Q=1(A)

→ With Some degree of Automation

After Some minutes = L_1, L_2, L_3

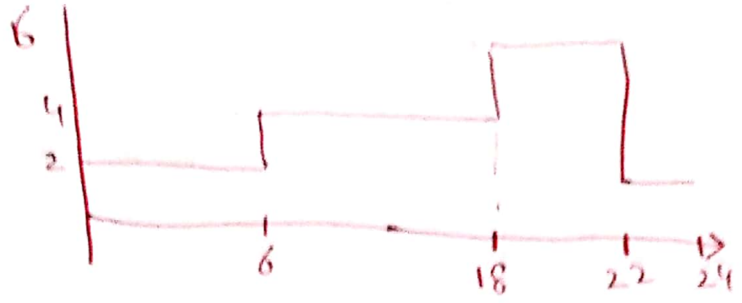
Crew member = L_4, L_5

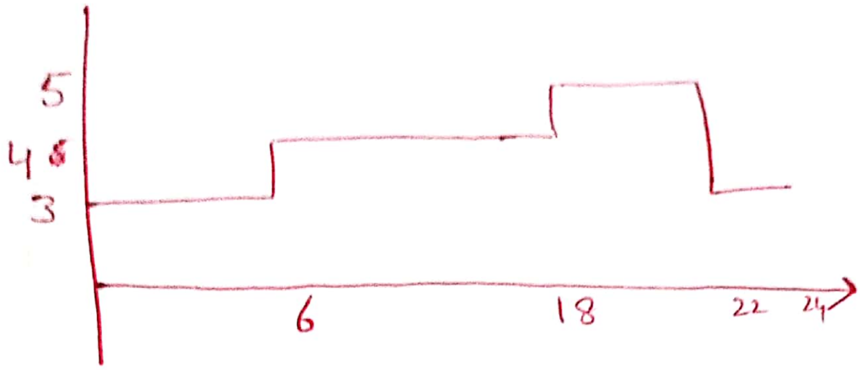
→ With full degree of Automation.

After Some minutes = L_1, L_2, L_4, L_5

Crew members = L_3.

Q-1 (B)





Load (MW)	$I = \frac{P}{(\sqrt{3} \times 33 \times 10^3)}$	Losses $= I^2R$ (KW)
2	34.99	6.09
3	52.48	13.77
4	69.98	24.48
5	87.47	38.25
6	104.97	55.09

Energy losses without DSI.

$$= 8 \times 6.09 + 12 \times 24.48 + 4 \times 55.09$$

$$= 562.84 \text{ Kwh}$$

Energy loss with DSI

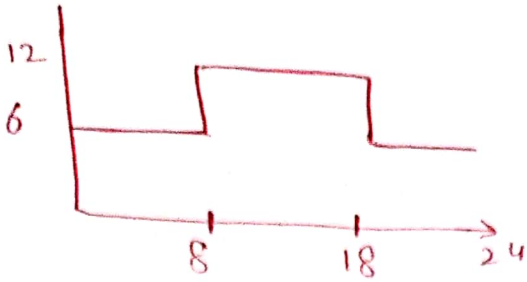
$$= 8 \times 13.77 + 12 \times 24.48 + 4 \times 38.25$$

$$= 556.92 \text{ Kwh.}$$

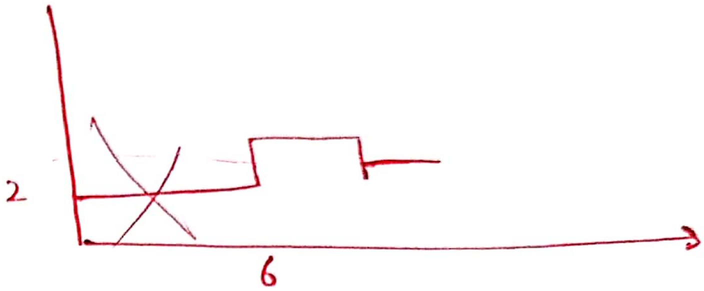
$$\% \text{ Reduction} = \frac{562 - 556.92}{562.84} \times 100$$

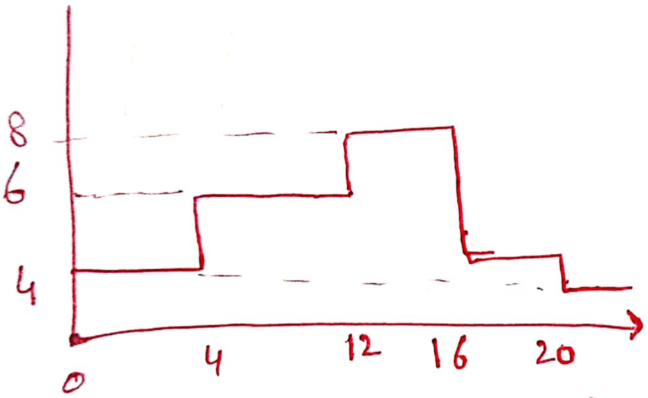
$$= 1.1\%$$

1(c)

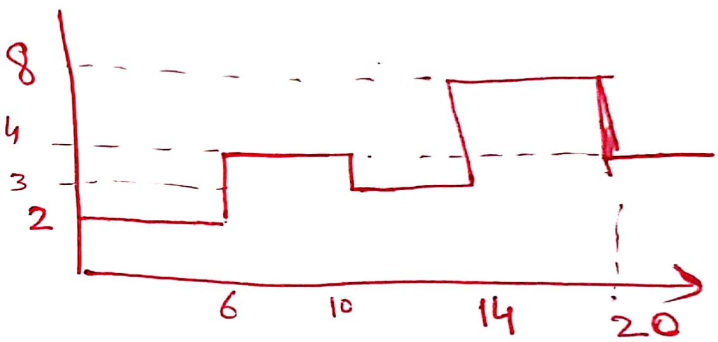


L1



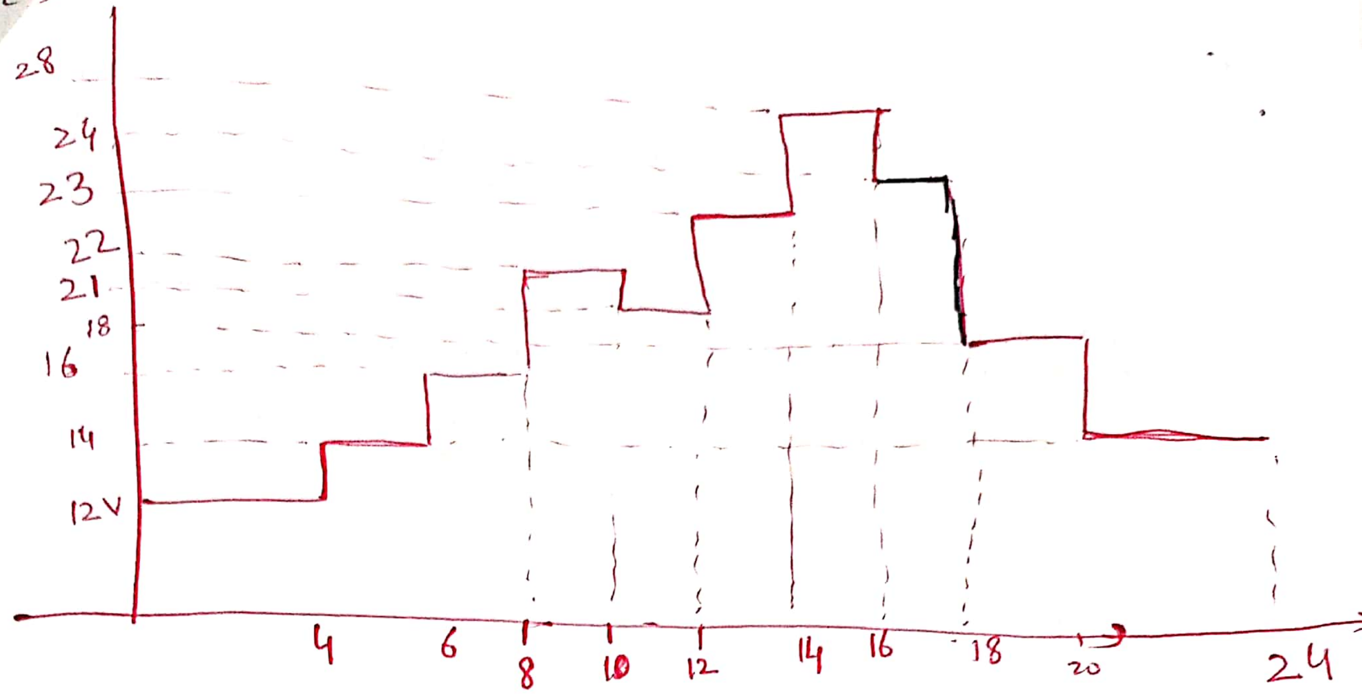


L2



L

1 (c)



⇒ Time Duration:

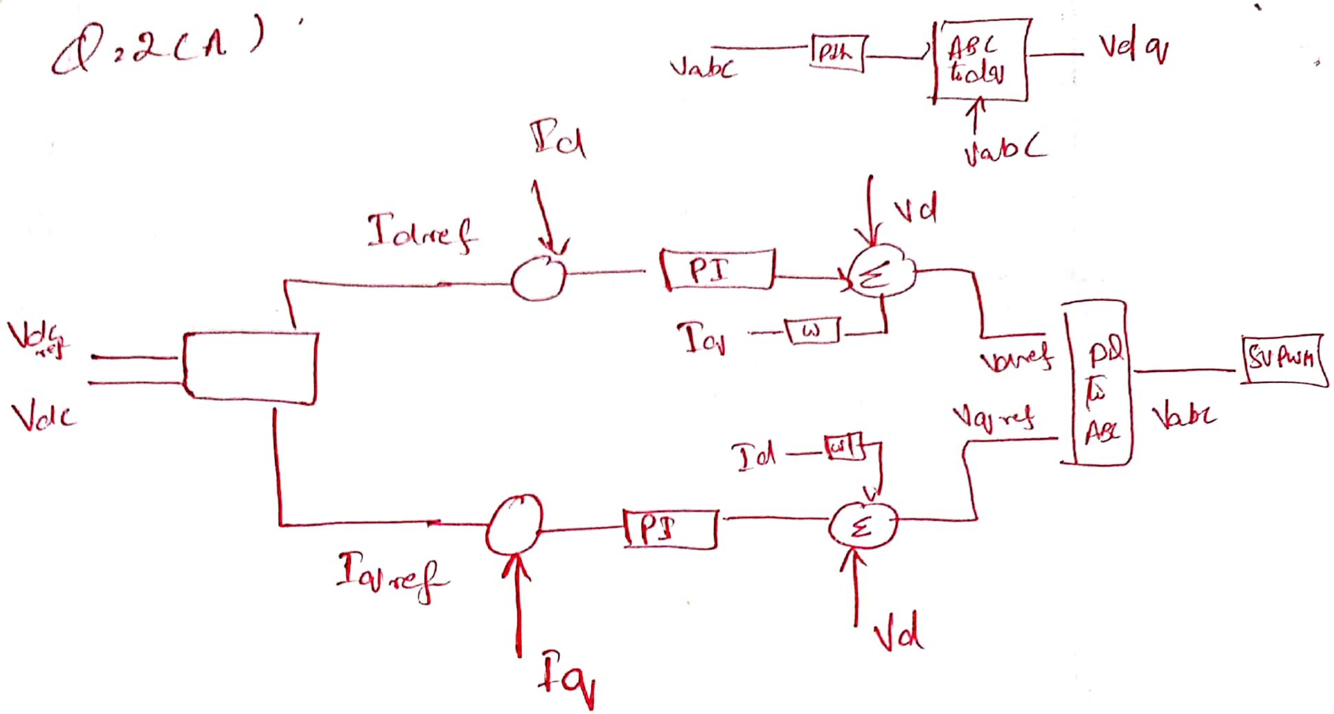
8 – 12 hr ⇒ 4 MVA →

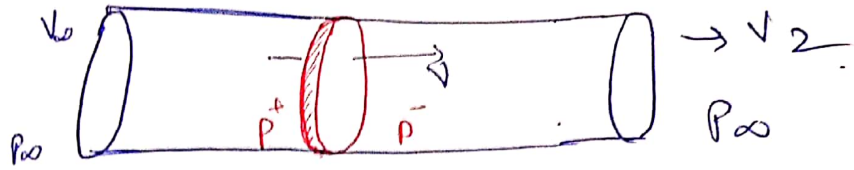
12 – 14 hr ⇒ 6 MVA.

14 – 16 ⇒ (6 + 4) MVA ✓

16 – 18 ⇒ 6 MVA ✓

Q.2(A)


Vabc
Pll
ABC to dq
Vdq
Vabc
Id
Idref
Vd
PI
Σ
Iq
ω
Vdc ref
Vdc
Vdref
dq to ABC
SVPWM
Vqref
Vabc
Id
ω
Σ
PI
Iqref
Vd
Iq



$$\frac{1}{2}\rho V_\infty^2 + \cancel{P_\infty} = \frac{1}{2}\rho V^2 + p^+$$

$$\frac{1}{2}\rho V_2^2 + \cancel{P_\infty} = \frac{1}{2}\rho V^2 + p^-$$

$$p^+ - p^- = \frac{1}{2}\rho\left(V_\infty^2 - V_2^2\right)$$

what Thrust ?

$$T = A\left(p^+ - p^-\right) = \frac{1}{2}\rho A\left(V_\infty^2 - V_2^2\right)$$

⇒ Thrus also change in momentum.

$$T = \dot{m}\left(V_\infty - V_2\right) = \rho A V\left(V_\infty - V_2\right)$$

$$\frac{1}{2}\rho A\left(V_\infty^2 - V_2^2\right) = \rho A V\left(V_\infty - V_2\right)$$

$$\boxed{\frac{1}{2}\cancel{\rho A}\left(V_\infty + V_2\right) = V}$$

Axial Interface factor

a is interference factor

$a = \frac{V_\infty - V}{V_\infty}$

Speed decrease at wind turbine

$$V = V_\infty (1 - a) \quad \ldots (1$$

$$V_\infty (1-a) = \frac{1}{2}(V_\infty + V_2)$$

$$2V_\infty - 2aV_\infty = V_\infty + V_2$$

$$V_2 = V_\infty - 2aV_\infty$$

$$V_2 = V_\infty (1 - 2a)$$

Power extracted.

$$P = \frac{1}{2} \rho A V (V_\infty^2 - V_2^2)$$

$$P = \frac{1}{2} \rho A V_\infty (1-a) \left[V_\infty^2 - V_\infty^2 \{1 - 2a\}^2 \right]$$

$$= \frac{1}{2} \rho A V_\infty^3 (1-a) \left[1 - 1 + 4a - 4a^2 \right]$$

$$P = \frac{1}{2} \rho A V_\infty^3 \left[4a - 8a^2 + 4a^3 \right] \rightarrow (A)$$

$$\cancel{\frac{dP}{da} = \frac{1}{2} \rho A \; 3a^2 - 4a + 1}$$

$$\frac{dP}{da} = 12a^2 - 16a + 4$$

$$12a^2 - 16a + 4 = 0$$

$$\boxed{a = 1, \; 1/3}$$

Put in eq. (A)

$$= \frac{1}{2} \rho A V_\infty^3 \left[4/3 - 8/9 + \frac{4}{27} \right]$$

$$= \underbrace{\frac{1}{2} \rho A V_\infty^3}_{\text{Power contained in Wind}} \times \left[16/27 \right]$$

Power contained in Wind

(B)

$$\left[4a(1-a)^2\right]$$

$a = 1/4$

$$1(3/4)^2 = 9/16 = .56$$

$$\left[4a(1-a)^2\right]$$

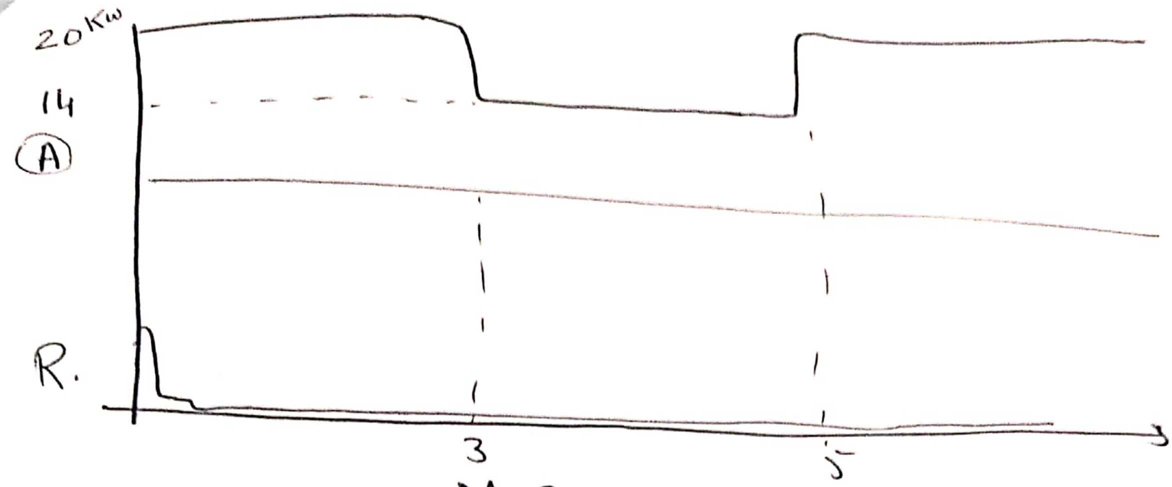
$a = 1/5$

$$4/5\,(4/5)^2 = .512$$

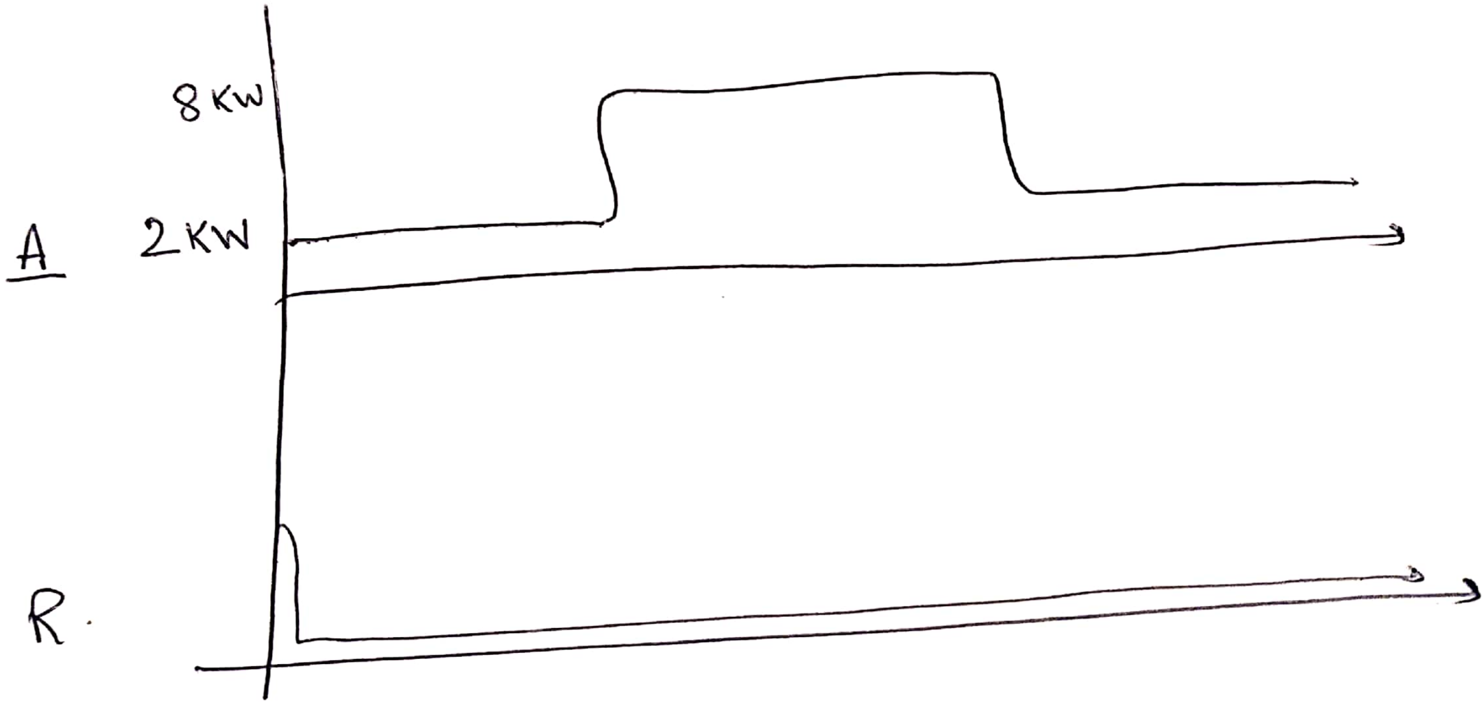
So as $\underline{a}$ value increase

Power cofficent decrease.

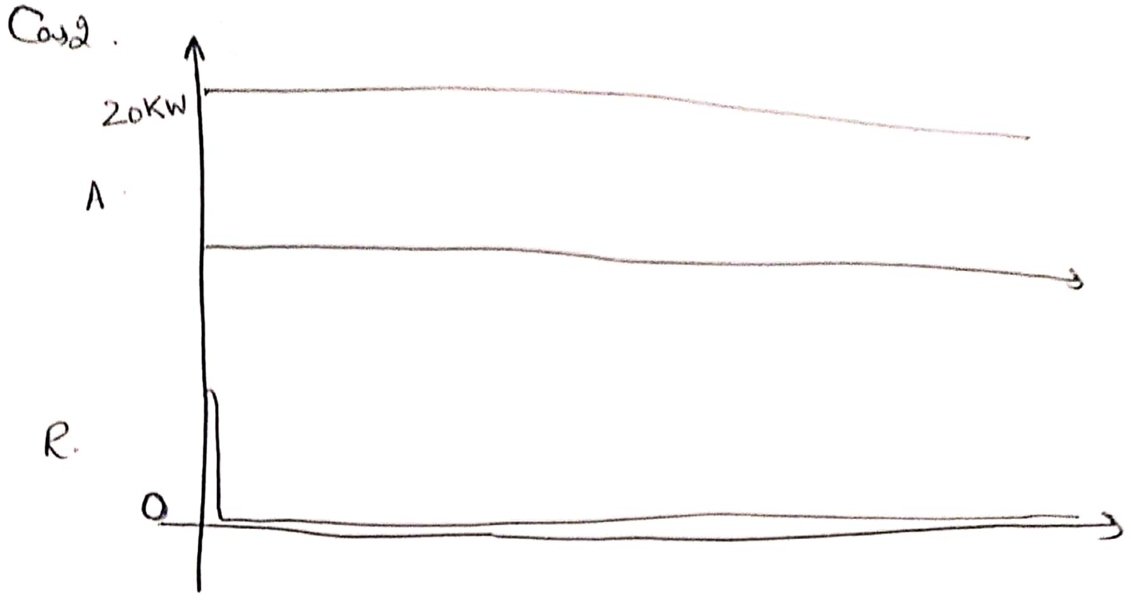
Q-2(C).



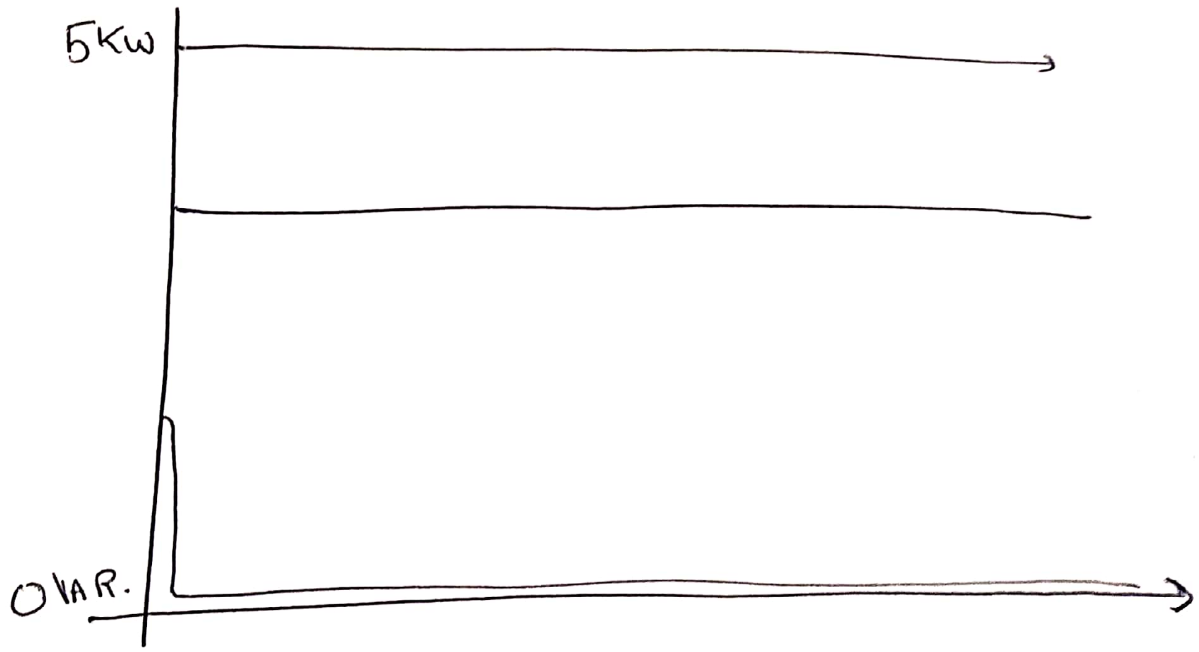
MG.



UG.

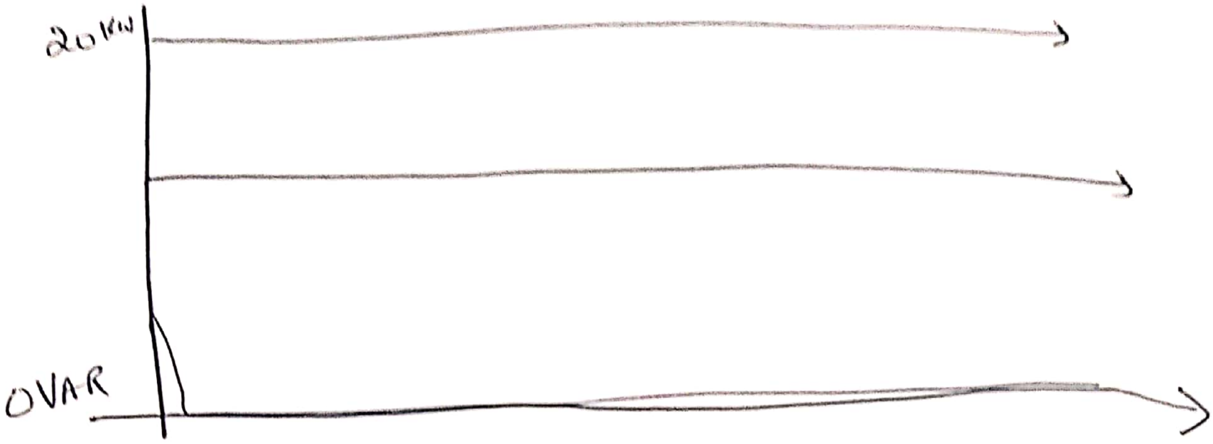


MG

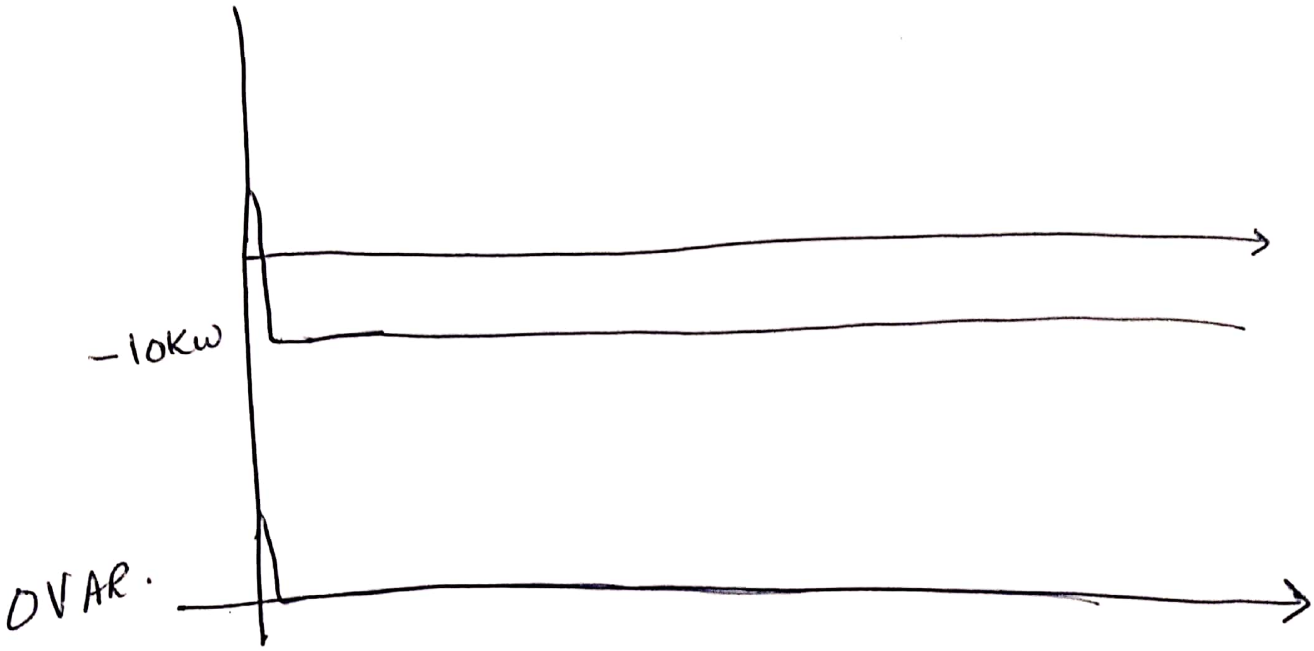


UG

Case 3 :

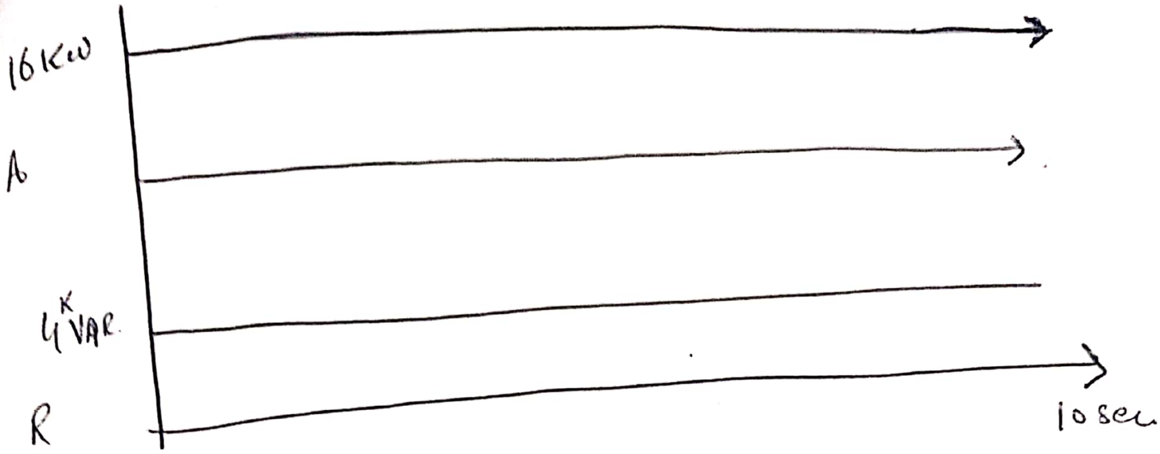


MG .

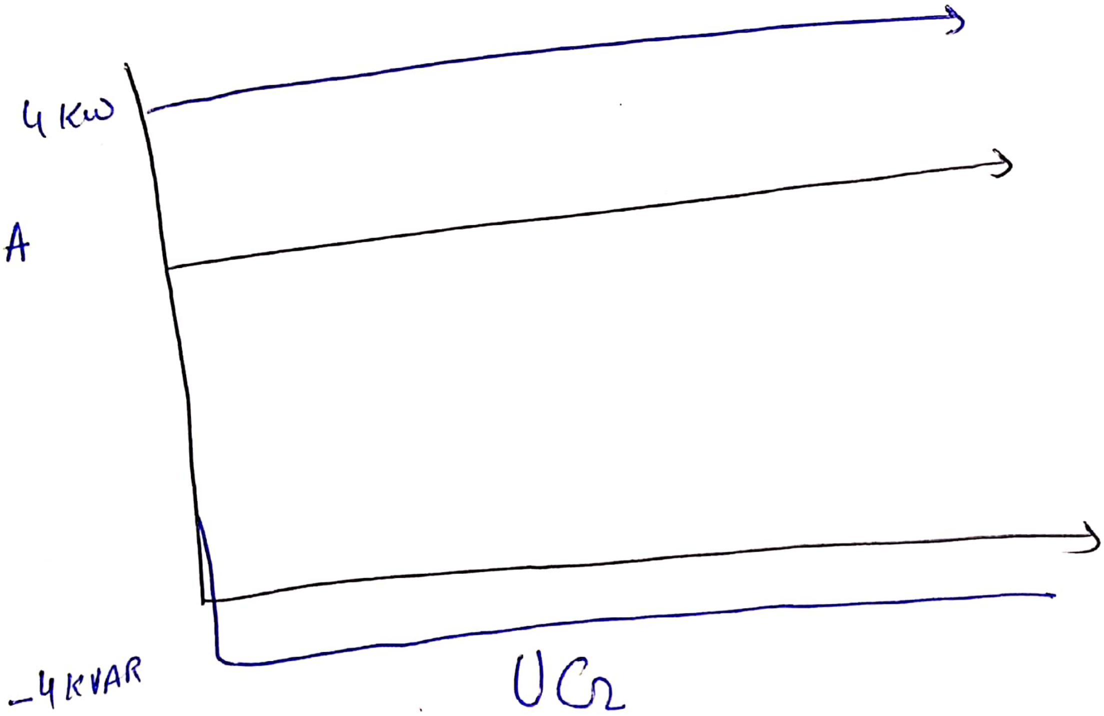


UG .

Case 4: Load is 20 KW:



MG2



UG2