Q1:

[1] Ineria refered to the motor shaft

* Energy converhion equation

$$\frac{1}{2} m V^2 = \frac{1}{2} J_{ref} \, \omega_m^2$$

$$J_{ref} = m \left(\frac{V}{\omega_m}\right)^2 = m \left(\frac{\omega_m r}{\omega_m}\right)^2 = m r^2$$

$$J_{ref} = (1520)(0.62)^2$$
$$= 584.288 \text{ kg.m}^2$$

$$J_{Lref} = \frac{J_{ref}}{\tau^2} \quad \because \tau = \frac{N_2}{N_1} = \frac{1}{7.94}$$

$$= 36835.6 \text{ kg.m}^2$$

$$J_{tot} = J_{Lref} + J_m$$
$$= 36836.92 \text{ kg.m}^2$$

[1]

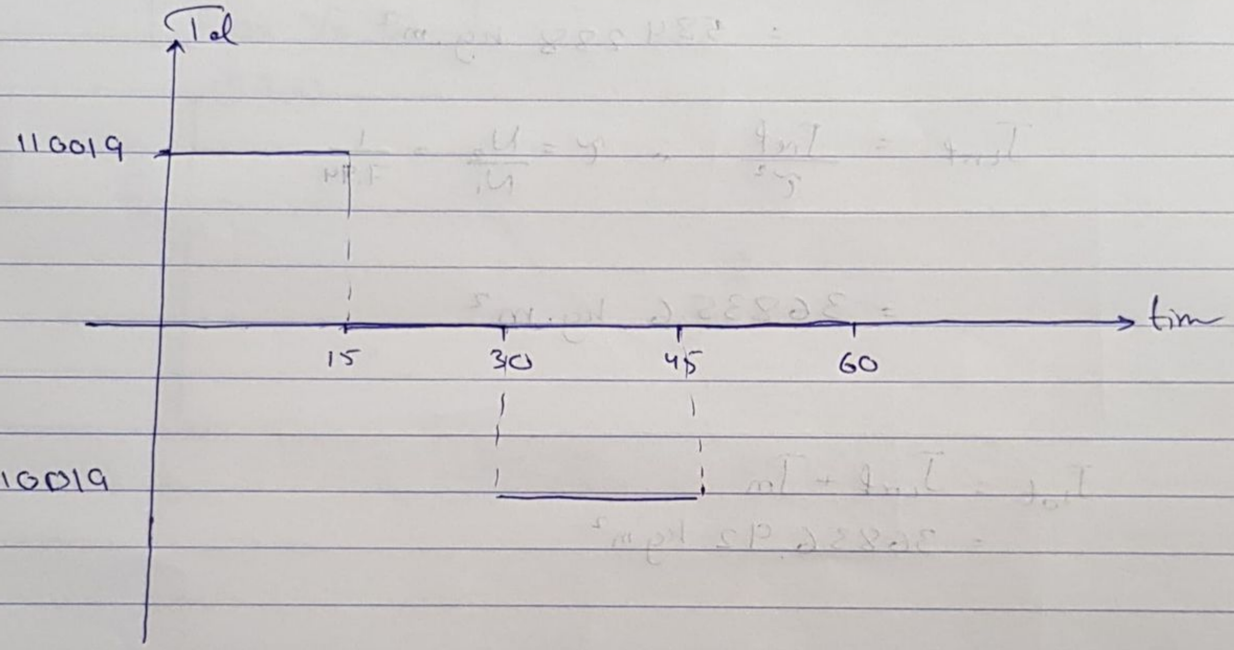
Q1:(b)

The velocity given in km/h it should turn to m/s then to rad/s.

$V(m/s) = 27.778\ m/s$

$\omega = \frac{V}{r} = 44.8$

$T_{el} = T_L + J\frac{d\omega_m}{dt} \quad \because T_L = 0$



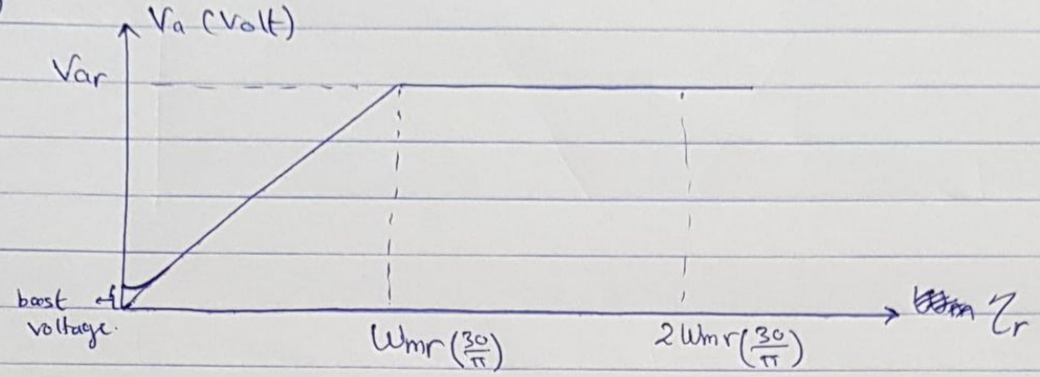
$$T_{eff} = \sqrt{\frac{(110019)^2(15) + (110019)^2(15)}{60}}$$

$= 77795\ N.m.$

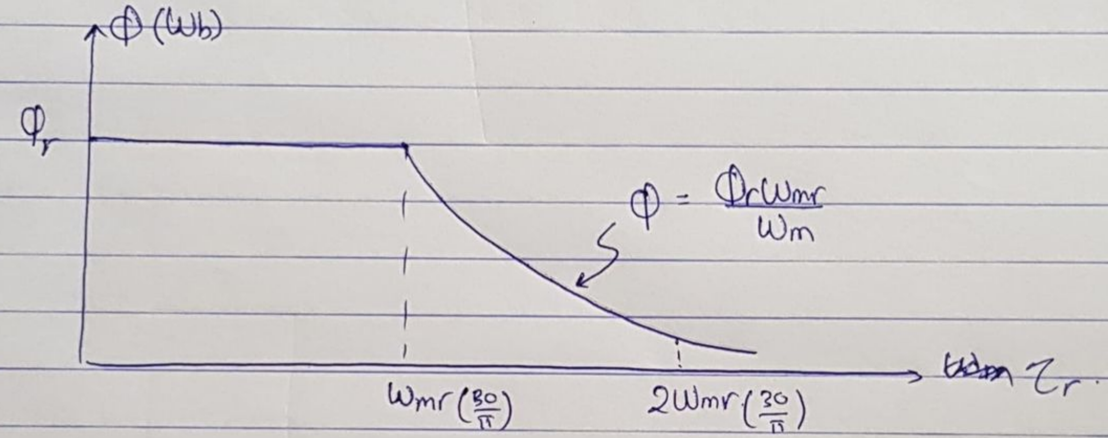
Q2:

Speed range [rpm] = [-2η_r ↔ 2η_r] ⇒

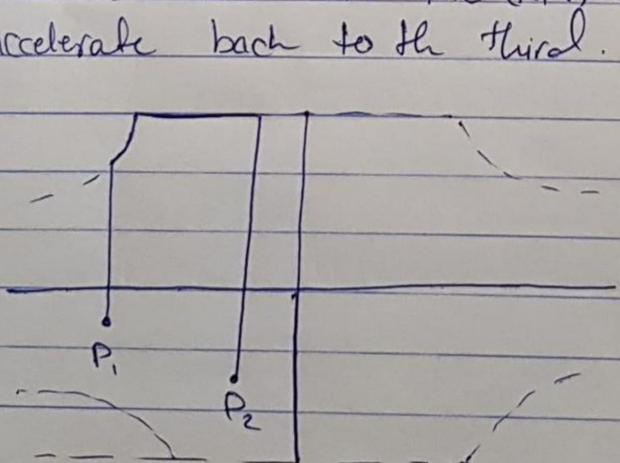
①



[Flux Vs Wm]



② Since point (P_1) is at higher speed than Point (P_2) so, it should move from the (RM)-Quad to the (RR)-Quad then accelerate back to the third.



Q3 :

$V_r = 200$

$\omega_{mr} = \frac{200}{3}\pi$ rad/s $\rightarrow \eta_r = 2000$ rpm

Single phase :

(230 volt rms) , 50 Hz

$R_a = 50 m\Omega$

$k\phi = 0.0975 \frac{V}{rpm}$

b) The rated current

$e_{a\,rated} = (k\phi)\,\omega_{mr} \Rightarrow (k\phi)\,\eta_r$ since $(k\phi) = \frac{V}{rpm}$

$= (0.0975)(2000)$

$= 195$

$V_r = R_a I_{ar} + e_{ar}$

$200 = (50m)\, I_{ar} + 195$

$I_{ar} = 100$ A

c) rated torque & rated power.

① $T_r = (k\phi)\, I_{ar}$ but $k\phi = 0.0975 \frac{V}{rpm} = 0.0975 \times \frac{60}{2\pi} = 0.931 \frac{V}{rad/s}$

$T_r = (0.931)(100)$

$= 93.1$ N.m .

② ~~Par~~ ~~$P_r = V_{ar} I_{ar}$~~ ~~= 20000 W~~

$P_m = e_{ar} I_{ar}$

$= (195)(100)$

$= 19500$ W

d) $V = R_a I_a + (k\phi)\omega_m$.

$$\frac{2V_m}{\pi}\cos(\alpha) = (50m)(10) + 0.0975\, n_m$$

$$\frac{2(230)\sqrt{2}}{\pi}\cos(60) = \frac{500}{1000} + 0.0975\, n_m$$

~~$n_m = 918.27$ rpm.~~ $n_m = 1056.78$ rpm

~~$\omega_m = 96.1$ rad/s.~~ $\omega_m = 110.66$ rad/s

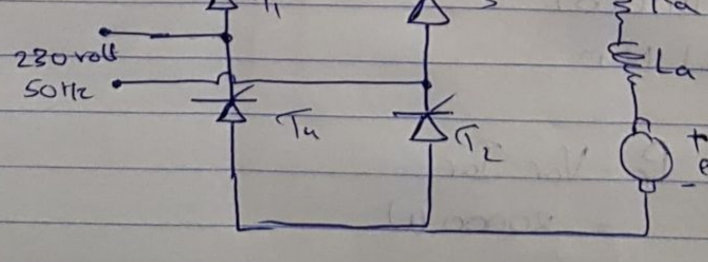
e) $$\frac{2(230)\sqrt{2}}{\pi}\cos(\alpha) = (50m)(100) + (0.0975)(2000)$$

~~cos(α) ...~~

$$\cos(\alpha) = \frac{200}{\frac{460\sqrt{2}}{\pi}} = 0.9658$$

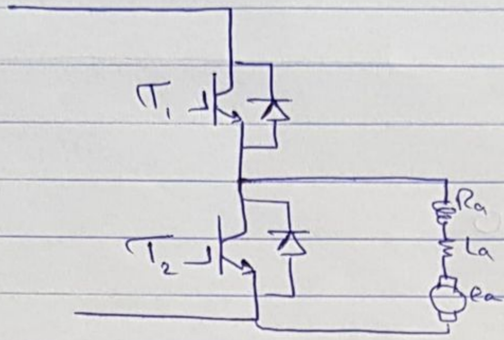
$\alpha = 15.027°$

a) Drive Circuit:

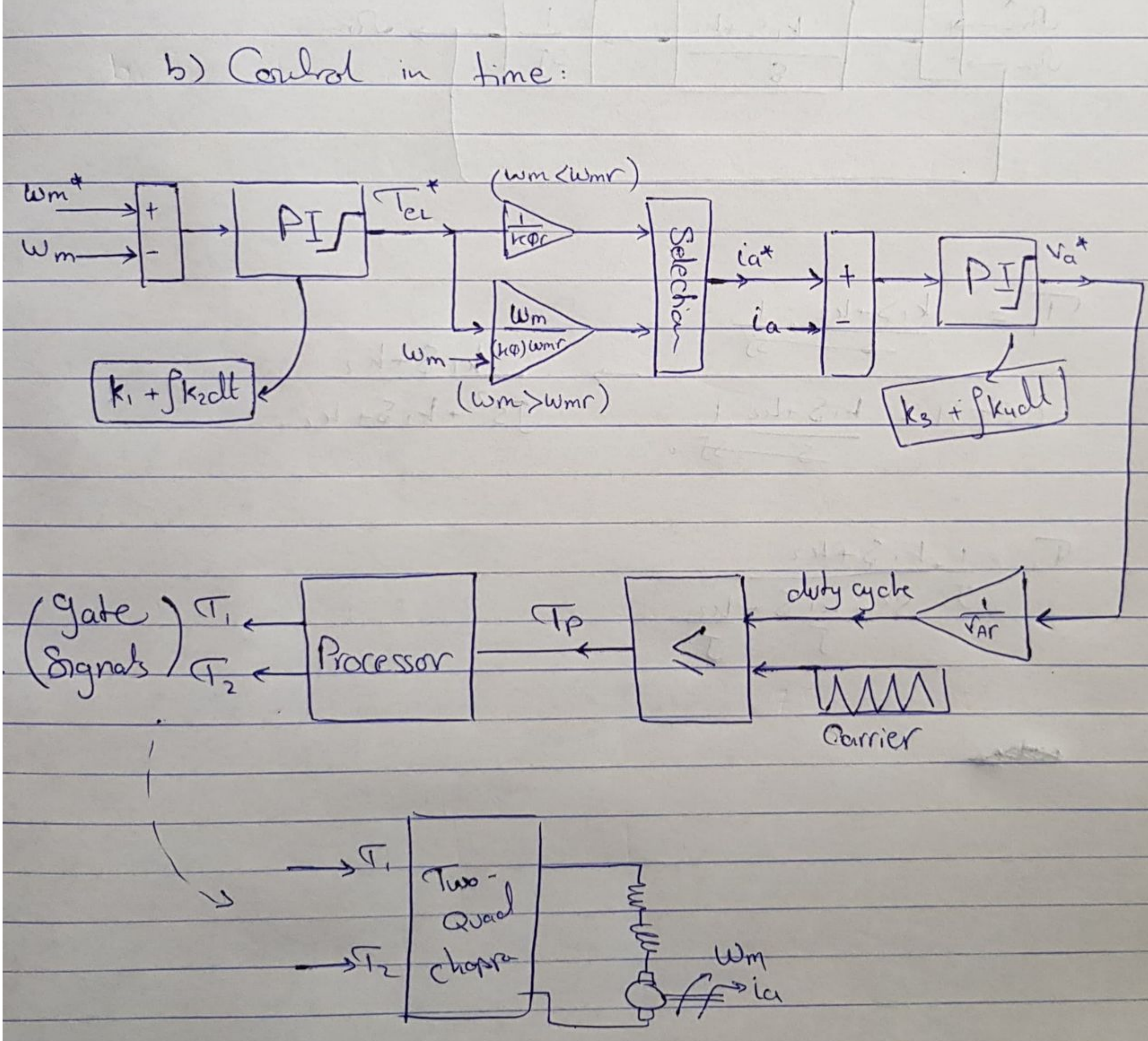


Q4:

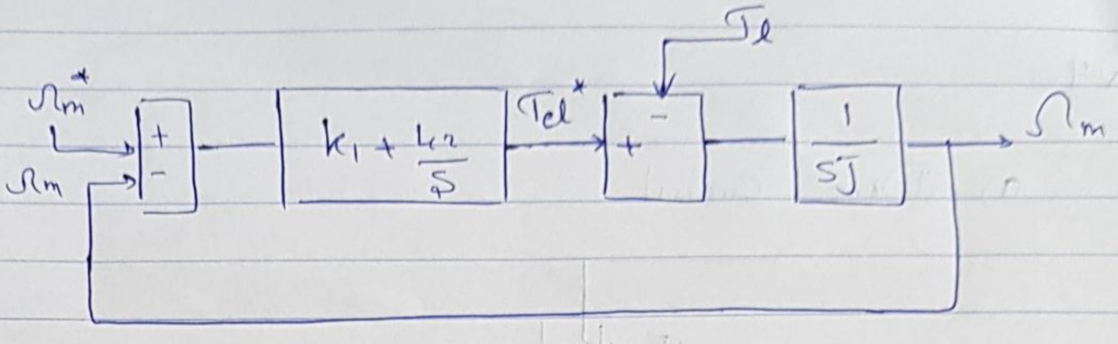
a) Drive circuit.



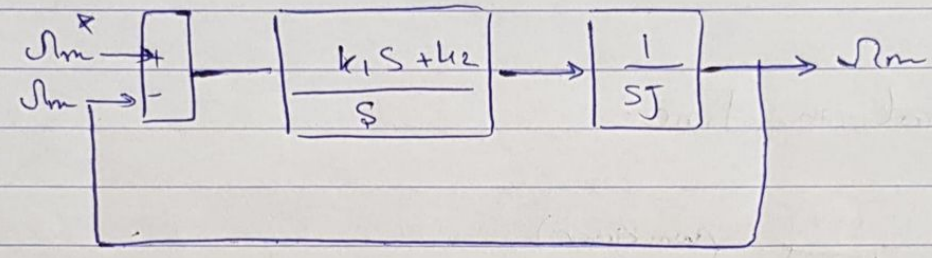
b) Control in time:



c)



d) When $T_1 = T_l = 0$



$$T_1 = \frac{\frac{k_1 S + k_2}{S} \cdot \frac{1}{SJ}}{(s^2 J)\,1 + \frac{k_1 S + k_2}{S} \cdot \frac{1}{SJ}} \rightarrow \frac{k_1 S + k_2}{J S^2 + k_1 S + k_2}.$$

$$T_1 = \frac{1}{J} \cdot \frac{k_1 S + k_2}{S^2 + \frac{k_1}{J} S + \frac{k_2}{J}}$$

e) For Forward motoring.

$T_p = T_1$