إستخدام القوى الكهربية

Utilization

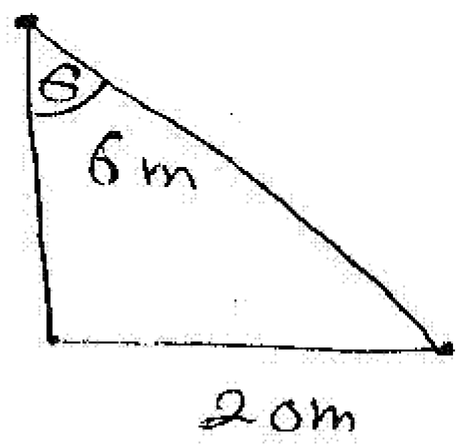
4 th electric power

June 2010

Dr. Jehan Shazly

Q(1 - 2)

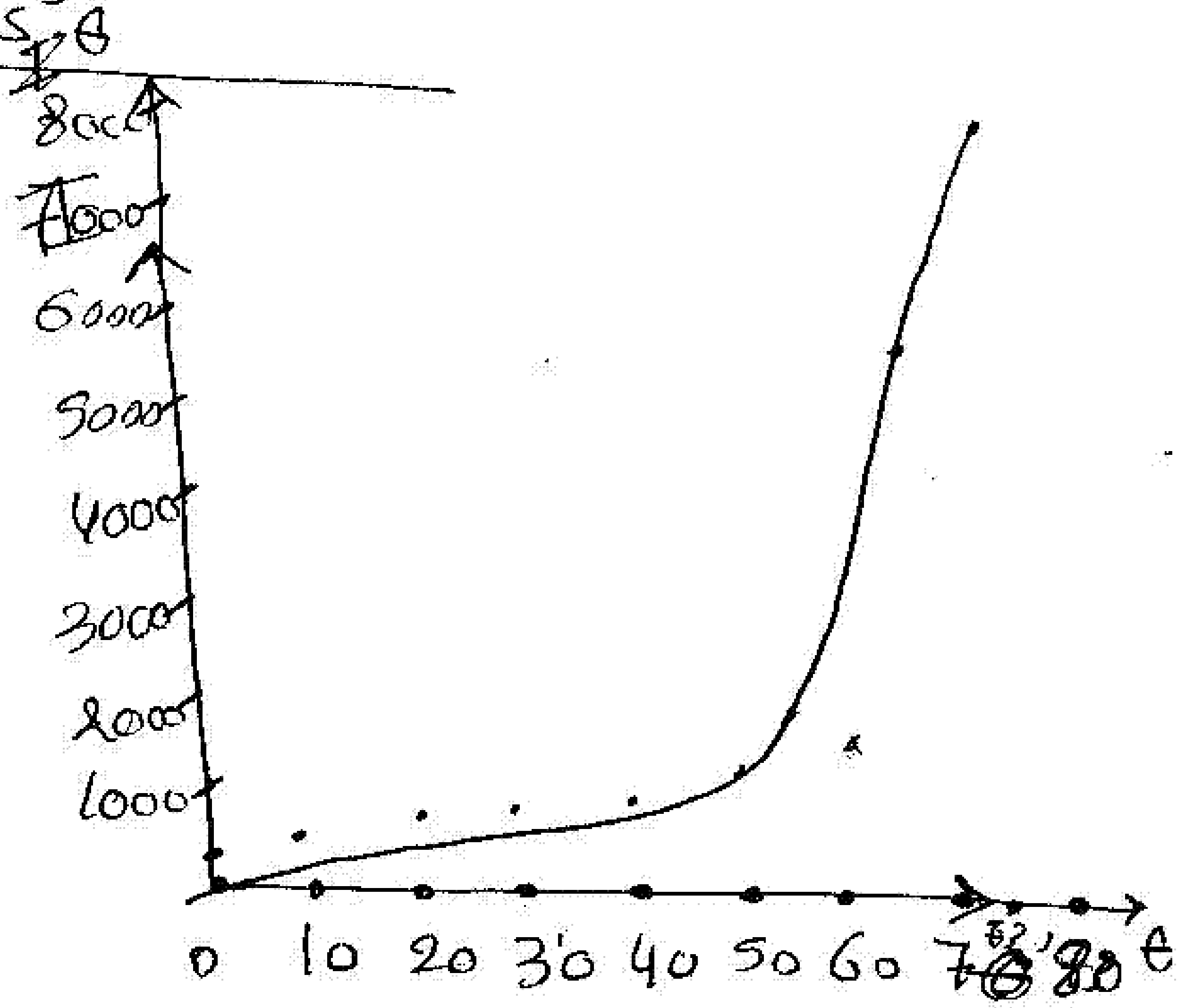
1. $E = \frac{I}{h^2} \cos^3\theta$



$5 = \frac{I}{(6)^2}\left[\cos \tan^{-1}\frac{20}{6}\right]^3$

$\theta_{max} = \tan^{-1}\left(\frac{20}{6}\right) = 73.3$

θ	$I = Eh^2/\cos^3\theta$
0	180
10	188.5
20	217
30	277
40	400.4
50	677.7
60	1440
70	4499
73.3	7586



Q(1-4)

$\phi_{w.p} = E * area$
$= 400\ lux * 35 \times 15 = 210000\ lm$

$\phi_{lamps} = \frac{\phi_{w.p} \times D.f}{u.f} = \frac{210000 \times 1.35}{0.6} = 472500\ lm$

$\phi_{lamp} = 100\ \frac{lm}{w} \times 45\ w = 4500\ lm$

$n_{lamps} = \frac{\phi_{lamps}}{\phi_{lamp}} = \frac{472500}{4500} = 105\ lamps$

$h = 4m$
$n \simeq 100$ lamps
$n \simeq 20 \times 5$

$S/h|_L = \frac{35/20}{4} = 0.43$
$S/h|_W = \frac{15/5}{4} = 0.75$ — bad ratio

using luminares

$S/h|_L = \frac{35/n_1}{4} = 1 \longrightarrow n_1 = 8.75$

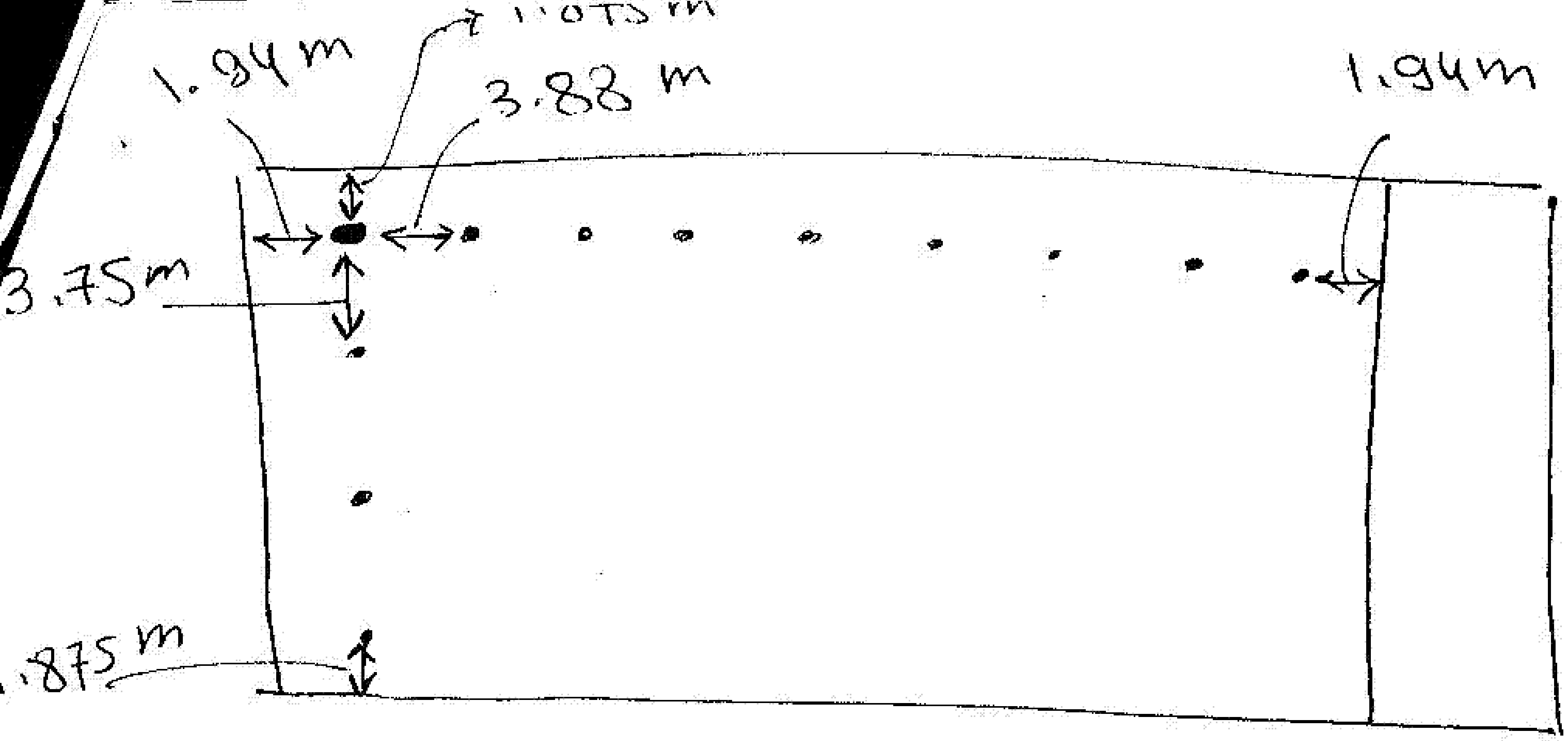
$S/h|_W = \frac{15/n_2}{4} = 1 \longrightarrow n_2 = 3.75$

each luminare has $= \frac{105}{8.75 \times 3.75} = 3.2 \simeq 3$ lamps

number of luminares $= \frac{105}{3} = 35$ lum.
$\simeq 36$ lum
$= 8 \times 4$

$S/h|_L = \frac{35m/9}{4} = 0.97$
$S/h|_W = \frac{15/4}{4} = 0.937$ — good ratio

use 36 lum. each has 3 lamps.



Q(2) lighting = 18KW

Sockets = 12KVA

7 motors 3-ph 380V 0.8pf $\eta = 70\%$

<u>light</u>

$$I_{1\phi \text{ rated}} = \frac{18 \times 10^{3}\, w}{220\, V \times 1 \rightarrow pf} = 81.82\, A$$

no. of circuits = $\frac{81.82}{5\,A}$ = 17 circuits

C.B = 10 A → Cable 3 X 1.5 mm^2 or 3 X 2 mm^2 1ϕ

Sockets

$$I_{1\phi} = \frac{12 \times 10^{3}\, VA}{220V} = 54.5\, A$$

no. of circuits = $\frac{54.5}{8\,A}$ = 7 circuits

C.B = 16 A → Cable 3 x 4 mm^2 1ϕ

motor 10hp

$$I_{rated\ ph} = \frac{10 * 746}{\sqrt{3} * 380 * 0.8 * 0.7} = 20.24\ A/ph$$

$I_{st} > 4 * I_{r_{ph}} = 4 \times 20.24 = 81\ A$

C.B = 100 A

Cable > $(2 \times 1.25 * I_{rated}) = 51\ A$

$5 * 6\ mm^2$ 3ϕ

or $4 * 6\ mm^2$ 3ϕ

---

motor 7.5 hp:

$$I_{rated} = \frac{7.5 \times 746}{380\sqrt{3} * 0.8 \times 0.7} = 15.18\ A/ph$$

$I_{st} > 4 * 15.18 = 60.72 \rightarrow CB = 63\ A$

Cable > $(2 \times 1.25 * 15.18) = 38\ A$

$5 \times 4\ mm^2$ 3ϕ

---

motor 5hp

$I_{rated} = 10.12\ A/ph$

$I_{st} > 40.48\ A \longrightarrow CB = 50\ A$

Cable > $25.3\ A \longrightarrow$ Cable $= 5 * 2.5\ mm^2$ 3ϕ

C.B & Cable for light & sockets.

$I_{rated} = \frac{17 \times 5 + 7 \times 8}{3ph} = 47$ A/ph

$CB > (1.25\ I_{rated}) = 58\ A \rightarrow$ **60 A**

$cable > (2\ I_{C.B}) = 2 \times 60 = 120 A$

Cable $3 \times 25\ mm^2$ 3ϕ

C.B & Cable for group of motors

$I_{rated\ motor\ group} = 1.25 * 20.24 + 0.75(20.24 + 2 \times 15.18 + 3 * 10.12)$

$= 86.02$ A/ph

$cable > (2\ I_{rG.M}) = 172\ A \rightarrow$ **$5 * 50 mm^2$ 3ϕ**

$I_{st\ Group of motors} = 4 * 20.24 + 0.75 (20.24 + 2 \times 15.18 + 3 \times 10.12)$

$= 141.68$

CB = 150 A

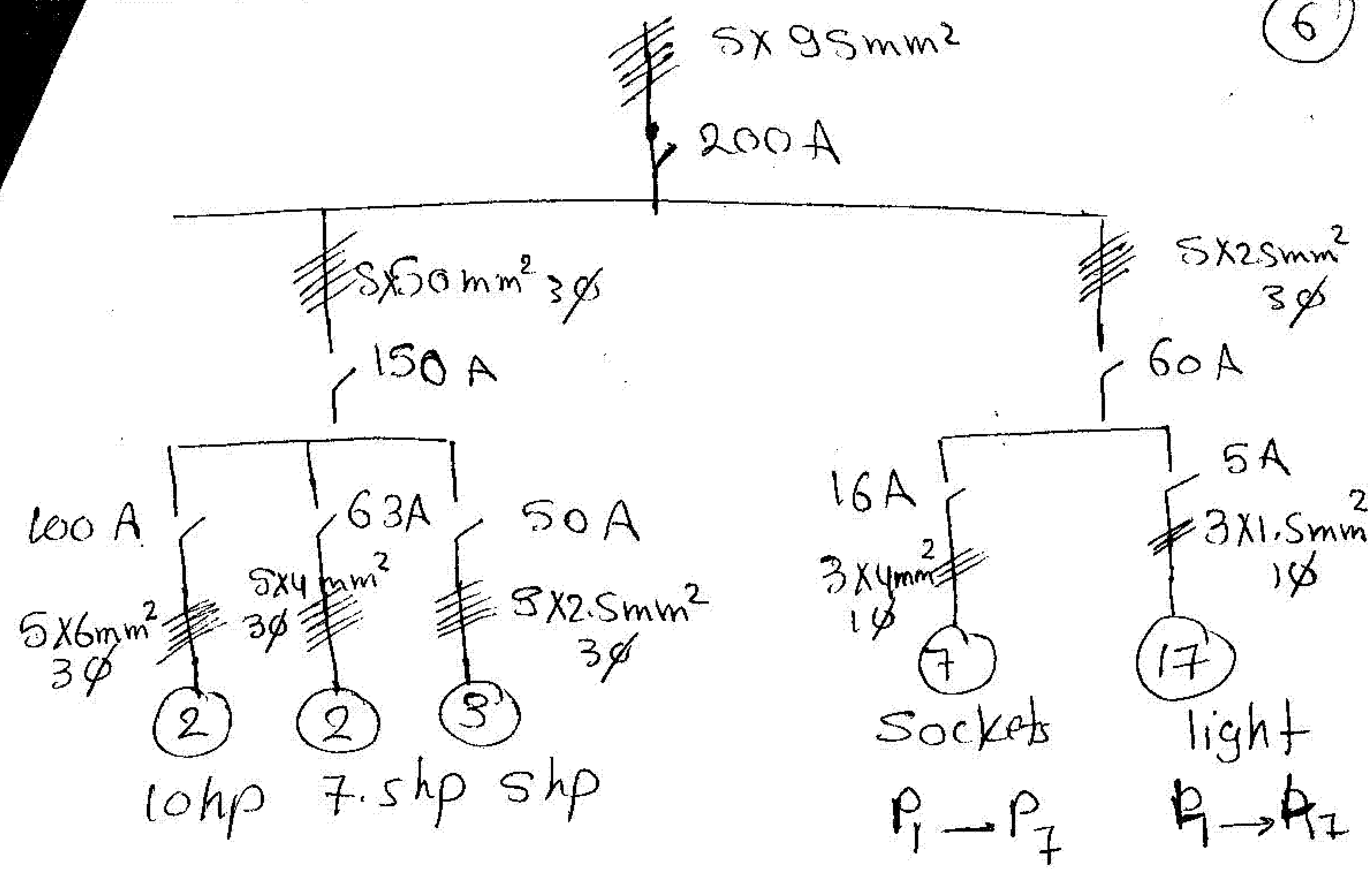
for the faculty

$I_{rated\ total} = 86.02$ A/ph $+ 1.25 (47$ A/ph$) = 145$ A/ph

$cable > 2\ I_{rated\ tot} = 290$ A/ph $=$ **$3 \times 95 mm^2$ 3ϕ**

$I_{st\ total} = 141.68 + 1.25 * 47 = 200.43$ A/ph

CB = 200 A or 250 A



Phase balance

loads	PhA	PhB	PhC
light	$L_1 - L_6$ 6X5A	$L_7 - L_{12}$ 6X5A	$L_{13} \rightarrow L_{17}$ 5X5A
Sockets	$P_1 - P_2$ 2X8A	P_3 P_4 2X8A	$P_5 \rightarrow P_7$ 3X8A
motors 10HP	2 X 20.24	2 X 20.24	2X 20.24
7.5Hp	2 X 15.18	2 X 15.18	2 X 15.18
5 Hp	3 X 10.12	3 X 10.12	3 X 10.12

$l = 150 m$

$I_{rated total} = 145 A/ph$

$V_L = 380V$

Cable = $5 \times 95 mm^2$

Voltage drop = 0.38 mV/A/m

$= 0.38 \times 10^{-3} V/A/m \times 145 A \times 150 m$

$= 8.265 V$

$$VD\% = \frac{8.265 V}{380 V} = 0.0217 = 2.17\%$$

accepted design

(3) $m = 350$ ton

acceleration: $\sin\theta = \frac{1}{300}$ (down) during acceleration

$$\alpha = 5 \text{ km/h/s} = \frac{5 \times 10^3 m}{60 \times 60 \text{ s.s.}} = 1.389 \text{ m/s}^2$$

$$V_1 = V_m = 80 \frac{km}{h} = \frac{80 \times 10^3 m}{3600 s} = 22.22 \text{ m/s}$$

$$\alpha = \frac{\Delta V}{T_1} = 1.389 \text{ m/s}^2 = \frac{22.22 - 0}{T_1}$$

$T_1 = 16$ sec

coasting $\longrightarrow$ level track

$T_2 = 1$ min $= 60$ sec

braking

$\beta = 3.2$ km/h/s $= \frac{3.2 \times 10^3 \, m}{3600 \, s^2} = 0.89 \, m/s^2$

$m_e = 1.1 m$

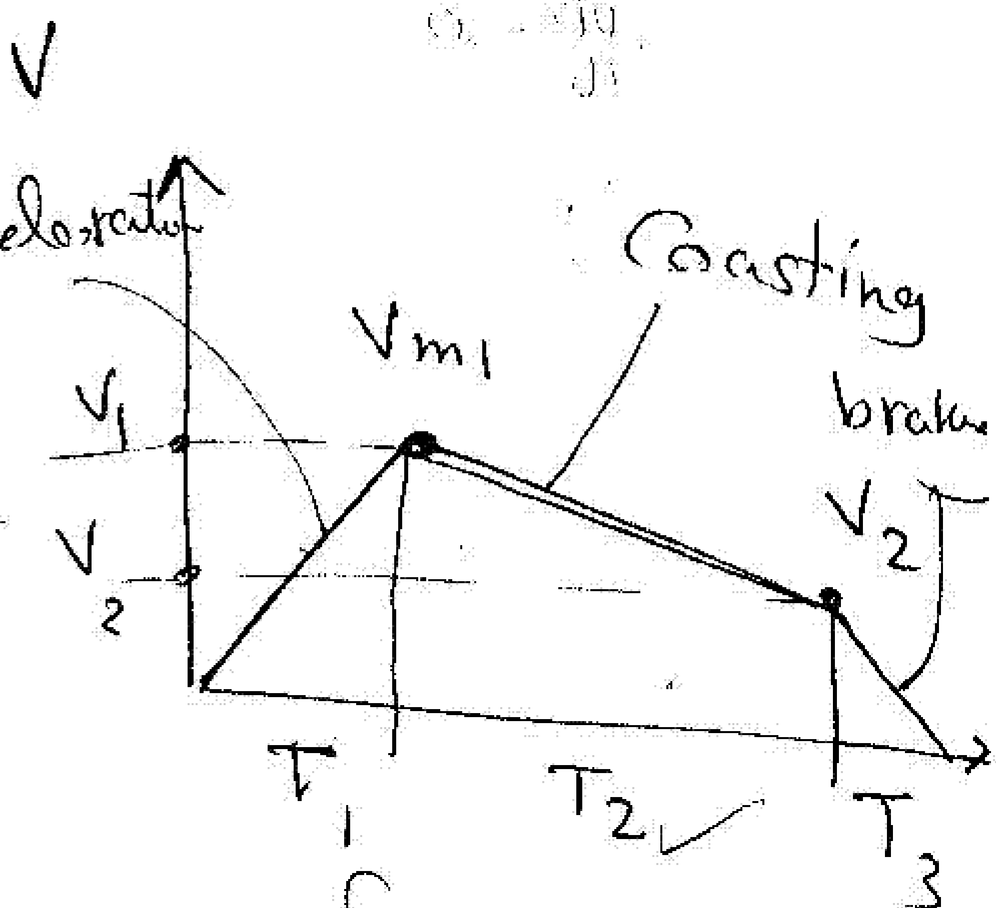
$r = 5 \frac{kg}{ton}$

$T_{stop} = 30$ sec

R// - Vschedule

- SEC.

$V_{sch} = \frac{\text{Distance}}{\text{actual time} + T_{stop}}$



---

during accleration

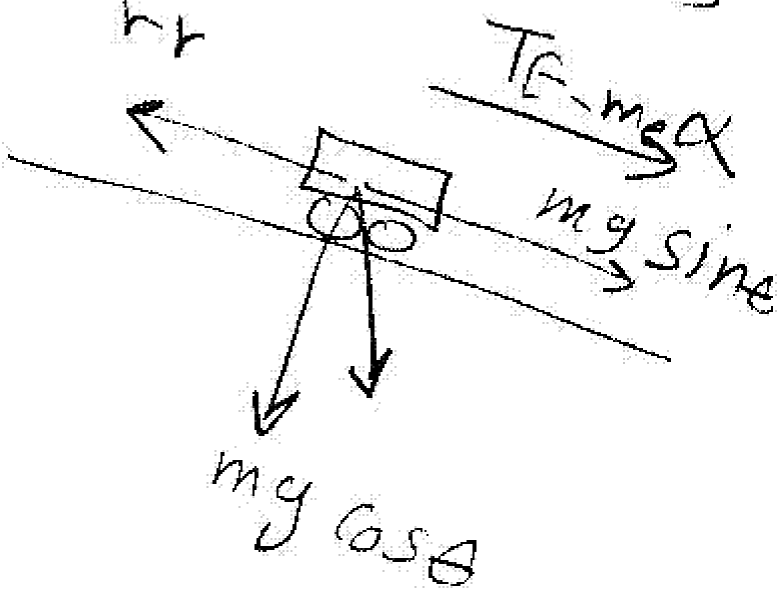
$TE - m_e\alpha + mg\sin\theta = F_r$

$TE - 1.1 * 350 \times 10^3 * 1.389 \frac{m}{s^2}$

$+ 350 \times 10^3 * 9.8 m/s^2 * \frac{1}{300}$

$= 5 \frac{kg}{ton} * 350 ton * 9.8 m/s^2$

$TE_1 = 535231.67$ N

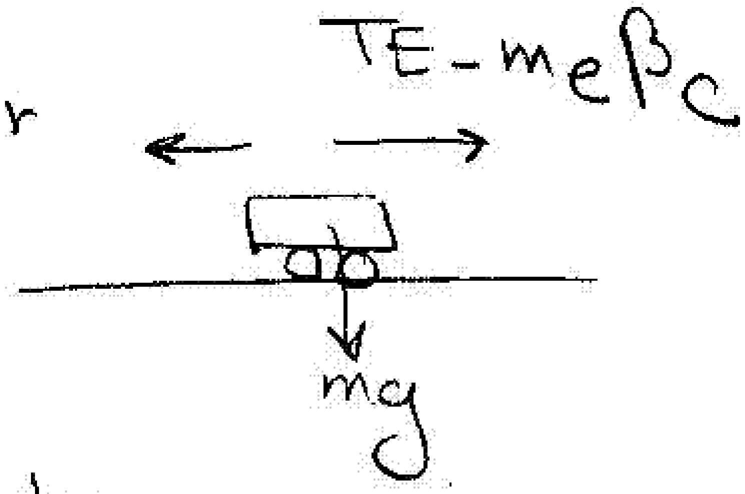


Coasting

$$\beta_{coasting} = \frac{V_1 - V_2}{T_2}$$

$$=$$

TE = 0 during coasting



$$TE - m_e \beta_C = f_r$$

$$0 - 1.1 * 350 \times 10^3 * \beta_C = 5 \frac{kg}{ton} \times 350 ton \times 9.8$$

$$\beta_C = 0.0445 \ m/s^2 = \frac{22.22 - V_2}{60 sec}$$

$$V_2 = 19.55 \ m/s$$

<u>during braking</u>

$$\beta = \frac{V_2 - 0}{T_3}$$

$$0.89 = \frac{19.55 - 0}{T_3} \longrightarrow T_3 = 22 \ sec$$

$$D_1 = \frac{1}{2} V_1 \times T_1 = \frac{1}{2} * 22.22 * 16 = 177.76 \ m$$

$$D_2 = \frac{1}{2}(V_1 + V_2) T_2 = \frac{1}{2}(22.22 + 19.55) * 60 sec$$

$$= 1253 \ m$$

$$D_3 = \frac{1}{2} V_2 * T_3 = \frac{1}{2} * 19.55 * 22 = 215 \ m$$

$$D_{tot} = D_1 + D_2 + D_3 = 1645 \ m$$

$$V_{sch} = \frac{1645\,m}{16+60+22+30} = 12.85\ m/s$$

$$E_{o/p} = TE_1 * D_1 = 535231.67\,N * 1645\,m$$
$$= 880456097\ J$$

$$SEC = \frac{E_c}{m*D} = \frac{880456097}{\eta\ 350\times10^3\,kg * 1645\,m}$$

$$0.7 \quad = 2.18\ \frac{J}{kg.m}$$
$$0.8 \quad = 1.911$$

(Q4-4) $D = 3m \rightarrow r = 1.5m$ & $l = 4m$

Filled 5 times daily

$$\eta = \frac{H}{H + losses}$$

$$H = mC_p\Delta T = \rho V C_p \Delta T = 750\,\frac{kg}{m^3} * (\pi \times 1.5^2 \times 4) * 5 * 1456\,\frac{J}{kg.c} * (90-30)$$

$$\approx 9262\times10^6\ J$$

$$losses = \frac{6w}{m^2.c} = \frac{6w * (2\pi\times1.5*4)m^2 * (90-30)^\circ c}{m^2.c}$$

$$= 13571.6\ w$$

$$H = \frac{9262\times10^6\ W.S}{24*60*60\ Sec} = 107199\ w$$

$$\eta = \frac{107199}{107199+13571} = 88.76\%$$