Name : M.Yasir shah

ID : 13172

Subject Power Electronics

Mid Assignment

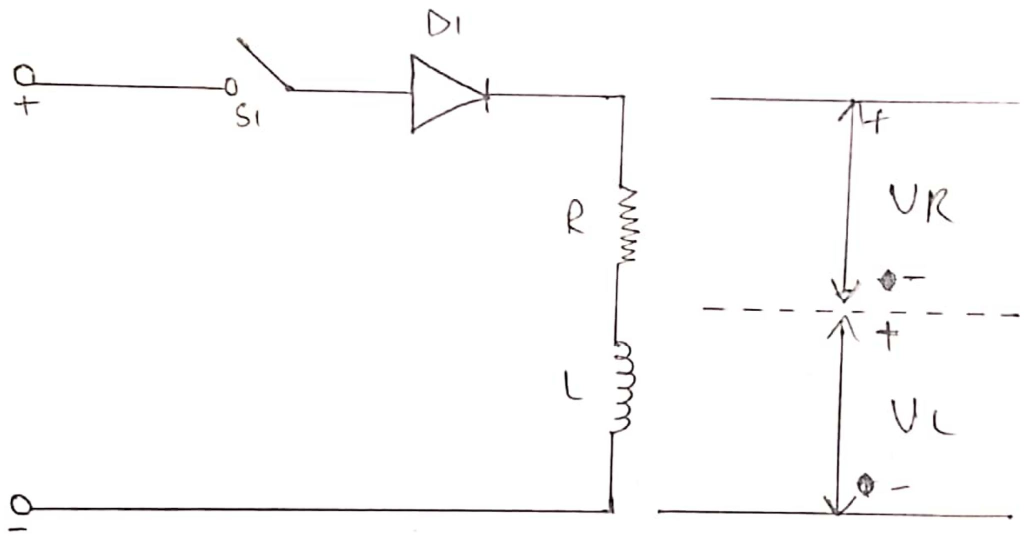
Submitted to Engr. Shayan Tariq Jan

M·Yasir shah

ID 13172

Q#01 (a)

R-L connected in series with diode:



→ t = 0 when S_1 is closed, current through the inductor increases and is expressed

$$V_s = V_L + V_2 = L\frac{di}{dt} + Ri$$

→ The initial condition $i(t=0) = 0$

$i(t)$ is

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

→ The rate of change of the circuit is obtained

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

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

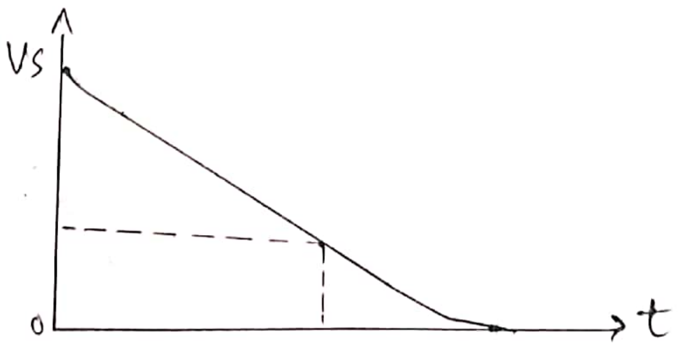
$$\left.\frac{di}{dt}\right|_{t=0} = \frac{V_s}{L}$$

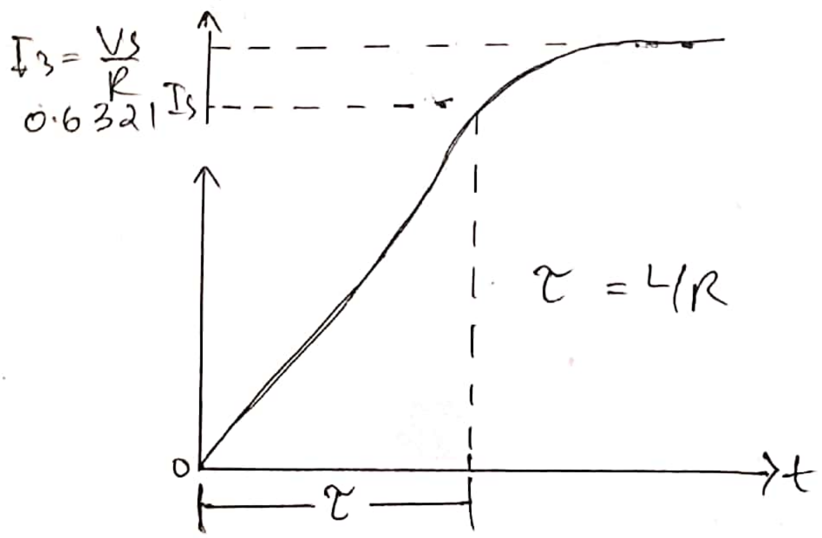
→ voltage across the inductor

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

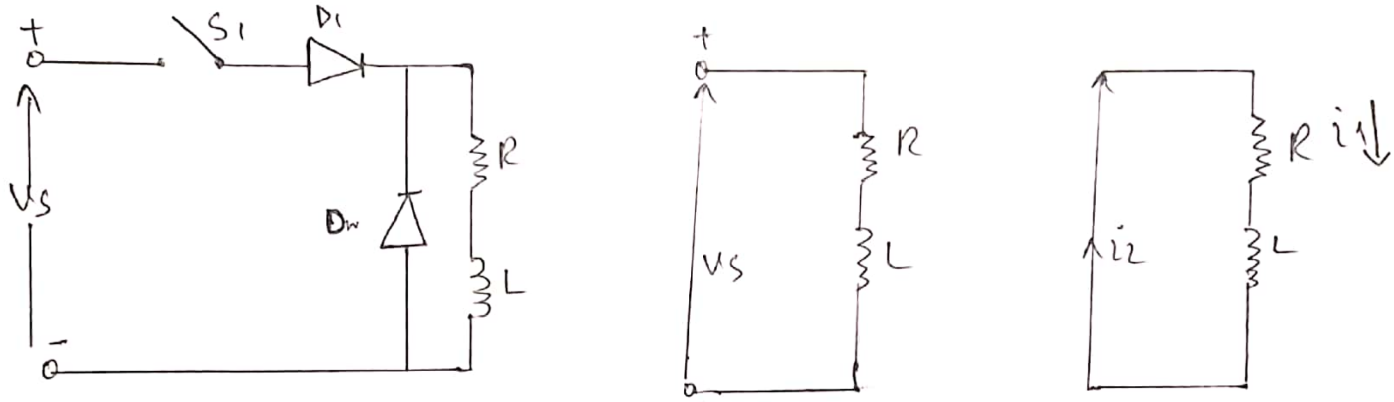
→ $L/R = \tau$ is the time constant of RL load.

→ The wave form for the voltage and current.





RL circuit connected in parallel with wheeling diode



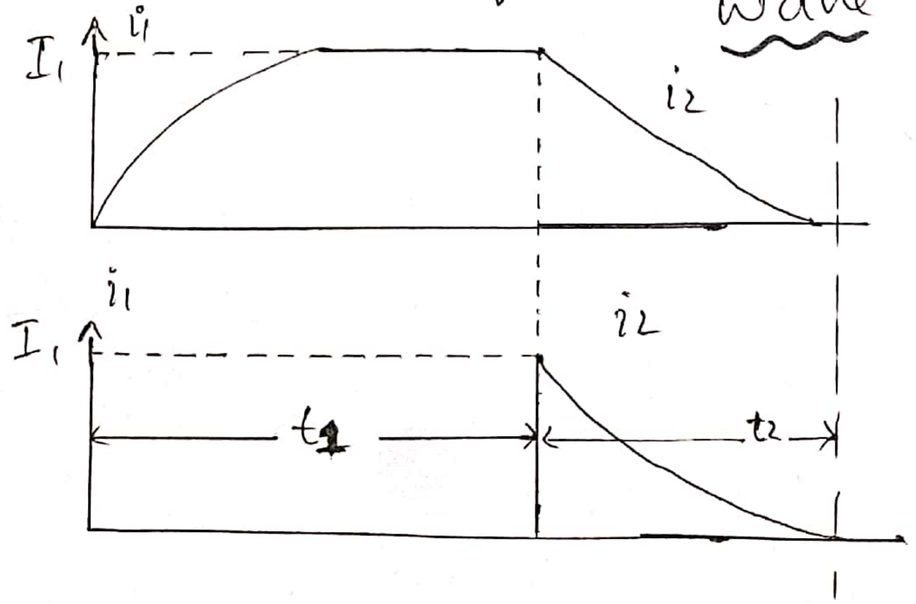
→ In AC current during positive high cycle the inductor closes energy.

→ At negative half cycle the inductor de-energies, This may cause reverse damage to circuit.

To avoid energy descipation free-wheeling diode is used.

On negative half cycle free-wheeling diode becomes forward bias so the current will flow through diode.

wave form:



Q#01 (b)

$V_{DS} = 72$

$V_T = 2$

⇒ For saturation

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

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

$V_{GS} = 72 + 2$

$V_{GS} = 74\,V$.

Q#02

Ratings $P = 500W$ $V = 220V$ $f = 500KHz$

$$I = \frac{500}{220} = 2.27\,A$$

→ If power mosfet is used, it switching resistance is

$$r_{ds} = \frac{1}{\mu_n C_{ox} \frac{W}{L}(V_{gs} - V_{th})}$$

$$I_D = 2.27A = \frac{\mu_n C_{ox} W/L}{2}(V_{gs} - V_{th})^2$$

→ The above equation shows that MOSFET is voltage control device, controlling voltage is Vgs

→ Gate current of MOSFET is zero, so no power dessipation during switching.

→ If BJT is used instead of MOSFET:
The following parameters would be affected.

(i) Performance: Since MOSFET is voltage control device and switching of the voltage across gate terminal can be carried out at higher rate even in Mega HZ, because the channel formation in MOSFET is too fast while using BJT, switching of current through Base terminal is comparatively slow.

Conclusion

performance
- → MOSFET is fast.
- → BJT is comparatively slow.

MOSFET is faster because only majority carriers constitute the current.

(ii) Efficiency and losses: BJT has lower conduction resistance than MOSFET, so it has low conduction losses but in this case frequency is high enough (500 kHz) which make BJT to be more power lossy than MOSFET, so in this case BJT is less epficient and more lossy then MOSFET.

BJT
- → low conduction losses.
- → high switching power losses.

MOSFET
- → little bit more conduction losses.
- → very low switching power losses.

In this case f >> I, so switching losses are important and considerable and hence MOSFET is in favor. (iii) Change to the circuit be required:
(iii) BJT is used bigger heat sink has to be installed with BJT, and power supply to BJT must be enough to ensure required power (500w) at output of BJT.

Q # 02 (b)

Replacement of MOSFET to SCR:

-> SCR's are slow less efficient and lossy even than BJT's.

(i) They are slow than MOSFET because SCR's are also current control device.

(ii) They are less efficient and more lossy because the conduction resistance and switching power losses are comparatively greater than MOSFET's and BJT's.

(iii) When SCR's have to be used than one must install stop conduction circuit or controller SCR have to be used which is slower and more power losses occurs as for this purpose an alternate path is to be provided to conduction current to stop the conduction through main circuit.

Q#03

(a) mode of transistor as a switch.

$B_F = 8$ to 40. $R_C = 72\,\Omega$, $V_{CC} = 172$ V, $V_B = 10$ V

(b) $R_B = ?$ $V_{CE} = 1$ V, $V_{BE} = 1.5$ V

$$I_{CS} = \frac{V_{CC} - V_{CE}}{R_C} = \frac{172 - 1}{72} = 2.375 \text{ A}$$

$$I_{BS} = \frac{I_{CS}}{B_{F(min)}} = \frac{2.375}{8} = 0.2968 \text{ A}$$

$$I_B = ODF \times I_{BS} = 5 \times 0.2968 = 1.484375 \text{A}$$

$$R_B = \frac{V_B - V_{BE}}{I_B} = \frac{10 - 1.5}{1.484} = 5.72776\,\Omega$$

(c) $B_{forced} = ?$

$$B_F = \frac{I_{CS}}{I_B} = \frac{2.375}{1.4843} = 1.6$$

(d) $P_T = ?$

$$P_T = V_{BE} I_B + V_{CE} I_C$$
$$= 1.5 \times 1.484 + 1 \times 2.375$$
$$= 4.601 \text{ W}.$$