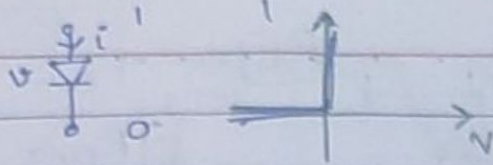


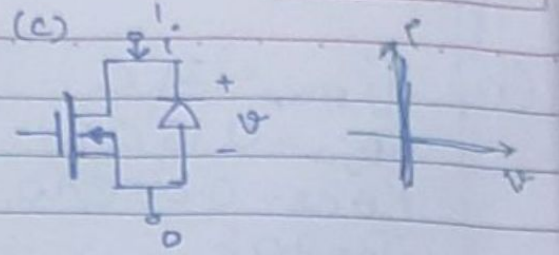
Assignment 1

19EE10039
Mansi Uniyal.

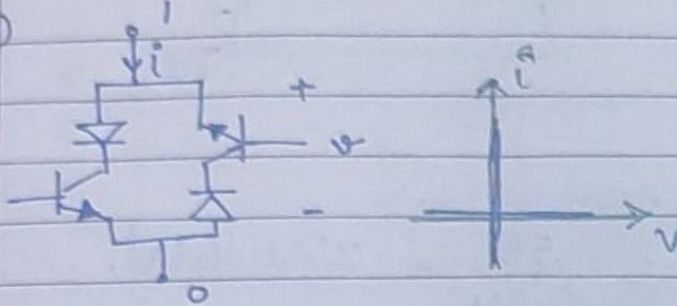
Q1. (a)



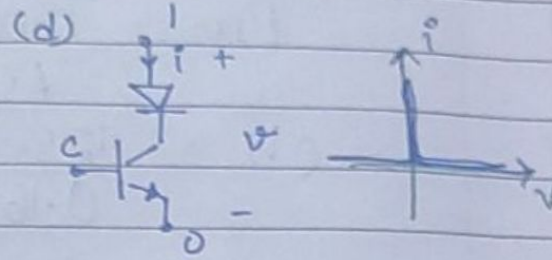
(c)



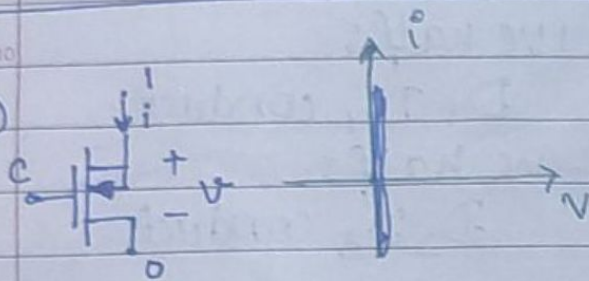
(b)



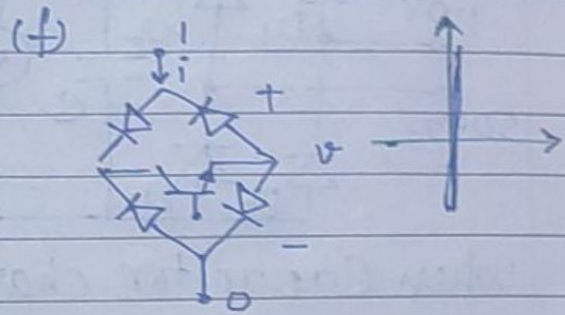
(d)



(e)

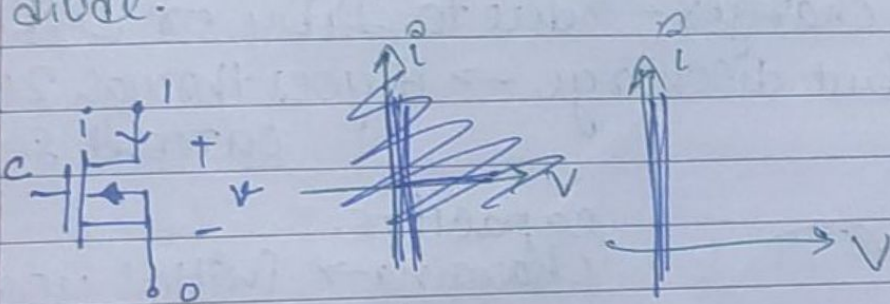


(f)



intrinsic body diode.

(g)



Q2. (a). $T_c = 100^\circ\text{C}$

$T_{j\max} = 125^\circ\text{C}$

$R_{\theta ca} = 0.5^\circ\text{C/W}$

$R_{\theta sa} = 0.4^\circ\text{C/W}$

$R_{\theta cs} = 0.1^\circ\text{C/W}$

$T_a = 40^\circ\text{C}$, $T_s = ?$

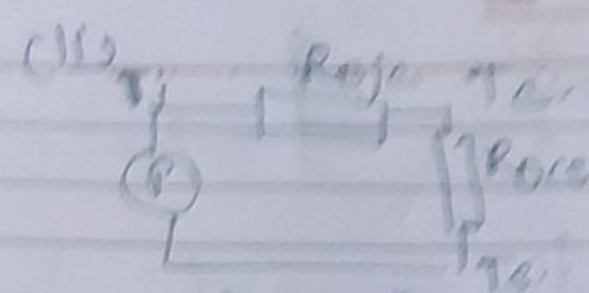
$$\frac{T_c - T_s}{R_{\theta cs}} = \frac{T_s - T_a}{R_{\theta sa}}$$

$$\frac{100 - T_s}{0.1} = \frac{T_s - 40}{0.4}$$

$$440 = 5T_s; \boxed{T_s = 88^\circ\text{C}}$$

Q2.

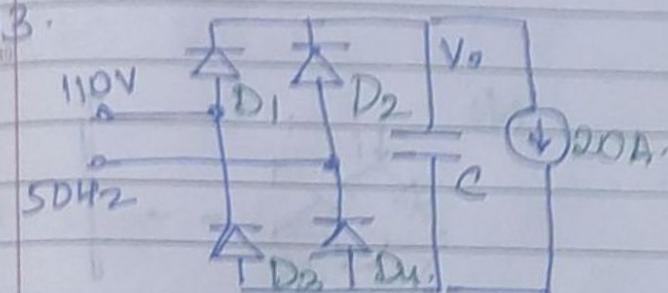
$T_{jmax} = 125^\circ C$
 $R_{\theta ja} = 0.16^\circ C/W$
 $R_{\theta cs} = 0.08^\circ C/W$
 $T_s = 70^\circ C$



$$P_{loss} = \frac{T_{jmax} - T_s}{R_{\theta ja} + R_{\theta cs}}$$

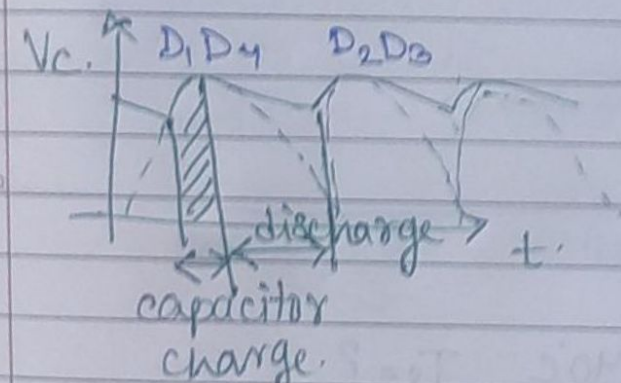
$$(b) = \frac{125 - 70}{0.16 + 0.08} = \frac{55}{0.24} = 229.16 W$$

Q3.



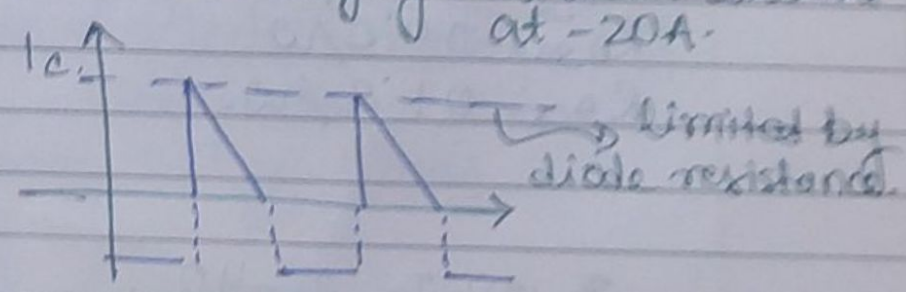
the halfs:
 D_1, D_4 conduct.
 -ve halfs:
 D_2, D_3 conduct.

When Capacitor charges \rightarrow due to D_1, D_4 or D_2, D_3 .
 but discharge \rightarrow it goes through 20A current source.

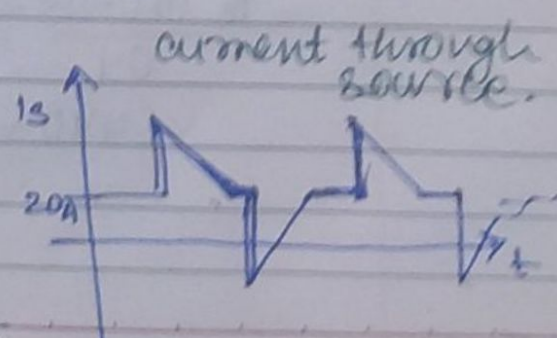
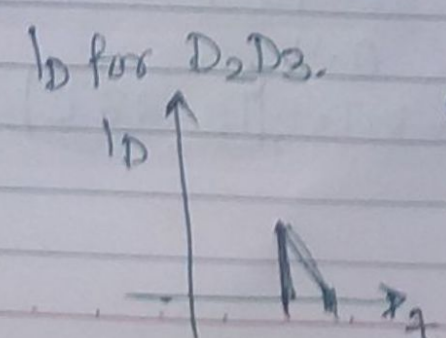
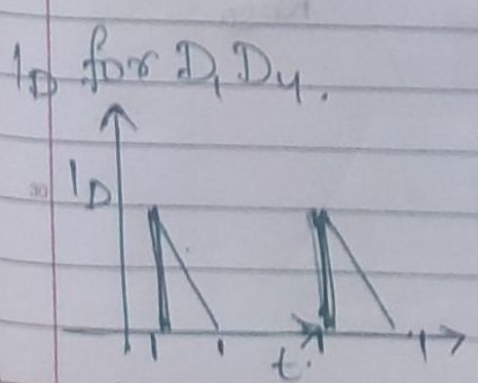


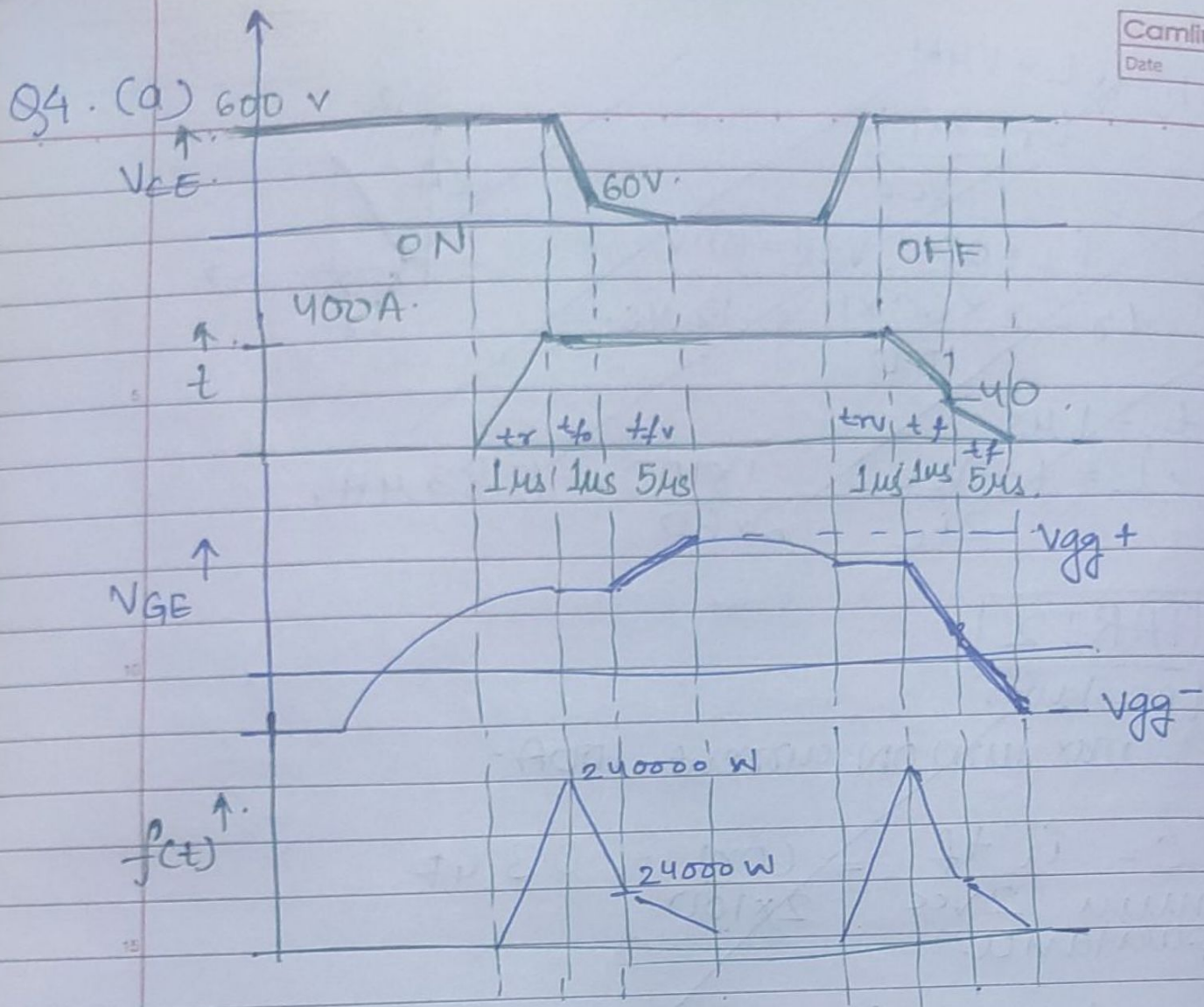
capacitor.
 charging \rightarrow initial current very high.
 at sudden voltage change \rightarrow finally 0.

discharging \rightarrow current constant at -20A.



limited by diode resistance.

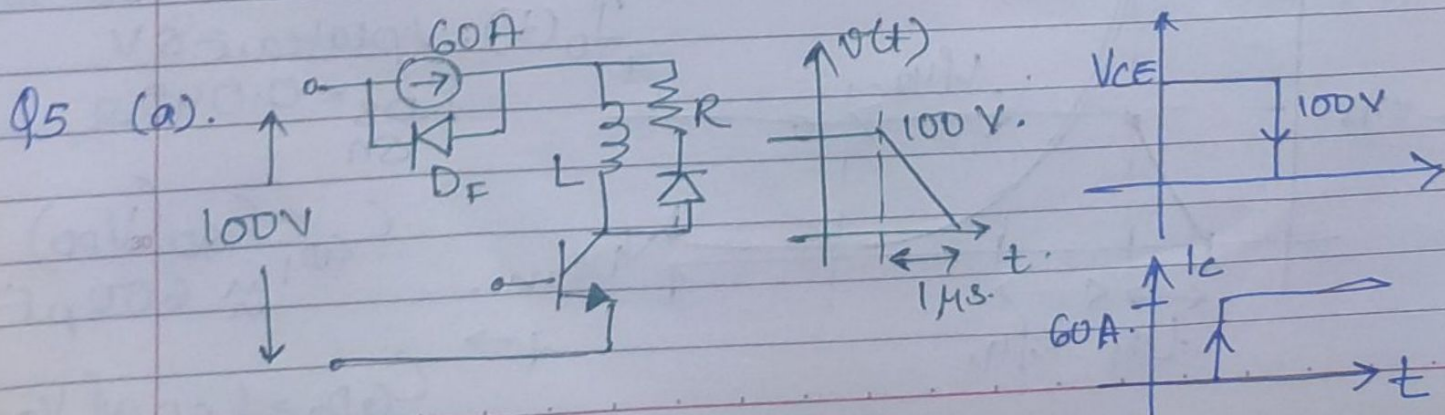




Q4 (b). $P_{peak} = 240 \text{ kW}$
 $P_{avg} = \frac{1}{T} \left(\frac{1}{2} (240000) + \frac{1}{2} (264000) + \frac{1}{2} \times 5 \times 240000 \right)$
 $\frac{P_{ON} + P_{OFF}}{2} = 44.57 \text{ kW} = P_{ON} = P_{OFF}$

(c) energy during 1 ON-OFF = 312000 μ J.
angle

avg switching power loss = $2 \times 312000 \text{ } \mu\text{J} \times 10^3$
 $= 624 \text{ W}.$



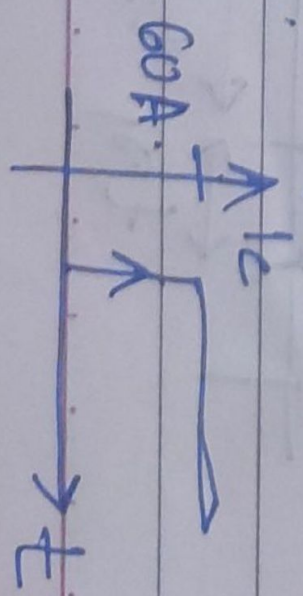
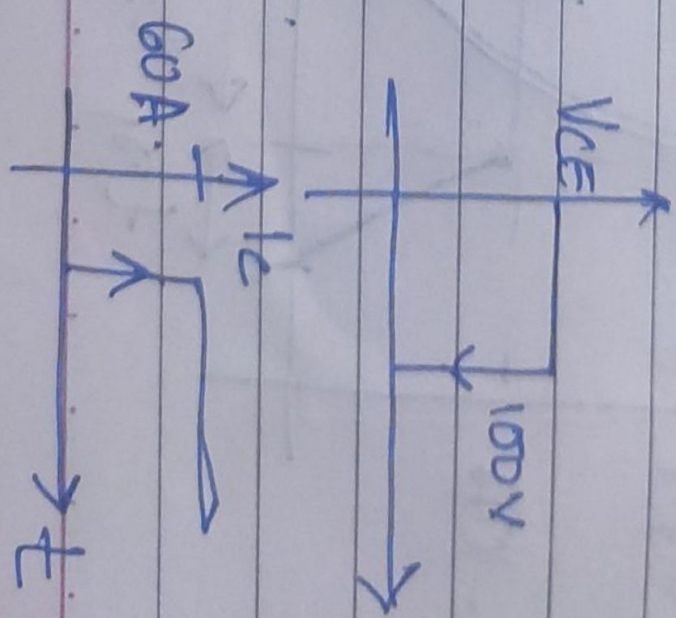
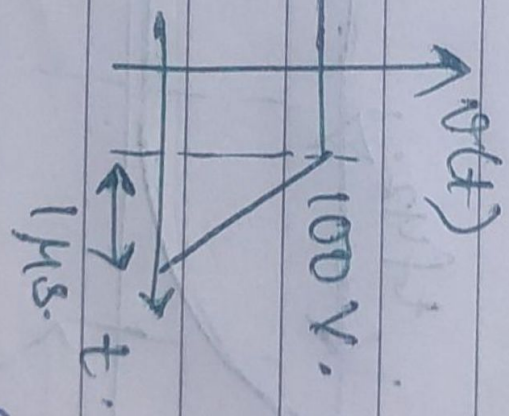
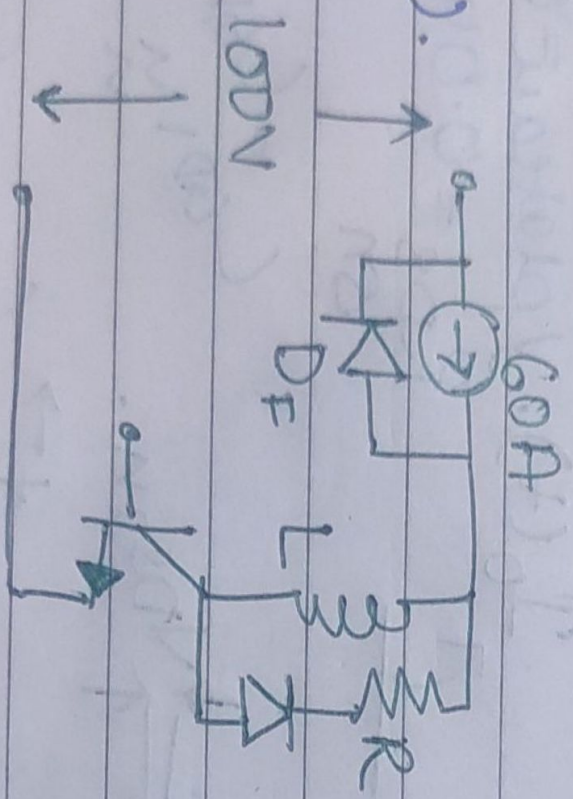
Q4 (c) for switching free.

$$P_{\text{on}} = E_{\text{on}} f_s \\ = \left[\frac{1}{2} \cdot 240 \cdot \frac{1}{2} (240 + 24) + \frac{1}{2} \cdot 240 \cdot \frac{1}{2} \right]$$

$$P_{\text{on}} = \underline{\underline{312 \text{ mW}}}$$

$$P_{\text{off}} = E_{\text{off}} f_s \Rightarrow \underline{\underline{312 \text{ mW}}}$$

Q5 (a).

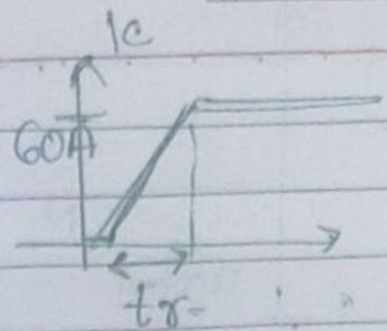


Q5 (b) $\Rightarrow L = 1 \mu H$

$$t_r = \frac{2i_L L}{V_{CE}}$$

$i_L = 60 A, V_{CE} = 100 V$

$$t_r = \frac{2 \times 60 \times 1}{100} = 1.2 \mu s$$



(c) $t_r = 1 \mu s$

$$L = \frac{t_r V_{CE}}{2i_L} = \frac{1 \times 100}{2 \times 60} = 0.83 \mu H$$

Q5 Part 2.

$$I_L = i_c + i_{\text{capacitor}}$$

$$i_{\text{cap}} = I_L - I_L \\ = -I_L \left(1 - \frac{t}{t_f}\right) + I_L$$

$$i_{\text{cap}} = I_L \frac{t}{t_f}$$

$$V_{ce} = \frac{1}{C} \int_0^{t_f} i_{\text{cap}} dt$$

$$V_{ce} = \frac{I_L t_f^2}{2C t_f}$$

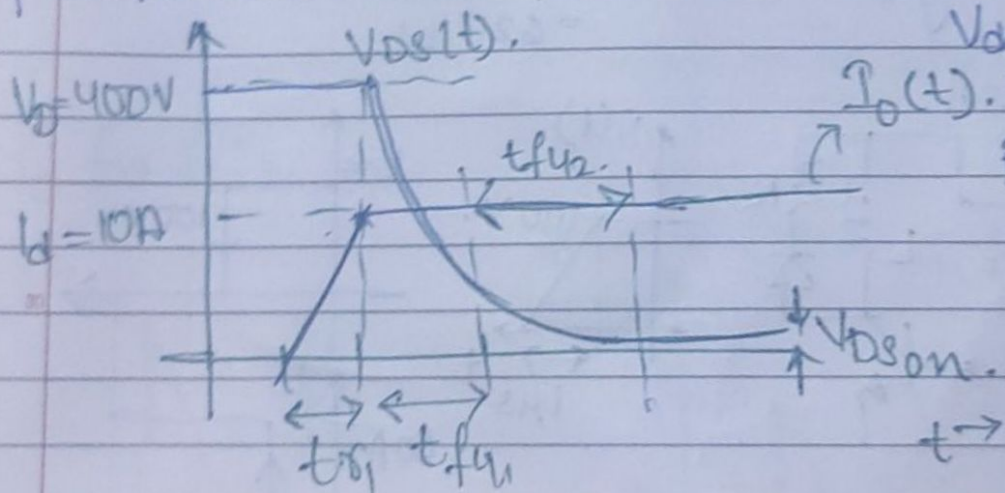
$$C = \frac{60 \mu}{2 \times 10^0} = 0.3 \mu F$$

$$R < \frac{60 \Omega}{5C}$$

$$R < \frac{1 \mu}{5 \times 0.3}$$

$$\underline{R < 0.67 \Omega}$$

Q6. Turn ON:



$$R_G = 1.5\Omega \quad I_{D(on)} = 10A$$

$$V_{DS} = 15V \quad V_{DD} = 400V$$

$$I_D(t) \cdot V_{plateau} = 8V$$

$$R_{DS(on)} = 0.045\Omega$$

$$C_{GD1} = C_{GD}(V_{DD}) \approx 600pF$$

$$C_{GD2} = C_{GD} \text{ at } V_{DS} \approx 750pF$$

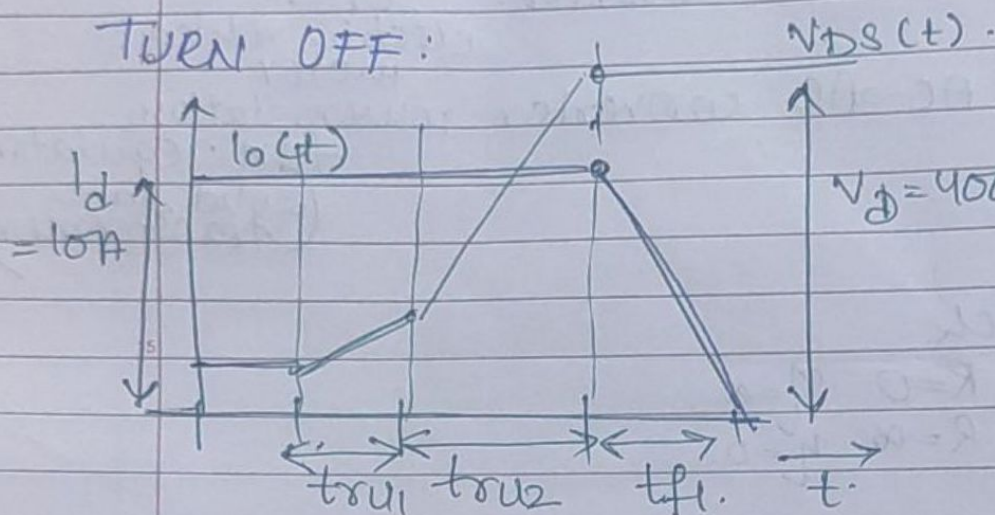
$$t_{f1} = (V_{DD} - R_{DS(on)} I_{don}) R_G \times \frac{C_{GD1}}{V_{DS} - V_{plateau}}$$

$$= (400 - 0.45) \times 1.5 \times \frac{600 \times 10^{-12}}{8} = \underline{51.75 \text{ ns}} \quad 17.12 \text{ ns}$$

$$t_{f2} = (V_{DD} - R_{DS(on)} I_{don}) \times R_G \times \frac{C_{GD2}}{V_{DS} - V_{plateau}}$$

$$= (400 - 0.45) \times 1.5 \times \frac{7500 \times 10^{-12}}{8} = \underline{642 \text{ ns}}$$

TURN OFF:



$$R_G = 1.5 \Omega$$

$$R_{DS(on)} = 0.045 \Omega$$

$$V_D = 400 \text{ V}, I_{don} = 10 \text{ A}$$

$$C_{GD1} = 600 \text{ pF}$$

$$C_{GD2} = 7500 \text{ pF}$$

$$V_{DS} = 15 \text{ V}$$

$$V_{plateau} = 8 \text{ V}$$

$$t_{tr1} = (V_{DD} - R_{DS(on)} I_{don}) R_G \times \frac{C_{GD1}}{V_{plateau}}$$

$$= (400 - 0.45 \times 10) \times 1.5 \times \frac{600 \times 10^{-12}}{8} = \underline{14.76 \text{ ns}}$$

$$t_{tr2} = (V_{DD} - R_{DS(on)} I_{don}) R_G \times \frac{C_{GD2}}{V_{plateau}}$$

$$= (400 - 0.45) \times 1.5 \times \frac{7500 \times 10^{-12}}{8} = \underline{0.561 \mu\text{s}}$$

$$= \underline{561 \text{ ns}}$$