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

Course Details

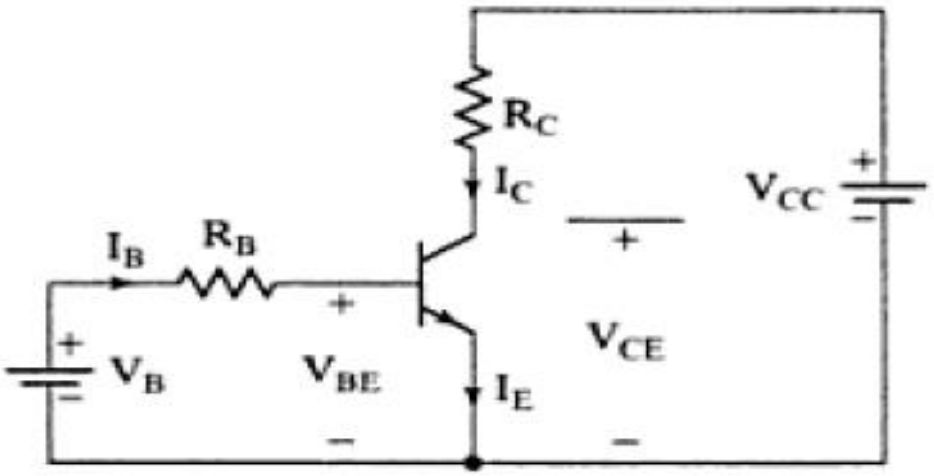
Course Title: Power Electronics **Module:** 8th
Instructor: **Engr. Shayan Tariq Jan Sir** **Total Marks:** 30

Student Details

Name: **FAWAD AHMAD** **Student ID:** **13204**

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 diode in 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 Rectifier 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
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
			

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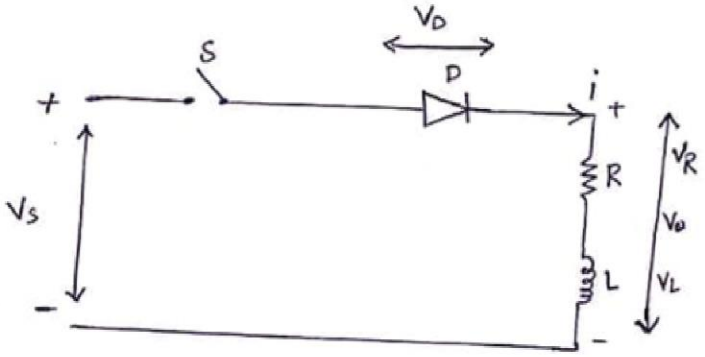
Q.1 (Part A)

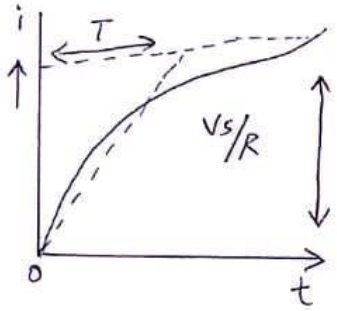
Answer :-

Diode Current with RL Load :-

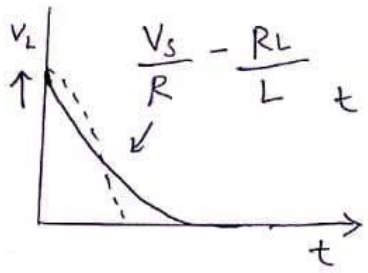


We are talking about Load in which Resistor and inductor are connected across it. We have also connected a diode with Switch and Dc Source Voltage. The Voltage through resistor and inductor is called output Voltage and the Voltage across the diode is called V_D. The Voltage across the resistor is called Voltage resistor and the Voltage across the inductor is called ~~Voltage~~ inductor Voltage

If our Switch is in ON condition means when it conducting on that time when we Provide the Dc Voltage through input Voltage then the current will flow through Positive Side and the diode will in Conducting Condition The Current will flow through output across the resistor and inductor.



* When it flow from zero and increasing slowly and then it stable on a particular point.



* When switch is close and $t = 0$, KVL

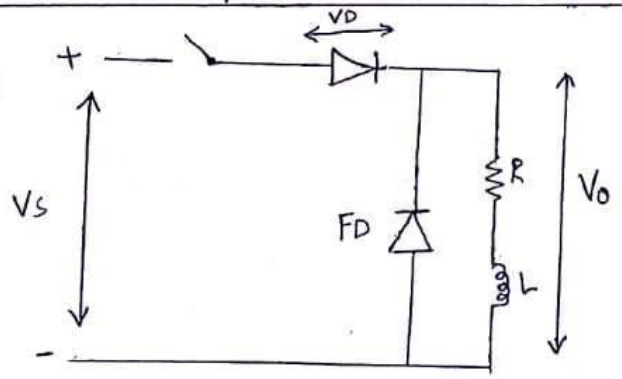
$$V_s = Ri + L\frac{di}{dt}$$

* Voltage across L is

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

$L/R = \tau$ time Constant.

* Free Wheeling Diode with RL Load:

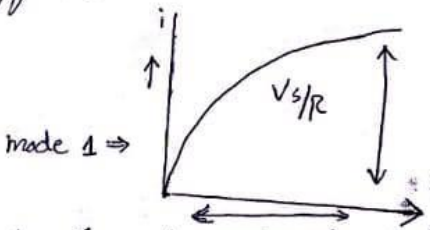


→ * Basically This current is work in two mode. The first mode in which the switch is in ON condition or steady state current. The first mode when our switch is in ON condition or short so in this time we provide source voltage from input

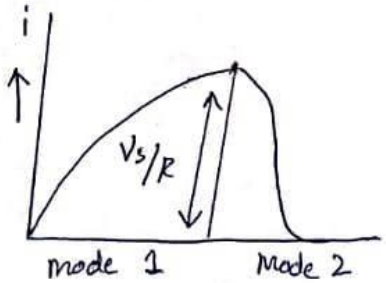
then the current flow through Positive and going to Positive. When the Current flow through diode then No Voltage will drop across the diode Because the diode is in conducting Condition and Current will go to output across the Load In this time when our Switch is in on Condition then the Inductor (L) will store the Energy.

$$i = \frac{V_s}{R} \cdot e^{-R/Lt}$$

Energy Store in L is $= \frac{1}{2} \cdot L \left(V_s/R\right)^2$



→ Now come to Second mode in which our Switch is off or open So in this time if we Provide Source Voltage then No Current will flow. The Store Energy which we Store in inductor (L) So that current will start flowing to Free wheeling diode.



$$ifd = \frac{V_s}{R} \cdot e^{-R/Lt}$$

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Q 1 (Part B)

Solution :-

$$V_{DS} = 04V$$

$$V_T = 4V$$

~~for Saturation~~

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

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

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

$$V_{GS} = 04 + 4$$

$$\boxed{V_{GS} = 8V}$$

Q 2 (Part a)

Answer :-

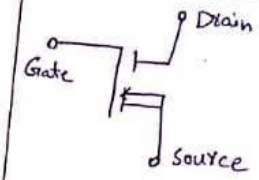
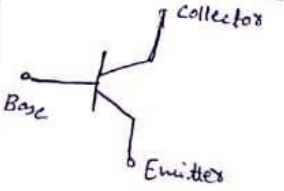
Power MOSFETs are capable of operating at very high frequencies compared with Bipolar Junction Transistor (BJTs) whose switching speed is much slower than a power MOSFET of similar size and voltage rating. Typical rise and fall times of power MOSFET are of the order of nano second which is two order of magnitude faster than bipolar devices of similar voltage rating and active area. BJTs are limited frequencies of less than 100 KHz. Whereas power MOSFET can operate up to 1MHz before switching losses become unacceptably high.

→ Power MOSFET are voltage controlled devices with simple drive circuitry requirements. Power BJTs on the other Hand are current controlled devices requiring large base drive current to keep the device is ON state.

→ Power MOSFET have been replacing Power BJTs in power application due to faster

Switching capability and ease of drive, despite the very advanced state of manufacturability and lower costs of BJTs.

(A) Comparison of MOSFET and BJT :-

Parameters	MOSFET	BJT
Symbol		
Polarity	- Majority Carrier device	- Bipolar device
Controlling	Voltage control	- Current Control
O/P Control	O/P Control of MOSFET is Based on gate Voltage	O/P Control of BJT is based on base Current
Temp Coefficient	(+)ve Temp Coefficient	(-)ve Temp Coefficient
Driver CKT	Simple and Easy to design	Complex to Designe
Losses	Higher Losses than BJT	Low
operating frevuency	High	Low.

Q 2 (Part B)

Answer :-

Basically The main difference between Thyristor and MOSFET is that Thyristor called as SCR is a Solid State Semiconductor device with a four alternating P and N-type material while in MOSFET is a metal-Based field effect Transistor and it most commonly fabricated by the controlled oxidation of silicon Side. ~~So that there~~

→ In thyristor majority carrier device current ~~given~~ driven device low switching speed low resistive input impedance while in MOSFET majority carrier device Voltage driven device High switching speed purely capacitive High input impedance.

→ Thyristor has an only single Pulse to turn ON but MOSFET has No ~~device~~ Dc required to maintain Conduction ~~except~~ except during turn on and turn off.

→ Thyristor has less temperature sensitive, no second breakdown but in MOSFET has to much

Temperature Sensitive, less susceptible to the second breakdown.

→ Thyristor has a most robust device, MOSFET has a less robust device.

→ Thyristor has a high voltage as well as a high current device while in MOSFET has a high current medium voltage device.

→ Thyristor has low on stage voltage drop MOSFET has high on stage voltage drop.

⊛ Comparison Between Thyristor and MOSFET.

Characteristic	Thyristor	MOSFET
Type of device	Minority Carrier	Majority Carrier
Rating	Very High Voltage Very High Current	High Voltage High Current
Switching Frequency	Low	Very High (~MHz)
ON state Drop	Low	Higher (Increasing)
ON state losses	Low	Considerable
Gate Drive	Current Driven	Voltage Driven
Driven by	Single Pulse	Continous large Voltage and large I_G at switching transition (Else more switching Time & more switching Losses)
Turn off	Line or forced commutation	Self commutation
Combination (series)	By Voltage Equaling Circuit	difficult
Combination (Parallel)	By Current equiling	Very Easy
Reliability	most Robust	Less Robust
Breakdown	No Second Break-Down	Less Chance of Second Breakdown.

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Q 3 :-

Solution :-

Given data:

β_f = 8 (β_{min}) to 40 (β_{max})

$R_c = 0.4\,\Omega$

$V_{cc} = 204\,V$

$V_B = 10V$

$V_{CE} = 1\,V$

$V_{BE} = 1.5V$

(a) It is Saturated Mode

(b) $$I_{cs} = \frac{V_{cc} - V_{CE(sat)}}{R_c}$$

$$I_{cs} = \frac{204V - 1V}{0.4\Omega}$$

$$\boxed{I_{cs} = 50.75A}$$

(*) $$I_{Bs} = \frac{I_{cs}}{\beta_{min}} = \frac{50.75}{8} \Rightarrow \boxed{I_{Bs} = 6.34A}$$

(*) $IB = ODF \times I_{Bs} = 5 \times 6.34A \Rightarrow \boxed{I_B = 31.7A}$

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

$$= \frac{10 - 1.5}{31.7}$$

$$\boxed{R_B = 0.268\ \Omega}$$

(b) Therefor

$$B_f = \frac{I_{Cs}}{I_B} = \frac{50.75A}{31.7A} \rightarrow \cancel{B_f}$$

$$\boxed{B_f = 1.60}$$

(c) $$P_T = V_{BE} I_B + V_{CE} I_C$$

$$P_T = (1.5)(31.7) + (1)(50.75)$$

$$= 47 + 50.75$$

$$\boxed{P_T = 97.75\ W}$$