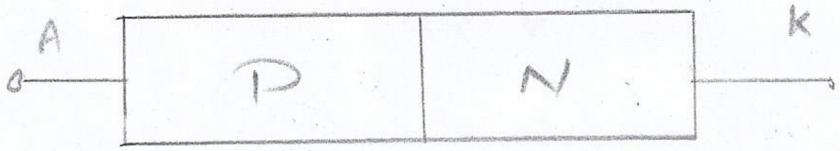
* In signal diode the drift region is not present.

* The voltage Current and ~~sig~~ power rating are lower in Signal diode.

* Signal diode operates at higher Switching Speed.

* Signal diode have less thickness.

* Signal diode are made up of Silicon and germinum.

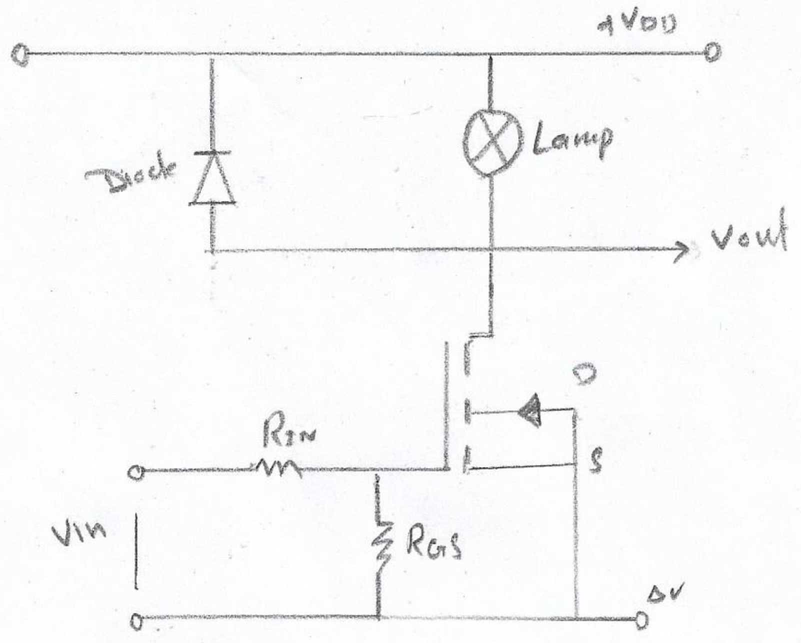


Question 2

Features of power mosfet :-

* MOSFET are 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.
* Dominand in high frequency application
* Biggest application is in switched mode power supplies.

* MOSFET Operation as a Switch:.



In this circuit using enhanced mode a Channel MOSFET is being used to switch the lamp for ON and OFF. the possitive 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 in 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 a switch device that needs to be switched b/w its cutoff region where $V_{GS} = 0$ and saturation region where $V_{GS} = +V$.

* Different region operation of power MOSFET :

(1) Ohmic region at low voltage V_{ds}. here the current is proportional to V_{ds} for given V_{GS}.

(2) the knee region at slightly heigher value V_{ds} Here the current is not on V_{ds} value at all.

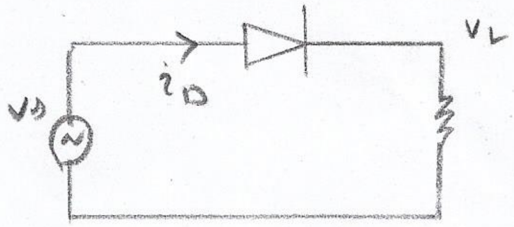
(3) Breakdown region at very high value of V_{ds} the device Breakdown.

Question (3)

Given data:

$V_s = 220 \sin 2\omega t$

$R = 1000\ k\Omega$



Required data:

(i) V_{avg} (ii) $I_{o\,avg}$ (iii) V_{rms} (iv) $I_{o\,rms}$

(v) Output power (vi) Input power factor

(vii) Conduction angle of diode.

(viii) Extension angle of diode.

(ix) Comparison 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 $V_{avg} = \frac{V_m}{\pi}$ — ①

put value in equation ①

so $V_{avg} = 220/3.14$ $\because \pi = 3.14$

$$\boxed{V_{avg} = 70.06\ v}$$

(ii) $I_{o\,avg}$ = ? we know that $I_{o\,avg} = \frac{V_m}{\pi R}$ — ①

Put value in equation ②

So $I_{o\,avg} = \frac{220}{3.14 \times 1000 \times 10^{3}\,\Omega}$

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

(iii) V_{rms} = ? we know that $V_{rms} = V_m/2$ — (ii)

So $V_{rms} = 220/2 = 110$ v

$V_{rms} = 110$ v

(iv) I_{rms} = ? we know that $I_{rms} = \frac{V_{rms}}{R}$ — (v)

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

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

(v) Output power = ?

$P_{output} = I_{o\,rms}^2 \times R$ — (vi)

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

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

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

$P_{output} = 0.0121$ w

(vi) Input power factor IPF = ?

$$IPF = \frac{V_{rms}}{V_s} - (i)$$

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

=

(vii) Conduction Angle $\gamma_D = \pi \Rightarrow 3.14$ or

(viii) Extinction Angle $\beta = \pi \Rightarrow 3.14$

(vii) Peak inverse voltage = V_m.

$$\boxed{PIV = 220}$$