OBOT MKPOUTO OBOT

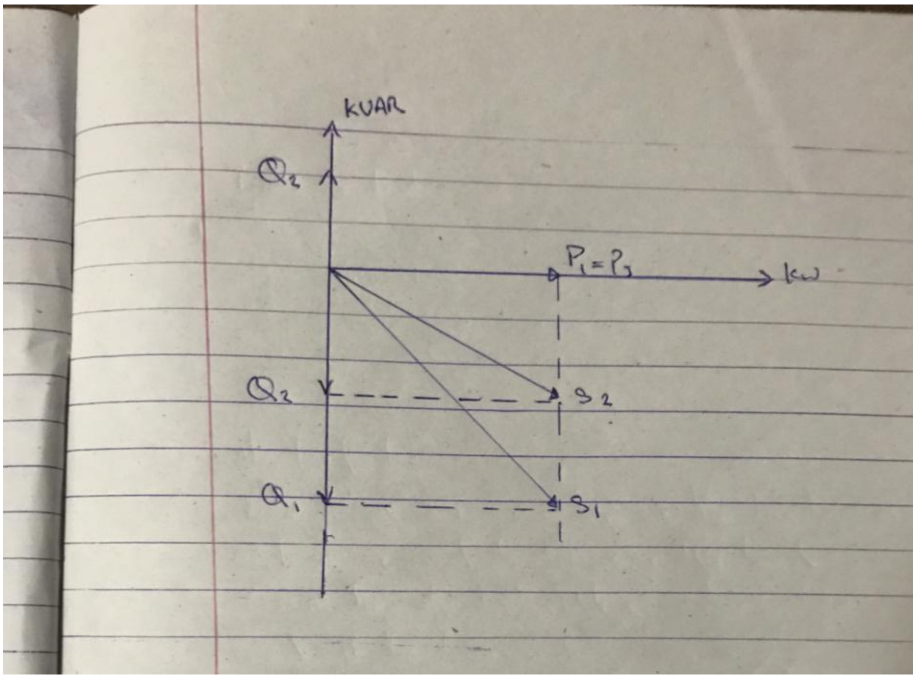
17/ENG04/046

ELECTRICAL/ELECTRONICS ENGINEERING

ELECTRICAL MACHINES ASSIGNMENT(EEE326)

SOLUTION/ANSWERS

1.



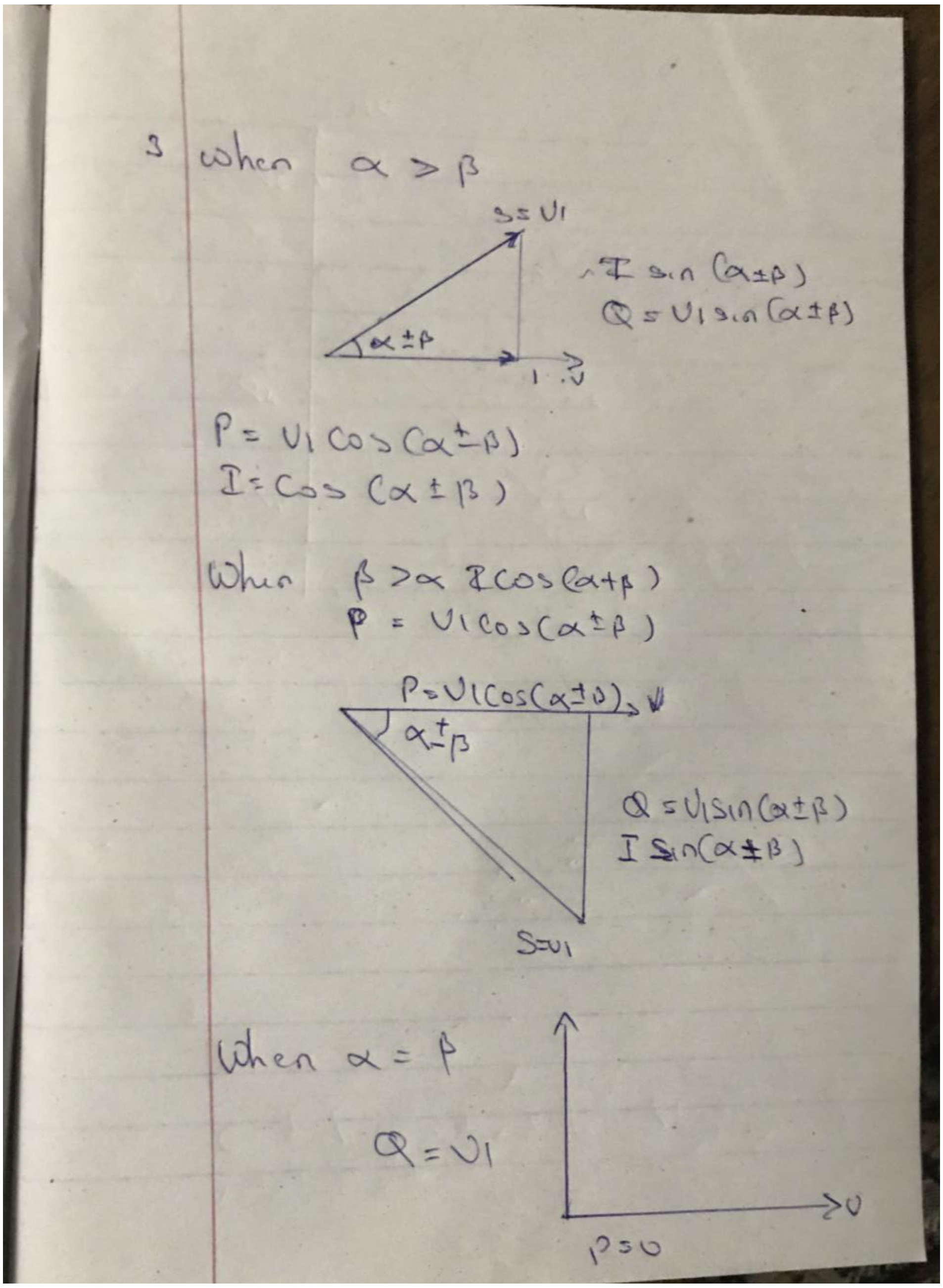
Power factor correction phasor diagram,

2.

The cement plant uses many of the miscellaneous equipment's, which are classifying as non linear loads such as induction motors, transformers and etc.The electrical equipments are absorbing additional currents called '' inductive reactive currents'' he effects of additional current making electrical network inefficient, result of reducing power factor. However, the low power

factor will affect the increases the loads on the power station on the one hand and on the efficiency of the equipment’s capacity of the transformers, sizes of cable and capacity of switchgears on the other hand this in relation to the cement plant. Having said that the power factor is the ratio of real power that is used to work and the apparent power that is supplied to the plant .It has a range value of 0-1.

3.



4.

P = VI cos(α±β)

Q =VIsin(α±β)

P represents active power

Q represents reactive power

5.

- **To improve voltage.**
- **To lower the cost of electric energy when the electric utility rates vary with the power factor at required rates.**
- **To utilise the full capacity of transformers, switches, circuit boards , buses and conductors for active power only to help lower the cost of investment capital and cost.**
- **To reduce the energy loss in conductors.**

6.

Reactive power is required to maintain the voltage to deliver active power(watts) through transmission lines. Motor loads and other loads require reactive power to convert the flow of electrons into useful work.

7.

True power = $0.4 \times 2\times10^6$

$= 2MW$

$\theta_1 = \cos^{-1}(0.4) = 66.42°$;

$\theta_2 = \cos^{-1}(0.85) = 37.79°$;

$\tan \theta_1 = \tan(66.42) = 2.29°$

$\tan \theta_2 = \tan(37.79) = 0.78°$

Required capacitor (C) = $P(\tan\theta_1 - \tan\theta_2)$

$= 2\times10^6 (2.29 - 0.78)$

$= 3020KVAR$

Reactive Power (Q) = $P (\sin\theta_1 - \sin\theta_2)$

$= 2\times10^6 (0.92 - 0.61)$

$= 958KVAR$

8.

Given: $S = 5$ MVA= $5*10^6$ VA , $V_{rms} = 6$ KV

$PF_1 = 40\% = 0.4$, $PF_2 = 85\% = 0.85$, Q=? , C=?

Recall : $\cos\theta = \frac{real\ power, P}{Appatent\ power, S}$, $P = \cos\theta * S$

But PF= $\cos\theta = 0.4$

$P = 0.4 * 5*10^6 = 2,000,000$ W

$\theta_1 = \cos^{-1}(0.4) = 66.421°$

$\theta_2 = \cos^{-1}(0.85) = 31.7883°$

Recall : $Q_1 = P * tan\theta_1$ **=** $S_1\ sin\theta_1$

$Q_2 = P * tan\theta_2$

$Q_c = Q_1 - Q_2$ **= P(** $\tan\theta_1 - \tan\theta_2$ **)**

C= $\frac{Q_C}{W*V_{RMS}^2}$ **where : w= 2**πF $but\ F = 50Hz$

$Q_1 = 2000 * 10^3 * \tan(66.421)$ **= 4582396.473 =4.58MVAR**

$Q_2 = 2000 * 10^3 * \tan(31.78833)$ **=1239488.647 =1.23 *10^6 VAR**

$Q_c =$ **4.58*10^6 - 1.23 *10^6 = 3350000 =3.35* 10^6 VAR**

C = $\frac{3350000}{2\pi*(6*10^3)^2} = 2.96205 * 10^{-4}\ F$

9. True power = 100KW

α = $\cos^{-1}(0.85)$ = 31.79°.

β = $\cos^{-1}(0.95)$ = 18.19°

Tan α = 0.62°

Tan β = 0.33°

Required Capacitor (C) = P (tan α – tan β)

= 100×10^3(0.62 – 0.33)

= 29KVAR

Reactive Power (Q) = P (sinα – sinβ)

= 100×10^3 (0.53 – 0.31)

= 23KVAR

10.

s/n	M_1	M_2
	Given : PF= 0.85, real power, P =20kw, V_L=415	Given : PF= 0.95, real power, P =20kw, V_L=415
1	Apparent power, s required = $\frac{P}{PF}$ = $\frac{20*10^3}{0.85} = 23529.41176\ VA$	Apparent power, s required = $\frac{P}{PF}$ = $\frac{20*10^3}{0.95} = 21052.63158\ VA$
2	$\theta_1 = \cos^{-1}(0.85)$ =31.7883° Reactive power Q_1 =sin $\theta_1 * S$ Q_1 = sin (31.7883) x 23529.41176	$\theta_1 = \cos^{-1}(0.95)$ = 18.1948° Reactive power Q_1 =sin $\theta_1 * S$ Q_1 = sin (18.1948) x 21052.63158

	Q_1 =12394.876 VAR	**Q_1 =6573.656853 VAR**

The induction motor, M_2 is recommended because it has the higher power factor of 0.95 from the above calculation .which is much closer to unity power factor and as such it is more efficient and its reactive power is low compared to that of M_1

Note: the higher the portion of reactive power, the lower the power factor.

It is observed that the reactive power of M_1 is high and as result has a low power factor than that of M_2. Hence it (M_1) is less efficient than M_2.