Assignment 1

19EE10039
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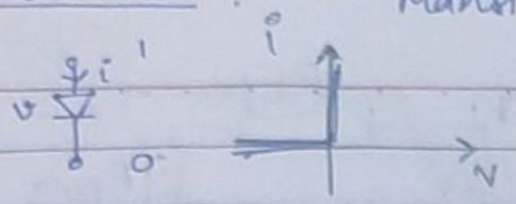
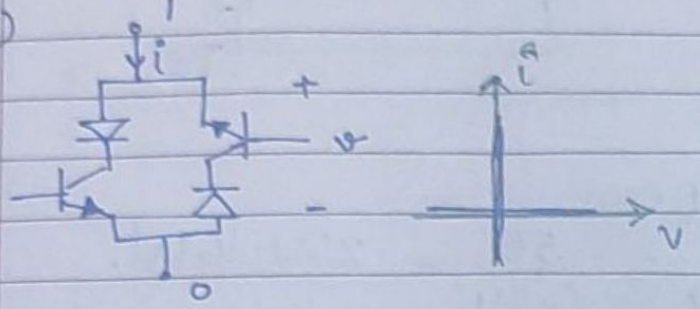
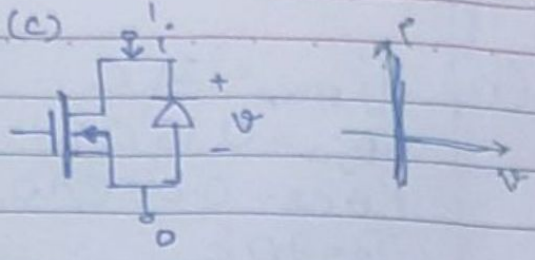
Q1. (a)



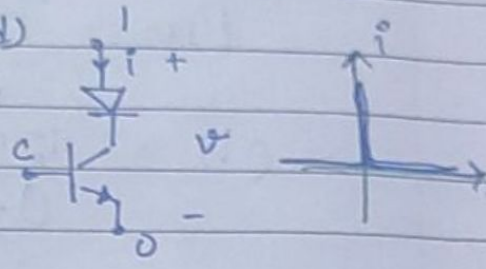
(b)



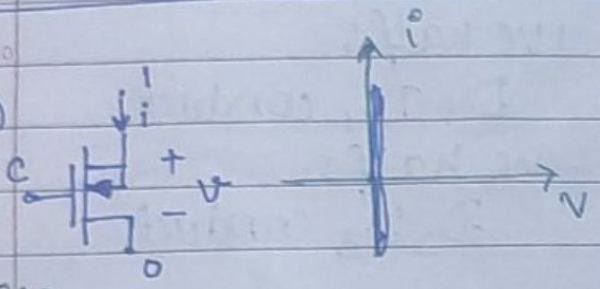
(c)



(d)

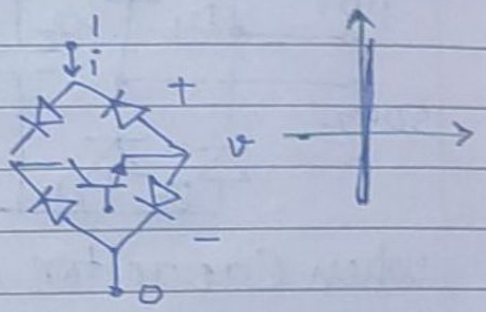


(e)

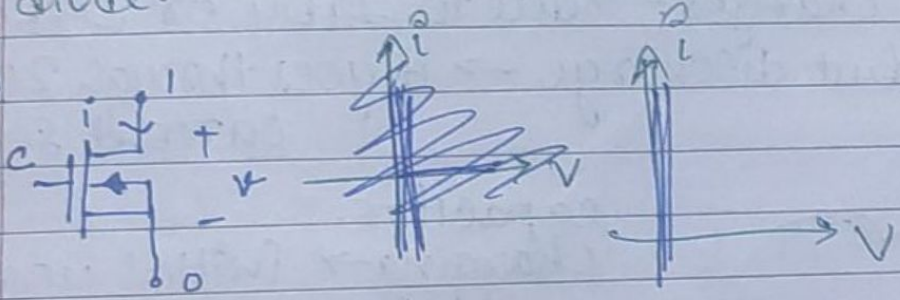


intrinsic body diode.

(f)



(g)



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

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

$R_{\theta ca} = 0.5^\circ C/W \quad T_a = 40^\circ C, \; T_s = ?$

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

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

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

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

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

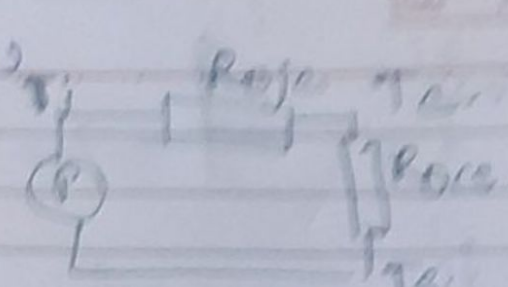
Q2.

(b) $T_{j\,max} = 125^\circ C$

$R_{\theta jc} = 0.16^\circ C/W$.

$R_{\theta cs} = 0.08^\circ C/W$.

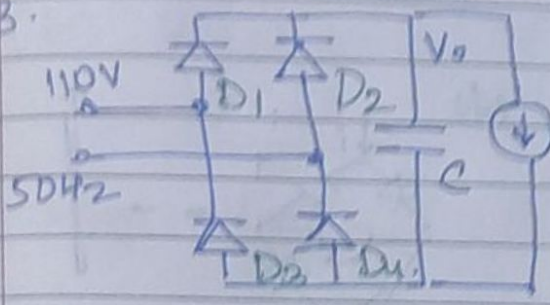
$T_s = 70^\circ C$.



$$P_{loss} = \frac{T_{j\,max} - T_s}{R_{\theta jc} + R_{\theta cs}}$$

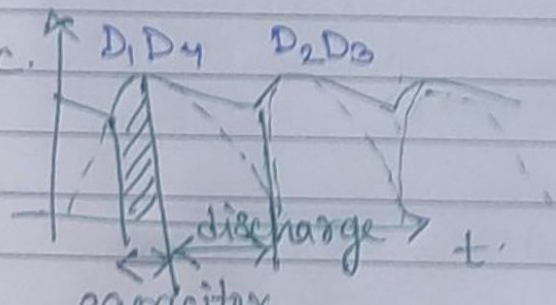
$$(b) = \frac{125 - 70}{0.16 + 0.08} = \frac{55}{0.24} = 229.16\,W.$$

Q3.



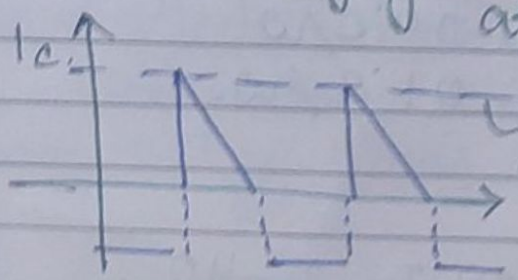
+ve half:
D_1, D_4 conduct.
-ve half:
D_2, D_3 conduct.

When Capacitor charges: → due to D_1D_4 or D_2D_3.
but discharge → it goes through 20A current source.

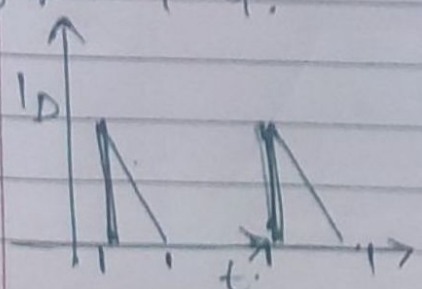


capacitor charging → initial current very high.
at sudden voltage change → finally 0.

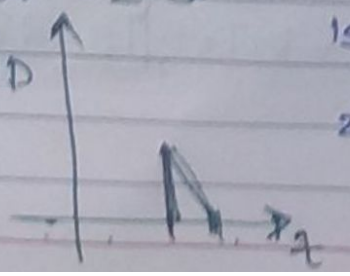
discharging → current constant at −20A.



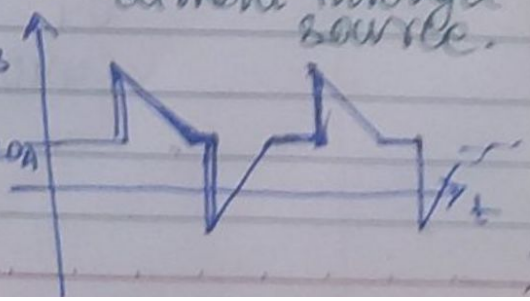
I_D for D_1D_4.



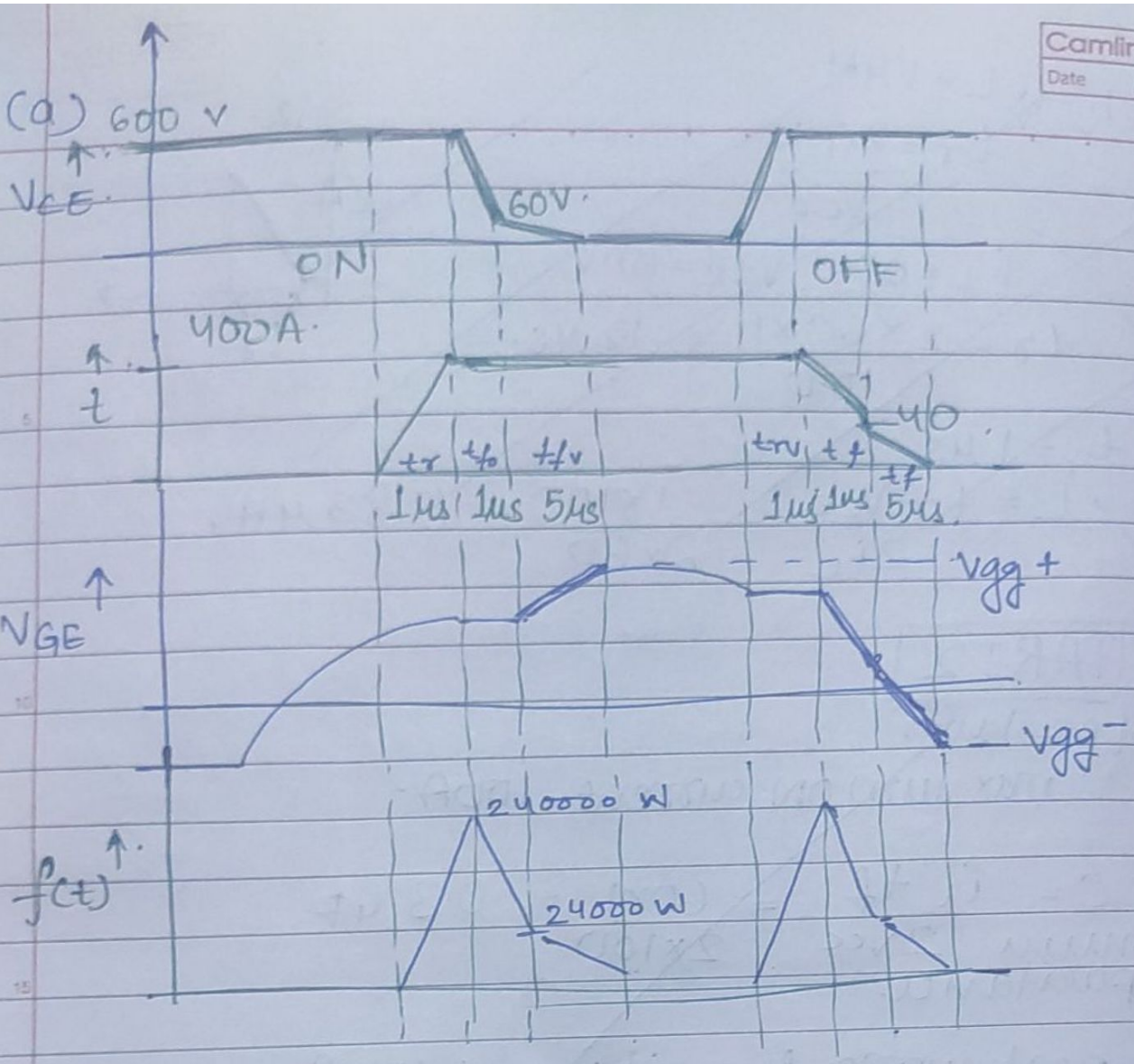
I_D for D_2D_3.



current through source.



Q4. (a)



Q4 (b). $P_{peak} = 240kW$

$$P_{avg} = \frac{1}{7}\left(\frac{1}{2}(240000) + \frac{1}{2}(264000) + \frac{1}{2}\times 5 \times 24000\right)$$

$$= 44.57\ kW. = P_{ON} = P_{OFF}$$

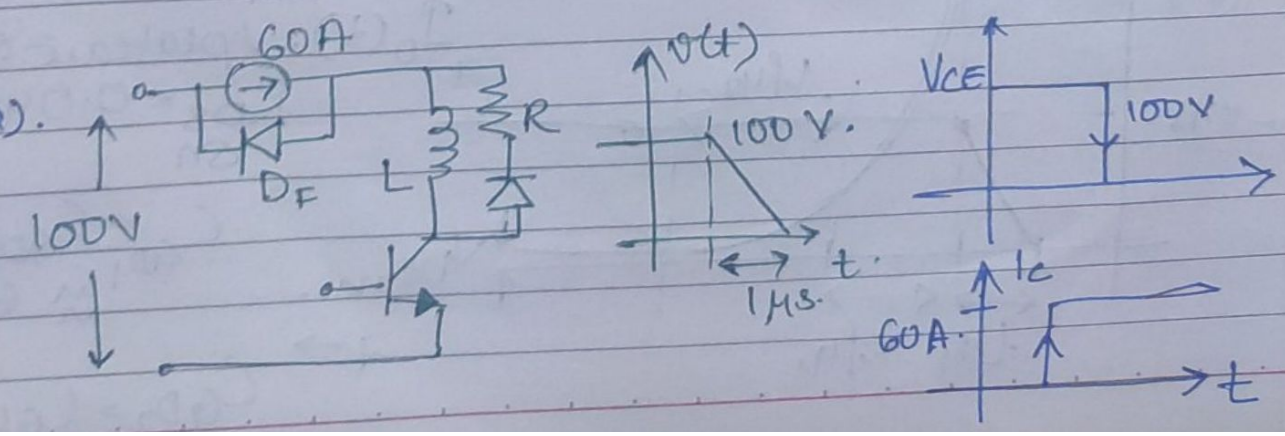
$\frac{P_{ON}+P_{OFF}}{2}$

(c) energy during 1_{ON-OFF} angle $= 312000\ \mu J.$

avg switching power loss $= 2 \times 312000\ \mu J \times 10^3$

$= 624\ W.$

Q5 (a).



Q4 (c) for switching freq.

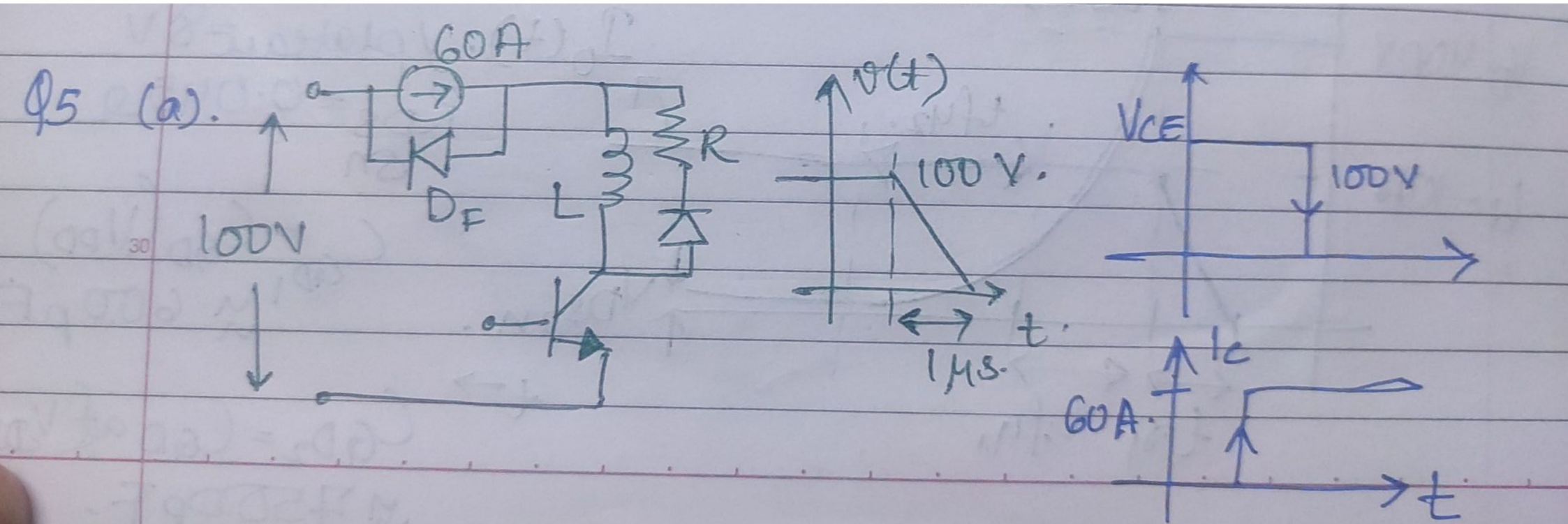
$P_{ON} = E_{ON} f_s$

$= \left[\frac{1}{2} 240 * \frac{1}{2} (240+24) + \frac{1}{2} 245 \right]$

$P_{ON} = \underline{312 \text{ kJ}}.$

$P_{OFF} = E_{OFF} f_s \Rightarrow \underline{312 \text{ kJ}}.$

Q5 (a).

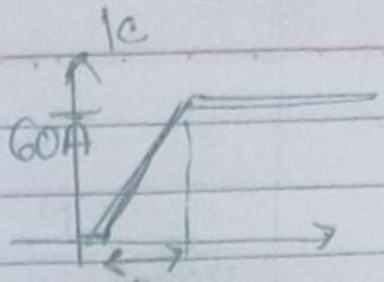


Q5 (b) $\Rightarrow L = 1\,\mu H$.

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

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

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



(c) $t_r = 1\,\mu s$

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

Q5 Part 2.

$I_L = i_c + i_{capacitor}$

$I_{cap} = I_c - I_L$

$= -I_L\left(1 - \frac{t}{tf}\right) + I_L$

$I_{cap} = \frac{I_L t}{tf}.$

$V_{ce} = \frac{1}{C}\int_0^t i_{cap}\,dt.$

$V_{ce} = \frac{i_L t f^2}{2C t f}.$

$C = \frac{60\mu}{2\pi 10^5} = 0.3\,\mu F.$

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

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

$R < 0.67\,\Omega$

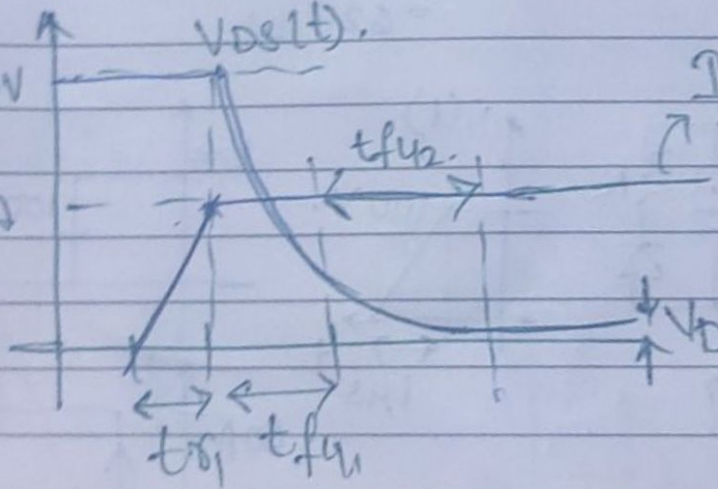
Q6. Turn ON:

$R_G = 1.5\,\Omega$ $I_{d_{ON}} = 10A$

$V_{GT} = 15V$ $V_{DD} = 400V$

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

$R_{DS_{ON}} = 0.045\,\Omega$



$C_{GD_1} = C_{GD}(V_{DD})$

$\approx 600\,pF$

$C_{GD_2} = C_{GD}$ at V_{DS}

$\approx 7500\,pF$.

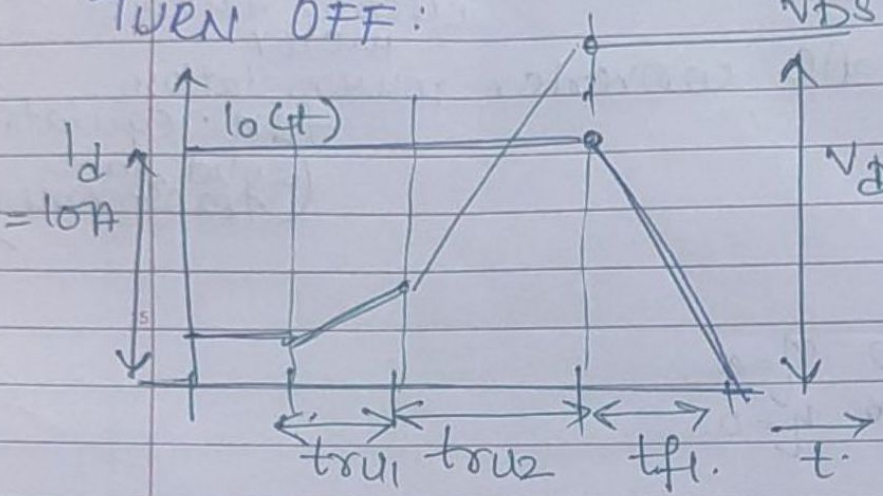
$t_{fu1} = (V_{DD} - R_{DS_{on}} I_{don}) R_G \times \frac{C_{GD1}}{V_{drr} - V_{plateau}}$.

$= (400 - 0.45) \times 1.5 \times \frac{600 \times 10^{-12}}{7} = 17.12\ ns$.

$t_{fu2} = (V_{DD} - R_{DS_{on}} I_{don}) \times R_G \times \frac{C_{GD2}}{V_{drr} - V_{plateau}}$.

$= (400 - 0.45) \times 1.5 \times \frac{7500 \times 10^{-12}}{7} = 642\ ns$

TURN OFF:



$R_G = 1.5\Omega$.
$R_{DS_{on}} = 0.045\Omega$.
$V_d = 400V$. $I_{don} = 10A$
$C_{GD_1} = 600pf$
$C_{GD_2} = 7500pf$
$V_{drr} = 15V$
$V_{plateau} = 8V$.

$t_{ru_1} = (V_{DD} - R_{DS_{on}} I_{don}) R_G \frac{C_{GD1}}{V_{plateau}}$.

$= (400 - 0.045 \times 10) \times 1.5 \times \frac{600 \times 10^{-12}}{8} = 14.76\ ns$.

$t_{ru_2} = (V_{DD} - R_{ds_{on}} I_{d_{on}}) R_G \times \frac{C_{GD2}}{V_{plateau}}$.

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

$= 561\ ns$.