IAT IV

Numericals.

(2b) Given Data. $\beta_{min} = 10$

$\beta_{max} = 60.$

$R_C = 5\Omega$; $V_{CC} = 100V$; $V_{BB} = 8V$

$V_{CE}(sat) = 2.5V$, $V_{BE}(sat) = 1.75V$

(i) $R_B = ?$ (ii) Forced $\beta = ?$ (iii) Total power loss.

ODF = 5

in saturation

(i) To Find R_B in saturation.

$$I_{CS} = \frac{V_{CC} - V_{CE}(sat)}{R_C} = \frac{200 - 2.5}{5} = 19.5A$$

$$I_{BS} = \frac{I_{CS}}{\beta} = \frac{I_{CS}}{\beta_{min}} = \frac{19.5}{10} = 1.95A.$$

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

$$= 5 \times 1.95 = 9.75A.$$

$$\boxed{I_B = 9.75A}$$

$$I_B = \frac{V_B - V_{BE}(sat)}{R_B} \Rightarrow R_B = \frac{V_B - V_{BE}(sat)}{I_B}.$$

$$= \frac{8 - 1.75}{9.75} = 0.641 A.$$

$$\boxed{R_B = 0.641 A}$$

(ii) Forced $\beta = \beta_{forced} = \frac{I_{CS}}{I_B} = \frac{19.5}{9.75} = 2.$

$$\boxed{\beta_{forced} = 2}$$

(iii) Total power loss.

$P_T = V_{BE(sat)} I_B + V_{CE(sat)} I_{C(sat)}$

$= (1.75 \times 9.75) + (2.5 \times 19.5)$

$$\boxed{P_T = 65.8125 \text{ watts}}$$

(4b) <u>Anti Saturation</u> <u>Control</u>.

$V_{CC} = 100V$, $R_C = 1.5\Omega$; $V_{d1} = 2.1V$; ~~$V_{d2} = 0.9$~~

$V_{d2} = 0.9V$; $V_{BE(sat)} = 0.7V$; $V_B = 15V$

$R_B = 2.5\Omega$, $\beta = 16$.

(i) I_C without clamping.

2) I_C with clamping

3) V_{CE} (CE clamping voltage).

(i) I_C without clamping.

$I_C = \beta I_B$.

$$I_B = I_1 = \frac{V_B - V_{d1} - V_{BE}}{R_B} = \frac{15 - 2.1 - 0.7}{2.5}$$

$I_B = 4.88A$.

$I_C = \beta I_B = 16 \times 4.88 = 78.08A$.

$$\boxed{I_C = 78.08A}$$

(ii) ~~Ic wi~~ V_{CE} (Collector Emitter Clamping Voltage)

$V_{CE} = V_{BE} + V_{d1} - V_{d2} = 0.7 + 2.1 - 0.9$

$$\boxed{V_{CE} = 1.9V}$$

(iii) <u>I_C with clamping.</u>

$$I_C = \frac{\beta}{\beta+1}(I_1 + I_L)$$

$I_1 = I_B = 4.88\,A.$

$$I_L = \frac{V_{CC} - V_{CE}}{R_C} = \frac{100 - 1.9}{1.5} = 65.4\,A.$$

$$I_C = \frac{\beta}{\beta+1}(I_1 + I_L) = \frac{16}{16+1}(4.88 + 65.4)$$

$$\boxed{I_C = 66.14\,A}$$

(5)

(7b) $V_s = 200V$; $R = 10\Omega$; $f_s = 3KHz$

$\frac{dv}{dt} = 100\ V/\mu s$; $I_{TD} = 100A$; $L = L_s = 0$.

(i) R_s & C_s = ? (ii) Snubber loss (iii) power rating of snubber circuit.

(i) <u>To Find R_s.</u>

$$R_s = \frac{V_s}{I_{TD}} = \frac{200}{100} = 2\Omega$$

<u>To Find C_s</u>

$$\frac{dv}{dt} = \frac{0.632\ R\ V_s}{C_s (R_s + R)^2}$$

$$\frac{100}{10^{-6}} = \frac{0.632 \times 10 \times 200}{C_s (2 + 10)^2}$$

$$C_s = \frac{.632 \times 10 \times 200 \times 10^{-6}}{(2+10)^2 \times 100} = 0.088 \times 10^{-6}$$

$$\boxed{C_s = 0.088\ \mu F}$$

(ii) Snubber loss $P_s = 0.5\ C_s\ V_s^2\ f_s$

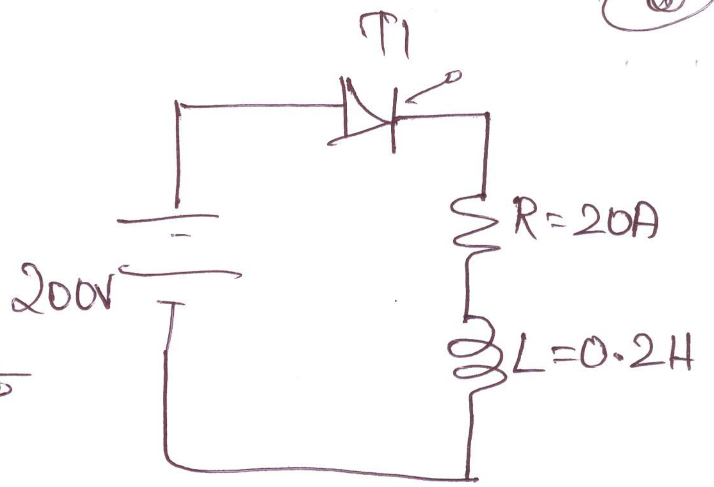
$= 0.5 \times 0.088 \times 10^{-6} \times 200^2 \times 3 \times 10^3$.

$= 5.28\ W$.

(iii) Power rating of snubber circuit = 5.28 W

(8 a) $I_L = 200\,mA$.

Minimum width of gate pulse required to turn on the SCR.



$V = 200V$; $R = 20\Omega$; $L = 0.2\,H$.

When the circuit is ON, it will act as a RL circuit

RL Circuit

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

$$200\times10^{-3} = \frac{200}{20}\left(1 - e^{-\frac{20}{0.2}t}\right)$$

$$0.02 = \left(1 - e^{-\frac{20}{.2}t}\right)$$

$$e^{-\frac{20}{.2}t} = 1 - 0.02 = 0.98.$$

$$-\frac{20}{0.2}t = \ln 0.98 = -0.02.$$

$$t = 202\,\mu s$$

(8b). $V_s = 200V$; $t = 40\mu s$

$I_L = 36 mA$. $R = 60\Omega$; $L = 2H$.

(i) Will the thyristor get triggered?

To turn on the SCR $I(t) > I_L$.

$$i(t) = \frac{V}{R}\left(1 - e^{-R/L\, t}\right)$$

$$= \frac{200}{60}\left(1 - e^{-\frac{60}{2} \times 40 \times 10^{-6}}\right)$$

$$i(t) = 3.99 \times 10^{-3} A = 3.99\, mA.$$

$i(t) < I_L$; $t = 40\mu s$ is not the pulse width to turn on the device.

(ii) <u>Pulse width for successful triggering</u>.

$$i(t) = \frac{V}{R}\left(1 - e^{-R/L\, t}\right)$$

$$36 \times 10^{-3} = \frac{200}{60}\left(1 - e^{-\frac{60}{2} t}\right)$$

$$0.9892 = e^{-\frac{60}{2} t}$$

$$\ln 0.9892 = -\frac{60}{2} t$$

$$t = 0.3619 ms$$

$$\boxed{t = 361.9\, \mu s}$$