Department of Electrical Engineering

Subject: Power Electronics

Spring: 2020

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ID: 13045

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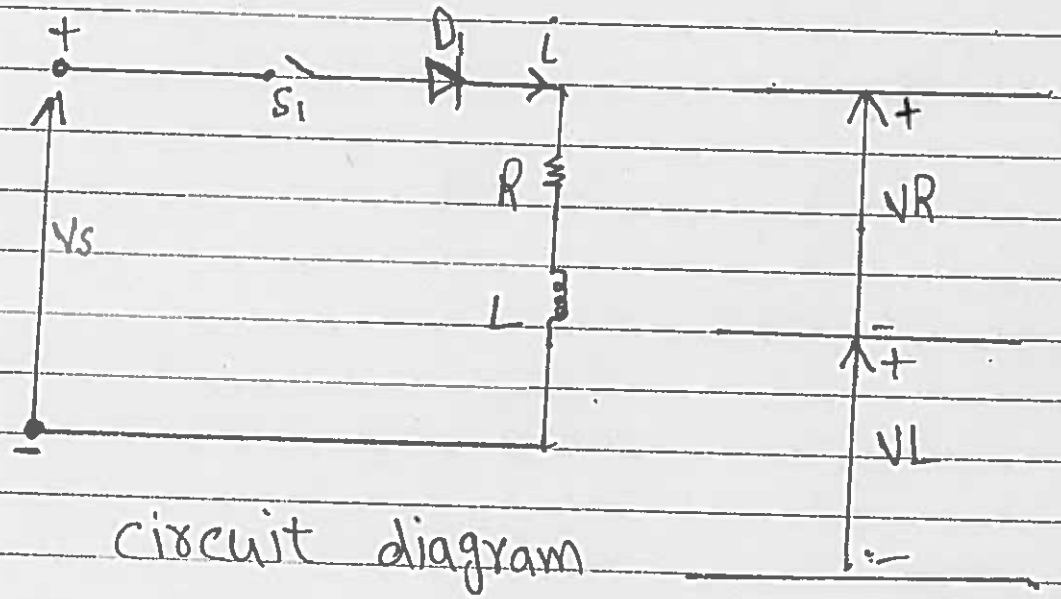
Q1	(a)	An appliance circuit has a R-L connected in series with a diode. After some time, modification is done to the circuit and a free-wheeling diodein added in parallel to the R-L. Will it have any impact on the performance and output of the circuit. Back your answer with before & after data, facts and figures. Does adding a free-wheeling diode in parallel to a R-C circuit have the same effect, different effect or no effect.	Marks 7 CLO 1

Ans:



circuit diagram

The circuit is consist of resistor and inductor connected in series. If we use one fan in the circuit. As we know that AC voltage is always up and down time by time if the voltage is suddenly high then the circuit will be

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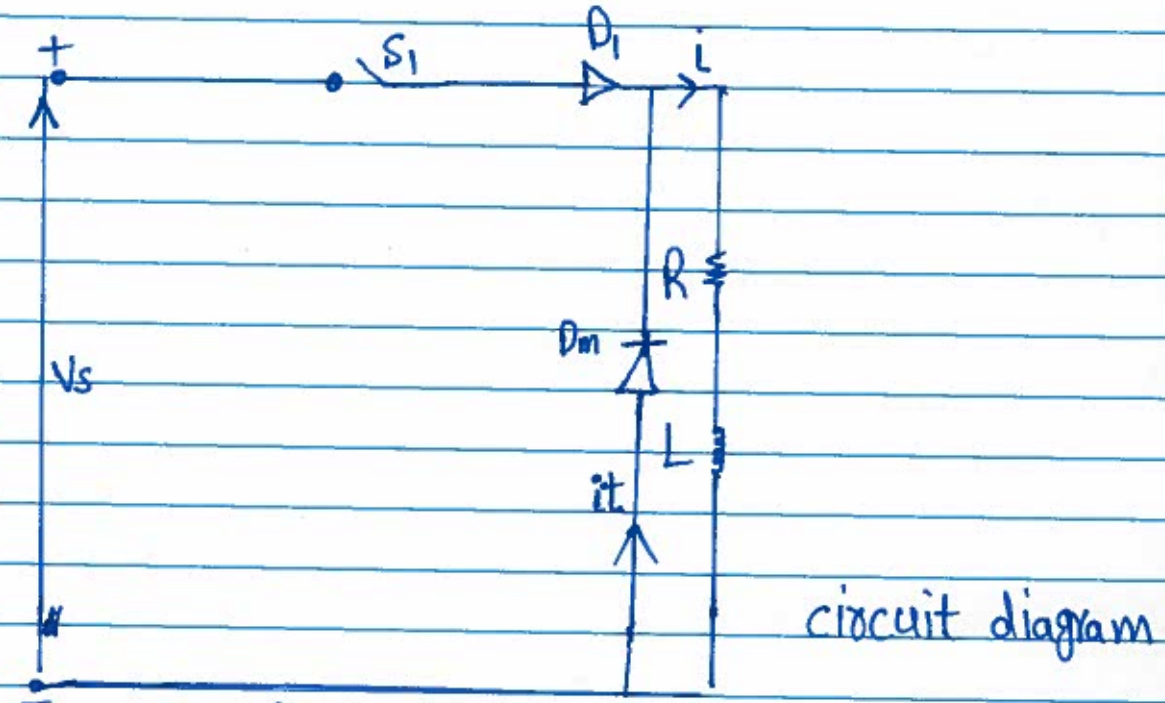
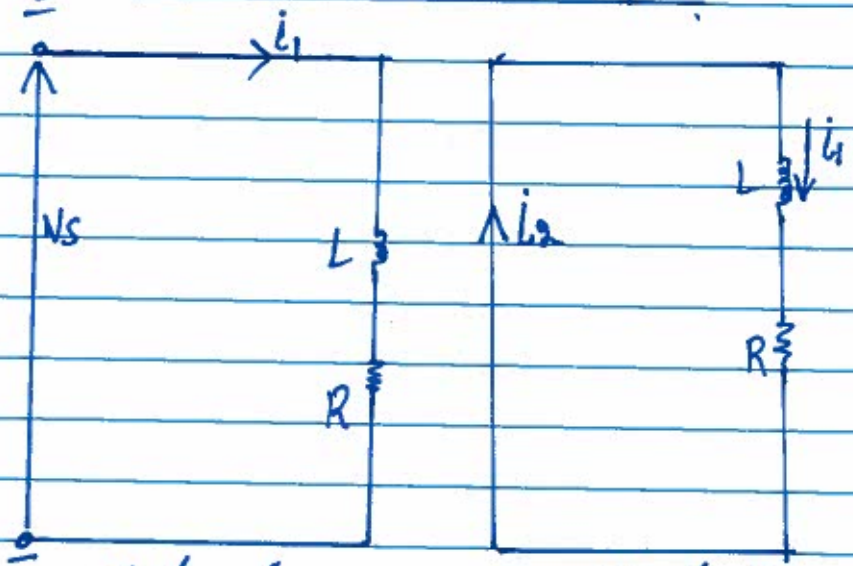


circuit diagram



Mode 1

Mode 2

demaged seen because there is no safety component in the circuit to control the high voltage the circuit will be demaged so the circuit is no safe. The circuit B is consist of resistor and inductor connected in series and free wheeling diode is placed in parallel to RL. free wheeling diode are basically connected across inductive coil to prevent from voltage spikes in case of power geting turned off to the device if the voltage is suddenly high i-e (440) The voltage is divided in to two parts half voltage moves towards to free wheeling diode and half moves towards to RL. so the circuit remain safe from demaging.

$$i_1(t) = \frac{V_s}{R}\left(1 - e^{-tR/L}\right)$$

switch is open at $t = t_1$

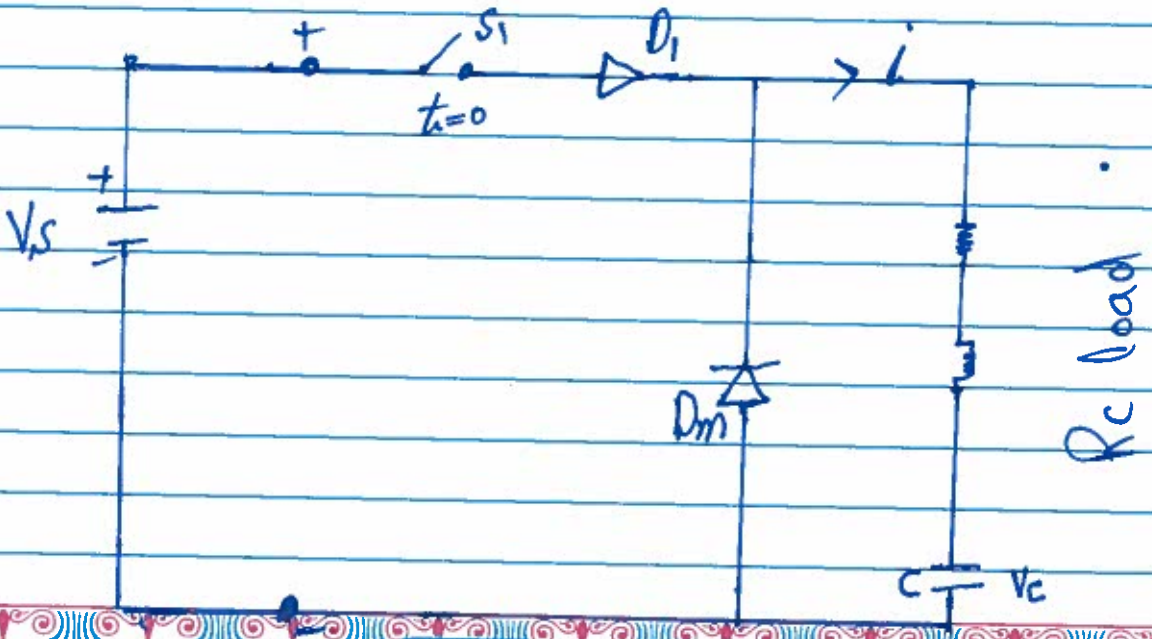
$$i_1 = i_1 (t = t_1) - \frac{V_s}{R} \left(1 - e^{-tR/L}\right)$$

The switch is opened and the load current starts to flow through the free wheeling diode Dm.

$$0 = L\frac{di_2}{dt} + Ri_2$$

initial condition $i_2(t) = 0 = i_1$

$$i_2(t) = i_1 e^{-tR/L}$$



$$\frac{di}{dt} = \frac{V_s}{L} e^{-tR/L}$$

at $t=0$

$$= \frac{di}{dt}\Big|_{t=0} = \frac{V_s}{L}$$

$$V_L(t) = L\frac{di}{dt} = V_s e^{-tR/L}$$

$$V_s = V_R + V_C = V_R + \frac{1}{C}\int_{-t_0}^{t} i\,dt + V_c(t_0) = 0$$

$$V_R = Ri$$

The inductor has property the store the energy. In AC current during positive high cycle the inductor stores energy. In negative half cycle in free-wheeling diode because forward bias so the current will flow through diode.

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Q 1 (B)

(b)	In the above appliance (Q2.a) if the P.Mosfet is replaced with a Silicon Controlled Rectifierwhat effect will it have on the performance, losses and efficiency of the appliance. Will any other changes to the circuit be required? Back your reasons with valid data, facts and figures.	Marks 5	CLO 1

Solution:

Give data

Student ID = 13045

$V_T = 3V$

$V_{DS} = 45$

Required data

$V_{GS} = ?$

Solution:- As We Know that

$V_{DS} = V_{GS} - V_T$

$V_{GS} = V_{DS} + V_T \Rightarrow 45 + 3$

$V_{GS} = 48V$ Ans.

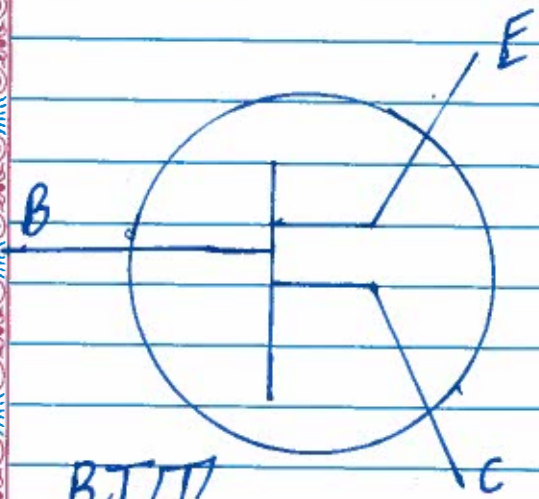
Q2	(a)	A Power Electronics appliance of 500W, 220V, 500KHz rating is using a Power Mosfet for switching purpose. If the P.Mosfet is replaced with a Power Bipolar Junction Transistor what effect will it have on the performance, losses and efficiency of the appliance. Will any other changes to the circuit be required?Back your reasons with valid data, facts and figures.	Marks 5 CLO 1

Solution:

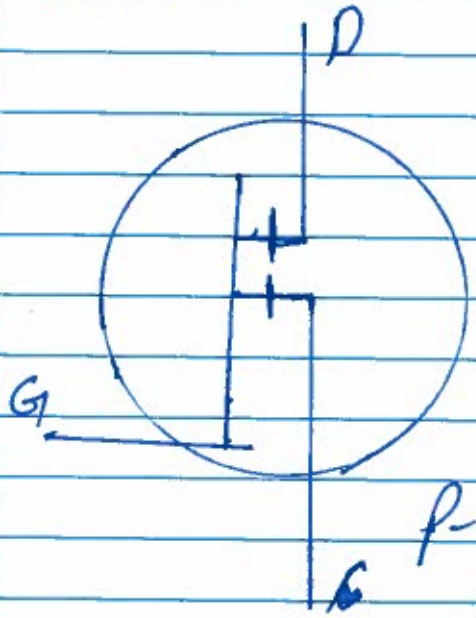
BJT has higher switching losses but lower conduction losses while pmosfet has lower switching losses and higher conduction losses.

BJT is a current controlled device in BJT the operation is controlled by base current. BJT has negitive Temperature cofficient so current sharing resistor are mandatory. BJT suffer from secondary breakdown issue while p-mosft have no breakdown issue.

Losses in BJT are low as compared to p-mosfet have higher power application while p-mosfet are used in low power appilation. BJT have high voltage and current rating p-mosfet have less voltage and current rating. There is saturation region in BJT. There is not ohmic



BJT



P- Mosfets

Region in BJT.

BJT have lower switching frequency than mosfet. BJT is ON in saturation region, so paralleling of BJT is difficult.

BJT is slow than P-Mosfet BJT device switching bt slower than P-mosfet.

BJT is used in switching power supply SMPS.

BJT are more noisy than P-Mosfet so it is less suitable for signal processing application or for voltage amplifier. BJT is difficult manufacture than mosfet.

Q2 Part (B):

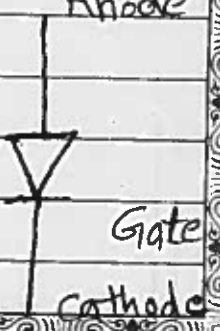
1	A Power Mosfet is connected in a circuit. The Drain to Source voltage, V_{DS}= (Last 2 digits of your student ID) V and Threshold Voltage, V_T= (Last 1 digits of your student ID) V. What is the minimum Gate to Drain Voltage, V_{GS} required for the P.Mosfet to be in saturation mood.	Marks 3 CLO 1

Ans: Silicon controlled rectifier:-

SCR is a semiconductor switch that is used to control switch amount of power with small signal input it is turned off by the con current through it naturally becoming zero.

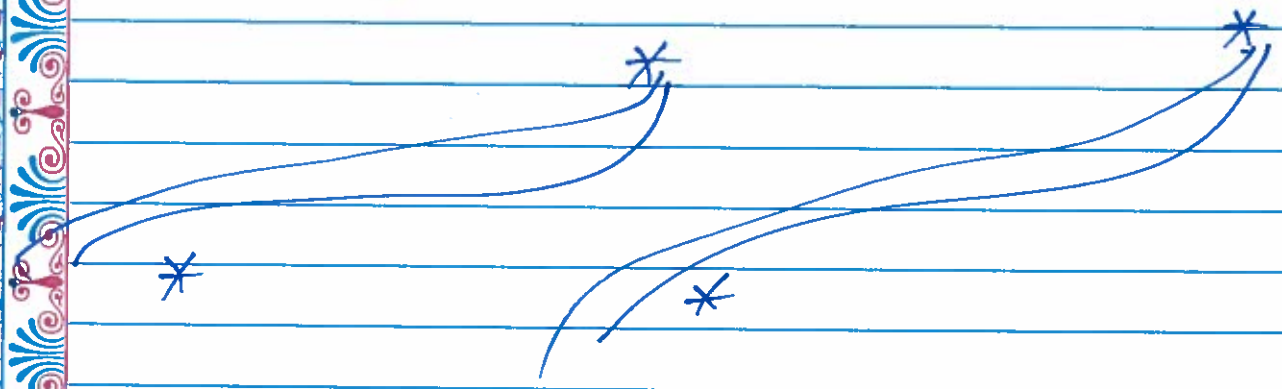
SCR cannot be used for amplification.

The SCR is an undirectional semiconductor which allows current SCR to flow in one



direction (act as a switch).
SCR control high voltage and power
The SCR require a gate signal
to turn it "ON" and once "ON"
its function like a rectifying diode.
There are three major part of
SCR. Gate control flow of current
b/w Anode and cathode)
Anode positive and cathode negtive
terminale.
The SCR works by applying positive
current or application to gate in
order to raise unity.
SCR have low freaquancey (400-500HZ)
than p-mostet (100KHZ)
SCR is current controlled need
signal pulse to turn ON.
SCR is a minority carrier
SCR is current controlled device
SCR have negtive temparature
coefficient.
so due to all these facts
p. mostet is better than SCR.

The efficiency of SCR is higher of SCR is less better than the P. Mosfet more losses occure in SCR as compared to P. Mosfet.



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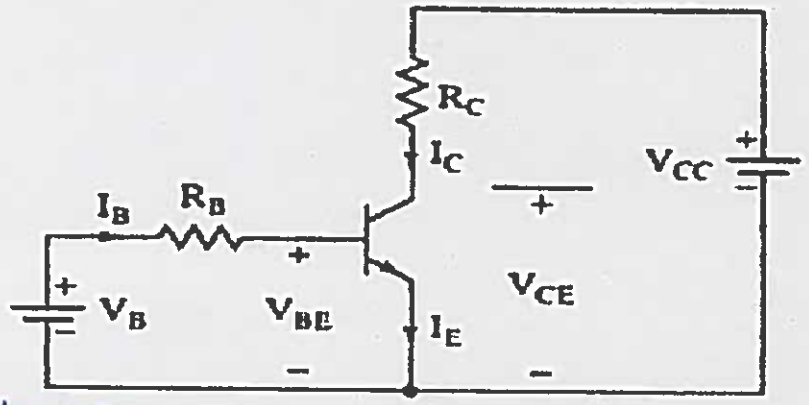
Q3	(a)	The bipolar transistor in the Figure below is specified to have β_F in the range of 8 to 40. The load resistance, R_C = (Last 2 digits of your student ID) Ω. The dc supply voltage, V_{CC} = (Last 3 digits of your student ID) V and the input voltage to the base circuit, V_B = 10 V. If V_{CE} = (First digits of your student ID) V and V_{BE} = 1.5 V, find (a) The mode of operation of the transistor (b) the value of R_B that results in saturation with an ODF of 5, (c) the β_{forced}, (d) the power loss, P_T in the transistor.	Marks 10 CLO 1



Solution: Give date

Student ID = 13045

$R_C = 45\Omega$

$V_{CC} = 045$

$V_B = 10V$

$V_{CS} = 6.0V$

$\beta_{min} = 8$, $\beta_{max} = 40$

ODE = 5

$V_B = 10V$

If V_{CE} and $V_{BE} = 1.5V$

Solution: As we know that

Formula

(A) $$I_{CS} = \frac{V_{CC} - V_{CS}}{R_C}$$

$$\frac{045 - 6}{45} = 0.866A$$

$I_{CS} = 0.866A$

Base current:

$$I_{BS} = \frac{I_{CS}}{\beta_{min}} = \frac{0.866}{8}$$

$$I_{BS} = 0.1083\ A$$

$$ODF = \frac{I_B}{I_{BS}}$$

$$I_B = ODF \times I_{BS}$$

$$I_B = 5 \times 0.1083 = 0.54A$$

$$\boxed{I_B = 0.54A}$$

(B) Value of R_B

$$I_B = \frac{V_B - V_{BS}}{R_B}$$

$$0.54 = \frac{10 - 1.5}{R_B} \Rightarrow 7R_B = 10 - 1.5$$

$$R_B = \frac{10 - 1.5}{0.54} = 15.74$$

$$R_B = 15.740\,A$$

(c)

$$B_{forced} = \frac{I_{cs}}{I_B} = \frac{0.866}{0.54}$$

$$B_{forced} = 1.603$$

(d) Power Loss P_T

$$P_T = V_{BE} I_B + V_{CE} I_C$$

$$P_T = (1.5)(0.54) + (6.0)(0.866)$$

$$= 0.81 + 5.196$$

$$P_T = 6.006\,W \rightarrow Ans$$

$$P_T = 6.006\,W \quad Ans$$

The END: