Department of Electrical Engineering
Assignment
Date: 20/04/2020

Course Details

Course Title: Power Electronics **Module:** 4rth
Instructor: ENGR. AMIR AMAAN **Total Marks:** 30

Student Details

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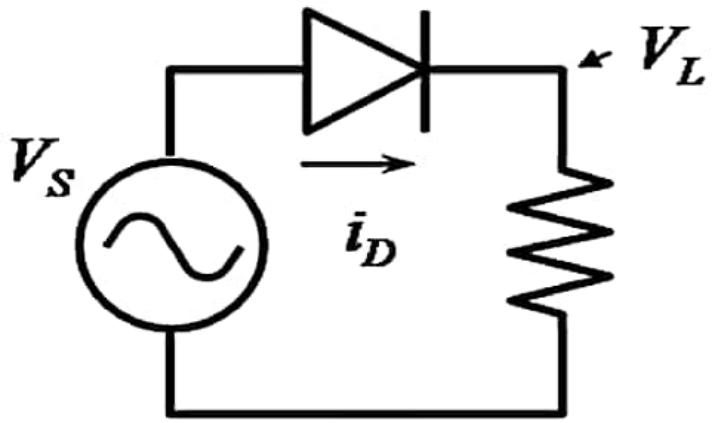
Q1.	(a)	In some applications, power semiconductor diodes are required to conduct several kilo amperes of current in the forward direction with very little power loss while blocking several kilo volts in the reverse direction. Explain the main differences of constructional features of a power diode and 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	Marks 10 CLO 2

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	vii)	Conduction angle of a diode
	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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Answer No 1 :-

SIGNAL DIODE :- Diodes are often used as straight forward rectifiers. as mixers in compounding the signals and as switches to open or close a circuit Diodes in the mixers are utilized for detecting the signals and these diodes are typically referred as signal diodes. The simple and conventional application of signal diodes is that it acts as a basic diode switch.

Signal diode enable the current capability up to 100 milliamps and they are known for processing the information found in electrical signals sent from electrical. transmitter Germanium diodes have a forward ~~diode~~ voltage drop about 0.2 volts are used as detecting circuits in radios.

The PN junction signal diode is usually fabricated in glass case or plastic case and generally has a black or a red band at the cathode end of the terminal.

Power DIODE :

Definition :- A diode that has two terminals like anode & cathode and two layers like P & N used in the power eletronics circuits is known as power diode. This diode is more

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Complex in Construction as well as in operation because the Power device has to change to make them appropriate in high Power applications.
The junction of normal diodes can be formed through Semiconductor like P-type and n-type. The terminal at P-type is known as anode whereas the terminal at the n-type is known as the Cathode. In Power electronic Circuits this diode plays an essential role it can be used as a rectifier in Converter Circuits Voltage regulation Circuit.

Answer No # 2 :-

Switching Characteristics of MOSFET:

In Power Conversion, a MOSFET is essentially used as a Switch. As MOSFET Switching characteristics, the turn-on delay time $T_{d(on)}$, rise time t_r, turn-off delay time $t_{d(off)}$, and fall time t_f are generally indicated. For Example, the turn-on/off delay time may be called the on/off delay time, and the rise/fall time may be the rising/falling time and so on.

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Turn-on delay time: Time from 10% of the rise of V_{GS}

> Rise time: Time from 10% to 90% of the rise of V_{DS}

> Turn-off delay time: Time from 90% of the fall of V_{GS} until 90% of the fall of V_{DS}

> Fall time: Time from 90% to 10% of the fall of V_{DS}

The three operating regions of MOSFET is

I) ohmic region at low voltage Vds here the current is proportional to Vds for given Vgs

II) The knee region at slightly higher value Vds Here the current is Not on vds value at all [practically very less in micro ampere level]

III) Breakdown region at very high value of Vds. The device breaks down.

Answer 3 :-

$$V_s(t) = \frac{V_{pmk}}{220} \sin 2\omega t$$

For Half wave Rectifier and Sinusoidal Input Voltage

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$$V_{avg} = \frac{V_{Peak}}{\pi} \qquad \therefore V_{Peak} = V_m = V_i$$

$$V_{RMS} = \frac{V_{Peak}}{2}$$

I) V_{avg}

$$= \frac{V_{Peak}}{\pi} = \frac{220}{\pi} = 70.02V$$

II) I_{avg}

$$= \frac{V_{avg}}{R} = \frac{70.02}{1000k} = 70\,\mu A$$

III) $V_{RMS} = \frac{V_{Peak}}{2} = \frac{220}{2} = 110V$

IV) $I_{RMS} = \frac{V_{RMS}}{R} = \frac{110}{1000k} = 110\,kA$

V) Input Power factor $\cos\phi = \frac{V_{RMS}}{V_{Peak}}$

$$\cos\phi = \frac{110}{220} = 1/2 = 0.5$$

VI) Diode is Conducting only for 1st half therefore Conduction Angle, $\gamma_p = \pi$

VII) Output Power:

$$P_o = I_{RMS}^2 R$$

$$= (110\,uA)^2 \times 1000\,k\Omega$$

$$P_o = 0.0121\,W$$

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8) Extension angle of diode :-

Diode is Conducting upto π (first Cycle).

So, $\beta = \pi$

9) In all diode rectifier Circuits:

Conduction Angle	=	Extension Angle
(γ)		(β)

10) Peak Inverse Value (PIV)

During negative half Cycle diode acts as open Circuit and therefore all Voltage appears across diode.

Thus

11) Circuit turn-off time t_c

$\omega t_c = \pi$

$t_c = \pi/\omega$; assuming $f = 50$ Hz

$t_c = \pi/2\pi f = 0.01$ sec

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