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

Course Details

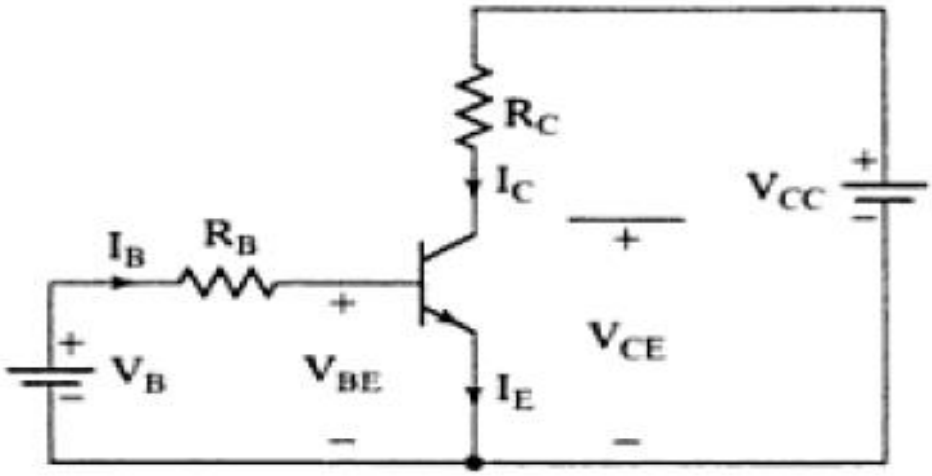
Course Title: Power Electronics **Module:** _____
Instructor: _____ **Total Marks:** 30

Student Details

Name: Kiramat Ullah **Student ID:** 13290

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
			

STUDENT NAME # KIRAMATULLAH

ID NO # 13290

COURSE TITLE # Power Electronics

DEPARTMENT # BEE

TEACHER NAME #

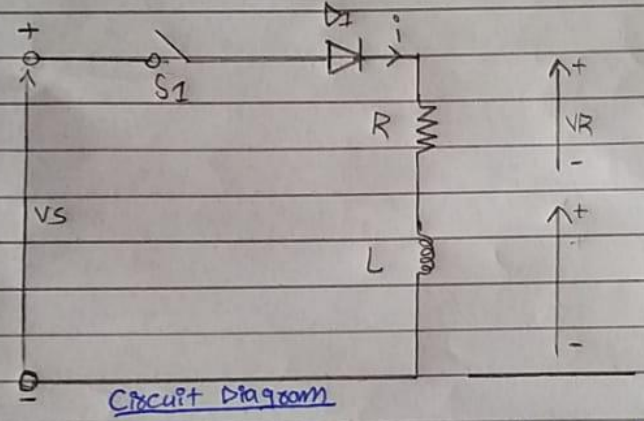
Engr. Shayan Tariq Jan

Question No 1

Part (A)

Answer

↳ A Circuit diagram of RL - connected in series with diode.



Circuit Diagram

When switch (S_1) is closed at t=0 then current through the inductor increases and is ~~exp~~ expressed as,

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

when the initial condition i(t=0) = 0 and i(t) is expressed as,

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

When the rate of change

this current can be obtained from

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

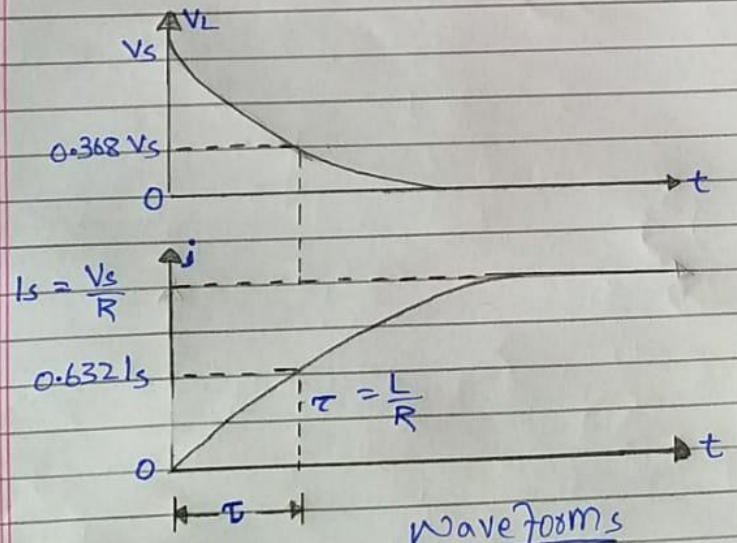
The initial rate of rise of the current at ($t=0$) is obtained

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

The voltage across the inductor is

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

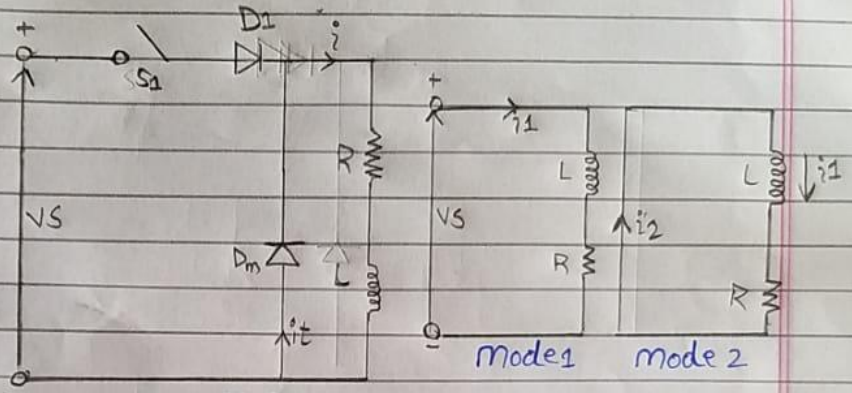
where $\frac{L}{R} = \tau$ is the time constant of an RL load. The waveforms for the voltage and current are shown below.



Waveforms

Kisamatullah (3) ID 13290

A circuit diagram of RL-connected in parallel in free wheeling diode of Dm.



Circuit Diagram.

1) The inductor has property to store energy.

2) In AC current during positive high cycle the inductor stores energy.

3) At negative half cycle the inductor de-energies.

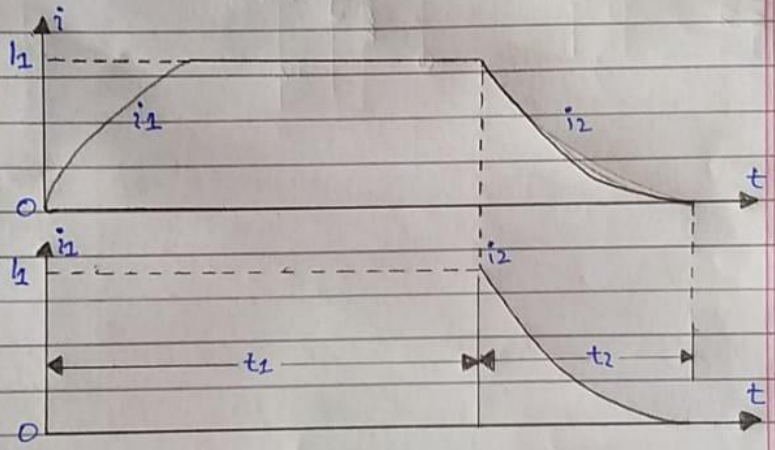
4) This may cause reverse damage to circuit.

5) To avoid energy dissipation free-wheeling diode is used.

6) In negative half cyle, the

Freewheeling diode becomes forward biased so that the current will flow through diode.

7) Therefore. it de-energies inductor.



Wave forms

Circuit with free wheeling diode.

So, Now

⇒ ~~R-L~~ Then it will only reduce in ripple and prevent in load current from leading to zero. And it has no impact on half wave rectification.

⇒ Secondly if R-C is taken instead of R-L the the effect will be same. The only difference will be the load voltage and it can be prevented from lending to zero.

X ═══ X ═══ X ═══

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Question No 1 Part (B)

Answer

Given data :-

$V_T = 1V$

$V_{DS} = 90$

Find = $V_{GS} = ?$ in saturation mode

Solution :-

In saturation mode.

$\Rightarrow \quad V_{DS} = V_{GS} - V_T$

$\Rightarrow \quad V_{GS} = V_{DS} + V_T$

$V_{GS} = 90 + 1 = 91$

As

$$\boxed{V_{GS} = 91\ V}$$

Ans

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Question No 2

Part (A)

Answer

A)⇒ When we replace a power mosfet with a power BJT there will be a high effect on its output and performance of the appliance.

BJT is a current controll device for such high voltage rating. ∯ g g recove the power mosfet.

But the losses occurs in the appliance becomes slightly lower because (BJT has lesser losses as compared to Mosfet). But BJT has switching limits i-e second Breakdown (SB). It is distructive phenomena results from current flow to a small portion of the base, producing localized hot spots. If the energy these hot spots is sufficiant, the excessive localized heating many damge the transistor.

But to avoid this problem the manufacture usually provide the forward biased safe operating Area (FBSOA). and Reverse biased safe operating area (RBSOA) which works in turn-ON and turn-OFF conditions.

It indicates the $i_C - V_{CE}$ limits of the transistor. For reliable operation the transistor must not be subjected to greater power dissipation then that shown by the FBSOA and RBSOA. The BJT have high switching frequencies. since there turn-ON and turn-OFF times are low. The Mosfet driver circuit is simple and easy to design, but the BJT driver circuit is complex. You can add a thyristor to circuit because both provides a good controll range of current with small controlling current. Also for the operating frequency because the operating frequency of BJT is quite low as compare to mosfet.

Question No 2 **Part (B)**

Answer

B) The silicon controlled rectifier is a current controlled needs. Single pulse to turn ON as BJT. The ON-state voltage drop is lower i-e less than 2 volts as compare to power Mosfet.

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The voltage given in the Question falls in the category of SCR and BJT as its maximum V-I rating of SCR is 100KV / 5000Amp and of BJT is 2KV / 100Amp

But the operating frequency of SCR is quite lower than Power Mosfet. So it will damage the efficiency and performance of the appliance.

Question No 3

Part (a)

Answer

a) Given that:-

$\Rightarrow V_{CC} = 290\ V$
$\Rightarrow R_C = 90\ V$
$\Rightarrow V_B = 10V$
$\Rightarrow V_{CE} = 1\ V$
$\Rightarrow V_{BE} = 1.5V$

Find Mood ?

Solution:-

The mode of operation of the transistor is an saturation mode.

Question No 3

Part (b)

Answer

Solution:-

Find $= R_B = ?$

So,

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

$$\frac{290 - 1}{90} = \frac{289}{90}$$

$I_{CS} = 3.2111A$ → Ampere

Ans

⇒ We know that

So,

$$I_{BS} = \frac{I_{CS}}{B_F (mini)}$$

$$I_{BS} = \frac{3.2111}{8}$$

$$\boxed{I_{BS} = 0.40138\ A}$$ Ans

⇒ Find = I_B = ?

So,

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

$$I_B = 5 \times 0.40138$$

$$\boxed{I_B = 2.0069\ A}$$ Ans

⇒ As we know,

when

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

$$R_B = \frac{10 - 1.5}{2.0069} = \frac{8.5}{2.0069}$$

$$\boxed{R_B = 4.2353\ \Omega}$$ Ans

Question No 3 Part (C)

Answer

Solution :-

We Find $B_{Force} = ?$

Now,

$$B_{Force} = I_{CS} / I_B$$

$$= \frac{3.2111}{2.0069}$$

Now,

$$\boxed{B_{Force} = 1.600029\ \Omega}$$ Ans

Question No 3 Part (D)

Answer

Solution :-

Now we Find

$$P_T = ?$$

So,

$$P_T = V_{BE} I_B + V_{CE} I_{CS}$$

$V_{BE} = 1.5\ V$

$I_B = 2.0069\ A$

$\Rightarrow V_{CE} = 1\ V$

$\Rightarrow I_{CS} = 3.2111\ A$

Now

$$P_T = V_{BE} I_B = V_{CE} I_{CS}$$

$$= (1.5)(2.0069) + (1)(3.2111)$$

$$= 3.01035 + 3.2111$$

$$\boxed{P_T = 6.22145 \text{ Watt}}$$

Ans///

X X X