Department of Electrical Engineering
Assignment
Date: 14/04/2020

Course Details

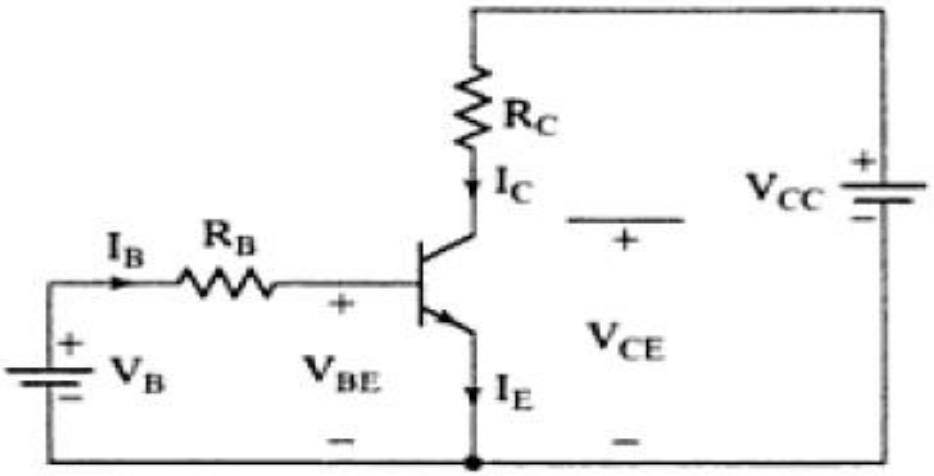
Course Title: Power Electronics **Module:** 8th semester
Instructor: Sir Shayan **Total Marks:** 30

Student Details

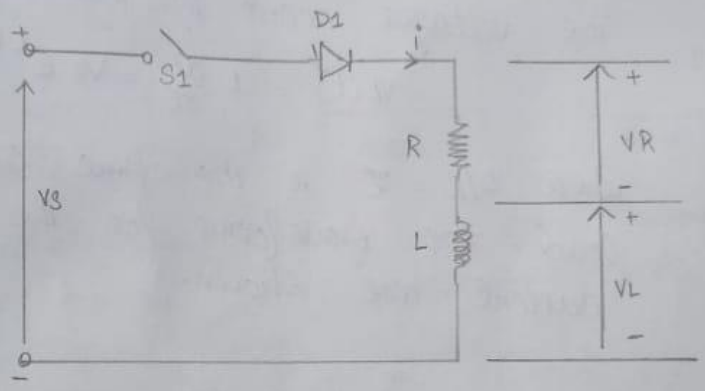
Name: M.Farhan Ali **Student ID:** 13032

Note: Plagiarism of more than 20% will result in negative marking.
Similar answers of students will result in cancellation of the answer for all parties.

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
	(b)	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
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
	(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
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.	Marks 10

		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.	CLO 1
			

⇒ R-L Connected in Series with Diode :-



⇒ when S1 is closed at $t=0$, the current through the Inductor increases and is expressed as

$$V_S = V_L + V_R = L\frac{di}{dt} + Ri$$

⇒ with the initial condition $i(t=0)=0$.
$i(t)$ is expressed as

$$i(t) = \frac{V_S}{V_R}\left(1 - e^{-tR/L}\right)$$

⇒ The rate of change of this circuit can be obtained from

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

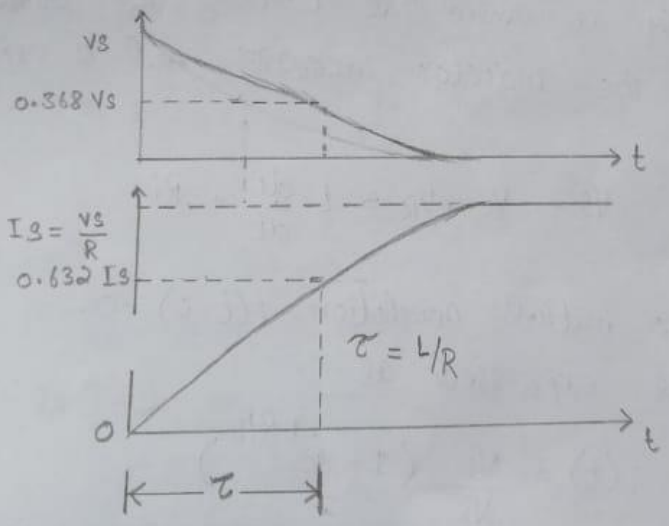
=> The initial rate of rise of the current (at $t=0$) is obtained:

$$\left.\frac{di}{dt}\right|_{t=0} = \frac{V_s}{L}$$

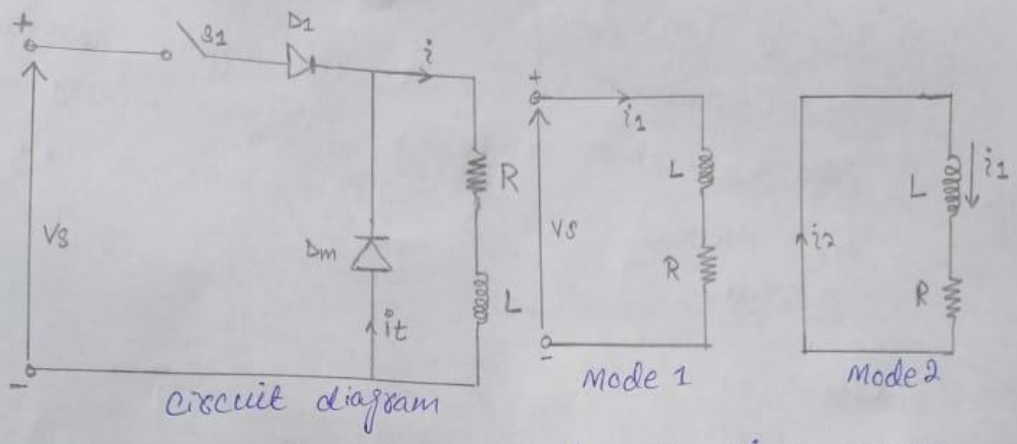
The voltages across the inductor is

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

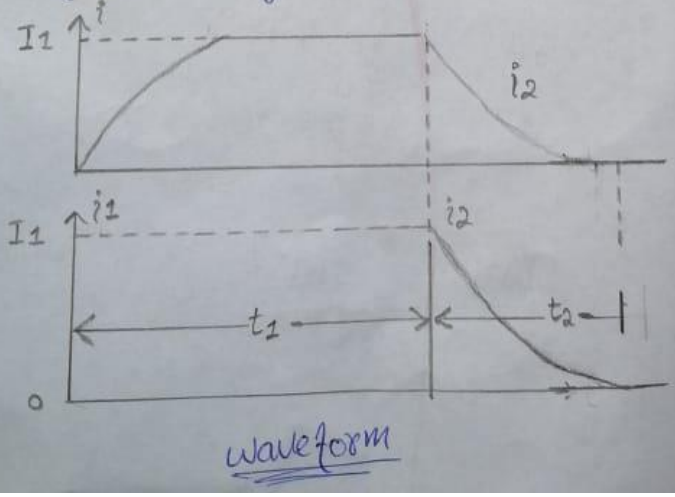
where $L/R = \tau$ is the time constant of RL-load. The waveforms for the voltage & current are shown.



RL Circuit Connected in parallel with wheeling diode:



→ The inductor has property to store energy
→ In AC current during positive high cycle the inductor stores energy.
→ At Negative half cycle the inductor de-engies.
→ This may cause reverse damage to circuit
→ To avoid energy descipation free wheeling diode is used.
→ In negative half cycle the free-wheeling diode is becomes forward bias so the current will flow through diode.



⇒ Adding free wheeling diode in parrallel with RC circuit will have no effect because free wheeling diode is always placed in RL circuit & it only works in RL circuits.

Question # 01
(Part b)

Data :-

$V_{DS} = 32V$

$V_T = 2V$

For saturation

$V_{DS} \geq V_{GS} - V_T$

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

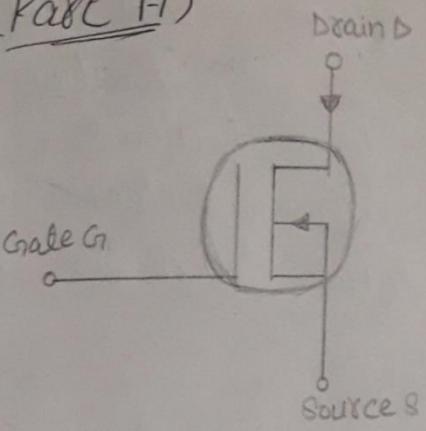
$V_{GS} = V_{DS} + V_T$

$V_{GS} = 32 + 2$

$\boxed{V_{GS} = 34V}$

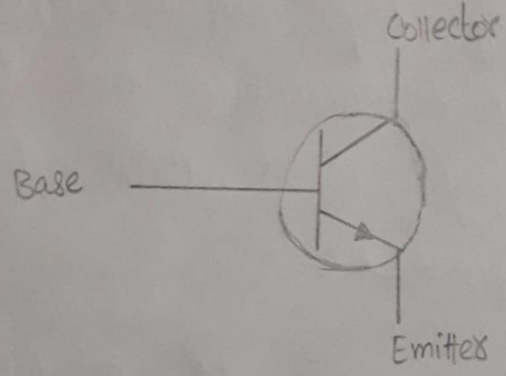
Question # 02
(Part A)

⇒ MOSFET :-



N-Channel MOSFET

⇒ BJT :-



NPN transistor

⇒ The BJT cannot be used at high power, they are slower & have more resistive losses when compare to MOSFET

⇒ BJTs are commonly power converters at a frequency below 10KHz, So putting it in a circuit that works on 500KHz frequency will make it much slower

⇒ The BJT is a current-controlled device where the o/p of the base terminal or emitter terminal is a function of the current in the base terminal, while MOSFETs are electronic semiconductors device where the voltage control determines the conductivity of the device.

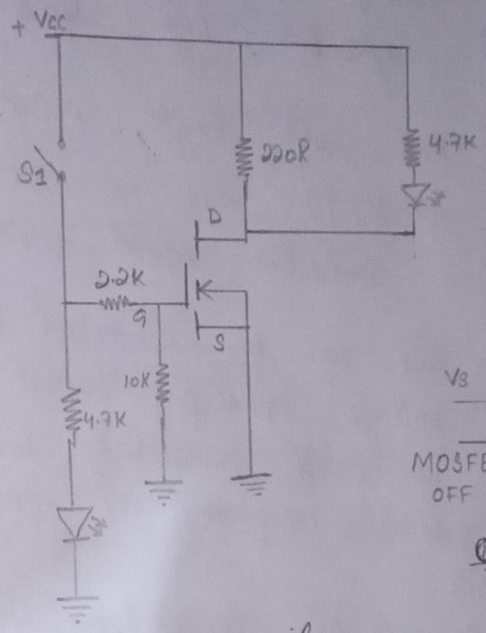
⇒ To carry high current, BJTs must have large base currents, thus these devices have high power losses as compared to MOSFETs.

⇒ So we can add a BJT in a 500W, 220V, 500KHz appliance instead of MOSFET but it will make the switching speed very slow

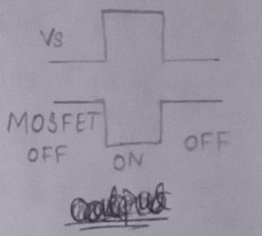
⇒ A load resistance should be added to the collector in high power circuits.

Question # 02
(Part b)

⇒P.MOSFET in a Circuit :-



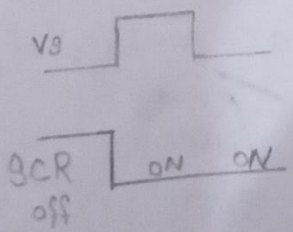
working Phenomena

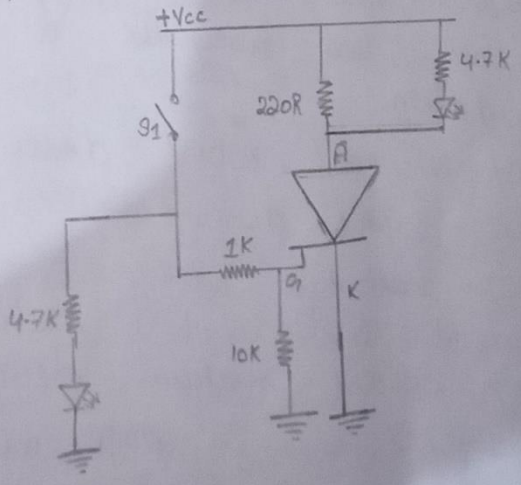


output

⇒ SCR in the Same Circuit :-

working Phenomena





⇒ In SCR majority carrier device current driven device, low switching speed low resistive input impedence while in MOSFET majority carrier device voltage driven device, high switching speed, Purely capacitive high ~~speed~~. input impedence.

⇒ SCR has only single pulse to turn ON but MOSFETS has no DC required to maintain conduction expect during turn off.

⇒ The SCR can be connected in series easily with voltage evualizing circuit whereas ~~in~~ MOSFET can be easily paralleled due to the positive temperature coefficient of resistance of the device

⇒ SCR is less temperature sensitive, no second breakdown but MOSFET is too much temperature sensitive, less susceptible to the second breakdown.

⇒ SCR is most robust device, MOSFET is less robust device

⇒ SCR ~~has~~ is high voltage as well as a high current device. while MOSFET is a high current medium voltage device.

⇒ SCR has low on stage voltage drop, MOSFET has a high ON stage voltage drop.

"Question # 03"

M. Farhan Ali
ID = 13032

Given data:-

$R_C = 3.2\Omega$

$V_{CC} = 33.2V$

$V_D = 10V$

$V_{CE} = 13V$

$V_{BE} = 1.5V$

$B_{min} = 8$

$B_{max} = 40$

(a) The mode of operation of the transistor:-

⇒ Saturated mode

(b) The value of R_B that results in saturation with an ODF of 5:-

$$I_{CS} = \frac{V_{CC} - V_{CE(sat)}}{R_C} \Rightarrow \frac{33.2 - 13}{3.2}$$

$$\boxed{I_{CS} = 9.968\ A}$$

$$I_{BS} = \frac{I_{CS}}{B_{min}} \Rightarrow \frac{9.968}{8}$$

$$\boxed{I_{BS} = 1.246\ A}$$

$$ODF = \frac{I_B}{I_{BS}} \quad \text{or} \quad I_B = CDF \times I_{BS}$$

$$I_B = 5 \times 1.246$$

$$\boxed{I_B = 6.23A}$$

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

$$R_B = \frac{10 - 1.5}{6.23}$$

$$\boxed{R_B = 1.36\,\Omega}$$

(c) The β forced is-

$$\beta_f = \frac{I_{CS}}{I_B} \Rightarrow \frac{9.968}{6.23}$$

$$\boxed{\beta_f = 1.6}$$

(d) The power loss, P_T in the transistor is-

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

$$1.5 \times 6.23 + 13 \times 9.968$$

$$9.345 + 129.5$$

$$\boxed{P_T = 138.8W}$$