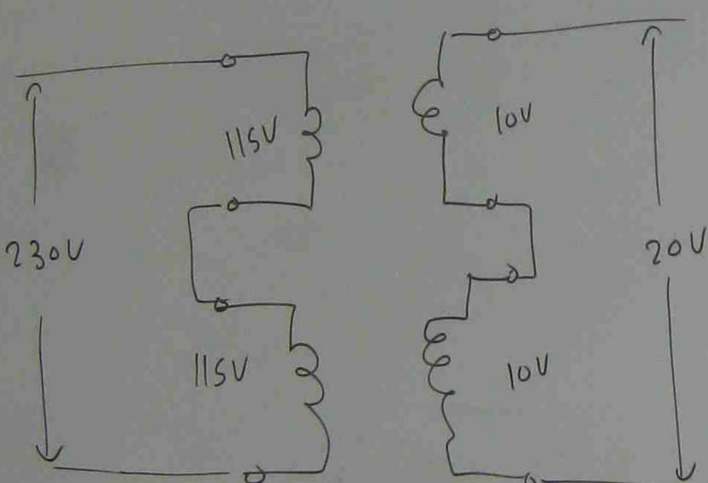
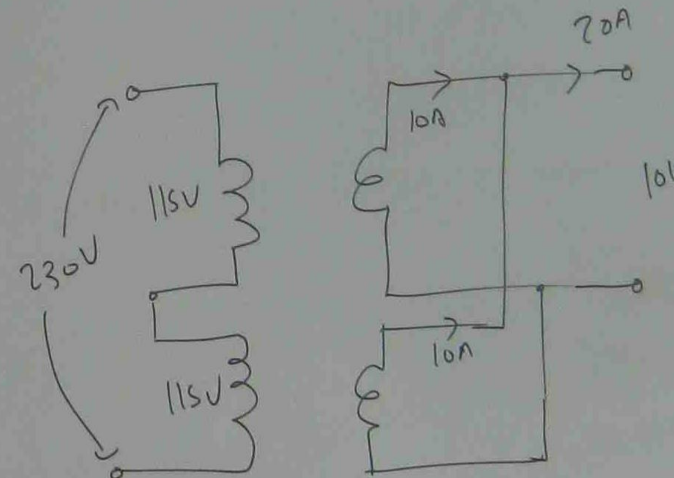
CONNECTING TRANSFORMER WINDINGS IN SERIES AND PARALLEL

TO SUPPLY HIGHER CURRENTS, WINDINGS ARE TO BE CONNECTED IN PARALLEL

TO SUPPLY HIGHER VOLTAGE, WINDINGS ARE TO BE CONNECTED IN SERIES

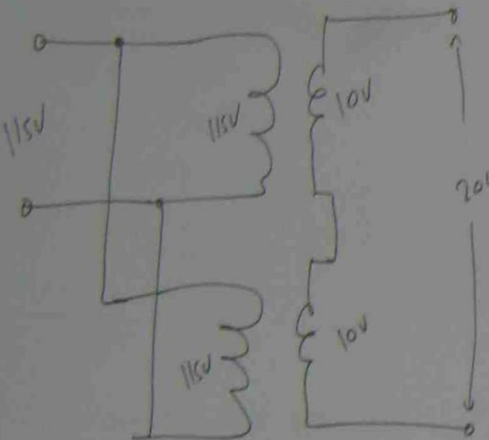


HV & LV COILS IN SERIES

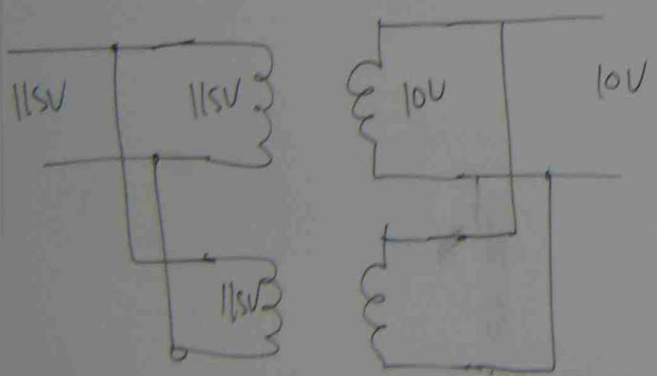


HV COILS IN SERIES

L.V COILS IN PARALLEL

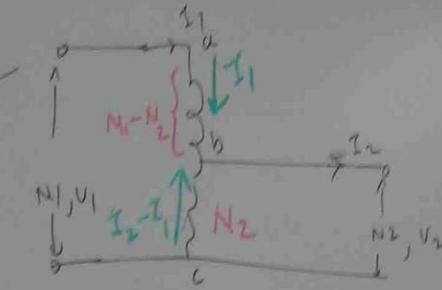


HV coils in PARALLEL, L.V coils in SERIES



HV & L.V COILS IN PARALLEL

pb



PROVE THAT

$$\text{VA RATING OF AUTO TRANSFORMER} = \left(1-\frac{1}{k}\right) \times \text{VA RATING OF 2 WINDINGS TRANSFORMER}$$

$$\text{WHERE} \quad k = \frac{V_1}{V_2} = \frac{N_1}{N_2} = \frac{I_2}{I_1}$$

To OPERATE SMOOTHLY

$$\underset{a \to b}{\text{MAGNETIZING FORCE}} = \underset{b \to c}{\text{MAGNETIZING FORCE}}$$

$$I_1(N_1 - N_2) = (I_2 - I_1)N_2$$

$$I_1 N_1 - \cancel{I_1 N_2} = I_2 N_2 - \cancel{I_1 N_2}$$

$$I_1 N_1 = I_2 N_2 \Rightarrow \frac{I_1}{I_2} = \frac{N_2}{N_1}$$

$$\frac{I_1}{I_2} = k$$

$$\therefore \frac{I_1}{I_2} = \frac{N_2}{N_1} = k$$

) x VA RATING OF 2 WINDINGS TRANSFORMER

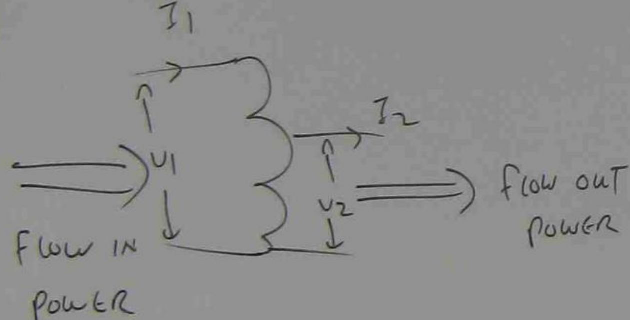
V.A RATING OF AUTO TRANSFORMER

TOTAL V.A RATING OF AUTO TRANSFORMER = $VA_{a\to b} + VA_{b\to c}$

$$= I_1(V_1 - V_2) + (I_2 - I_1)V_2$$

$$= V_1 I_1 - V_2 I_1 + V_2 I_2 - V_2 I_1$$

$$= V_1 I_1 + V_2 I_2 - 2V_2 I_1$$



Flow in power = Flow out power

$$V_1 I_1 = V_2 I_2$$

Thus

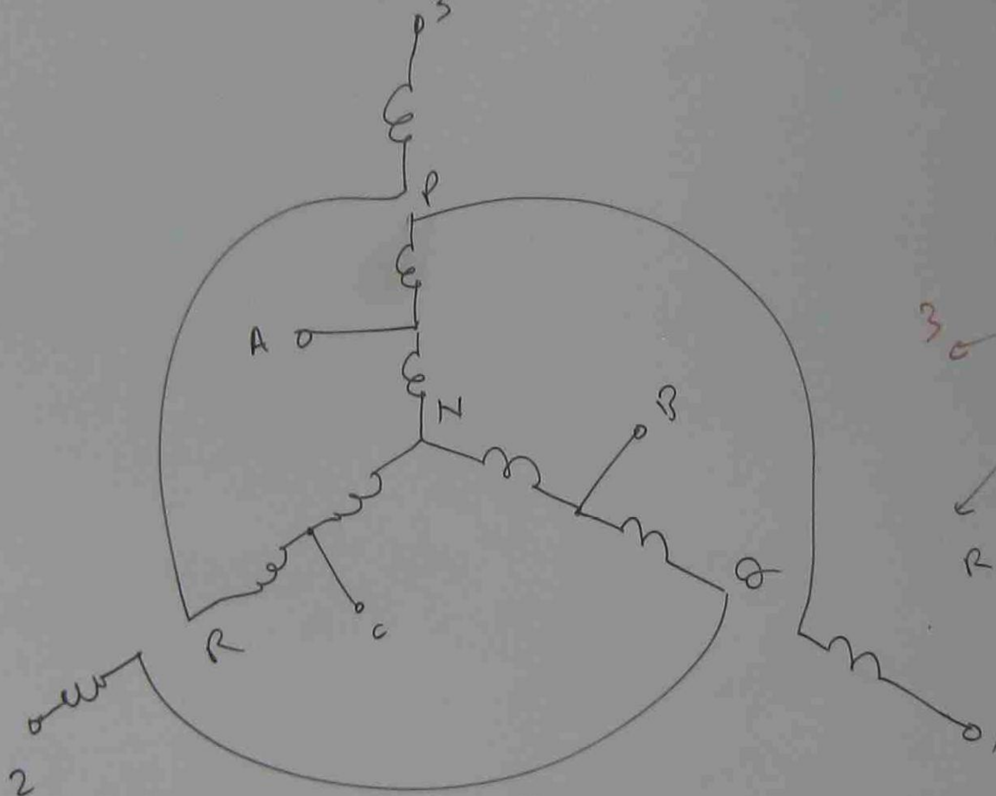
$$VA_{\text{Auto TR}} = V_1 I_1 + V_1 I_1 - 2V_2 I_1$$

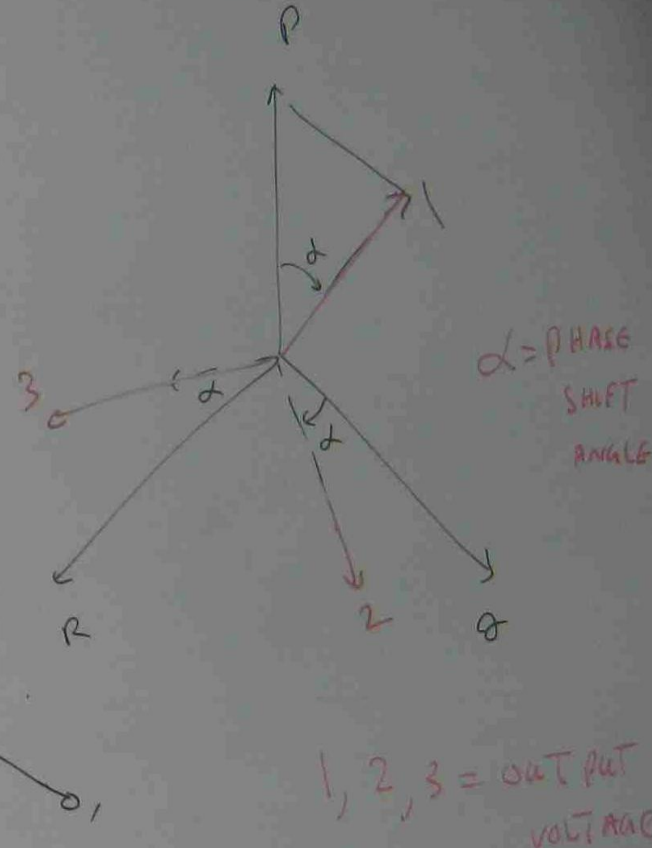
$$VA_{\text{Auto TR}} = 2V_1 I_1 - 2V_2 I_1 \quad \text{— (1)}$$

V.A OF 2 WINDING TR $= V_1 I_1 + V_2 I_2$

$$= 2V_1 I_1 \quad \text{— (2)}$$

PHASE SHIFT TRANSFORMER





pb A PHASE SHIFT TRANSFORMER IS DESIGNED TO CONTROL 150 MVA ON A 230 kV 3ϕ LINE. THE PHASE ANGLE IS VARIABLE BETWEEN ZERO AND $\pm 15°$

(a) CALCULATE APPROXIMATE BASIC POWER RATING OF TRANSFORMER

(b) CALCULATE LINE CURRENTS IN IN COMING AND OUT GOING LINES.

$$S_T = 0.025\, S_L\, \alpha_{MAX}$$

S_T = BASIC POWER RATING OF TRANSFORMER

S_L = APPARENT POWER CONTROLLED BY TRANSMISSION LINE

α_{MAX} = MAXIMUM PHASE SHIFT ANGLE

0.025 = COEFFICIENT

$S_T = 0.025 \times 150 \times 15 = 56$ MVA

$$I = \frac{\text{MVA} \times 10^3}{\sqrt{3}\, E(\text{kV})}$$

$$= \frac{150 \times 10^3}{1.7321 \times 230}$$

$= 377$ Amp.

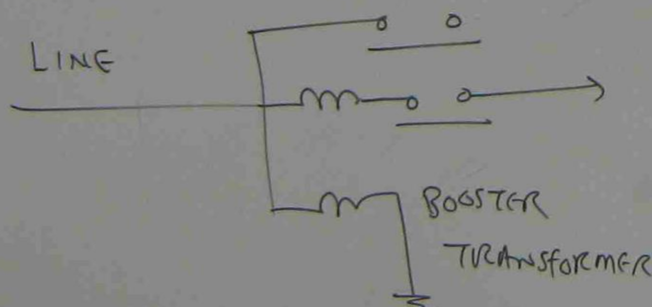
OVER HEAD LINE AND TRANSFORMER

WHEN FULLY LOADED LINE ABSORBS REACTIVE POWER, TRANSFORMER ALWAYS ABSORBS REACTIVE POWER.

$$\text{VAR ABSORBED} = \frac{(\text{VA OF LOAD})^2}{\text{RATED VA}} \times X_T$$

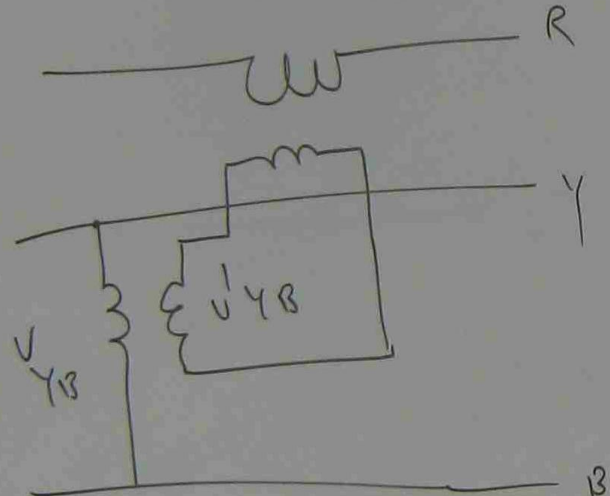
BOOSTER TRANSFORMER

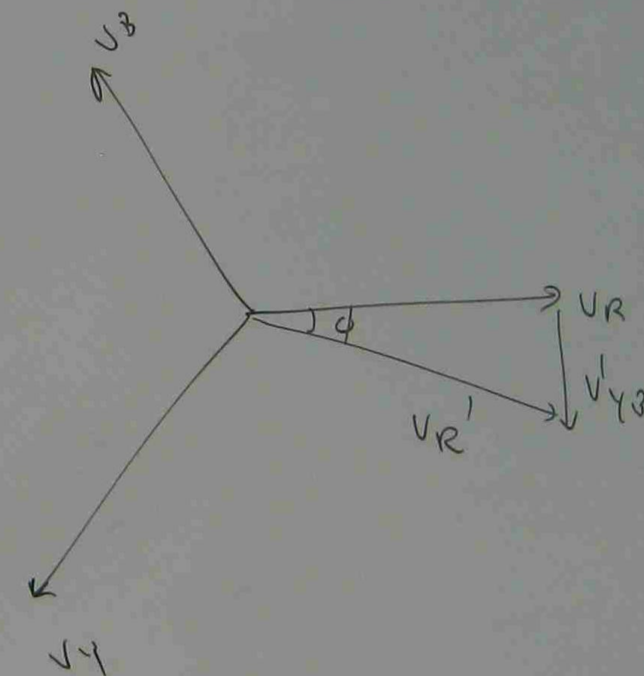
BOOSTER TRANSFORMER IS UTILIZED TO BOOST THE VOLTAGE IF SUPPLY VOLTAGE FALLS BELOW NORMAL



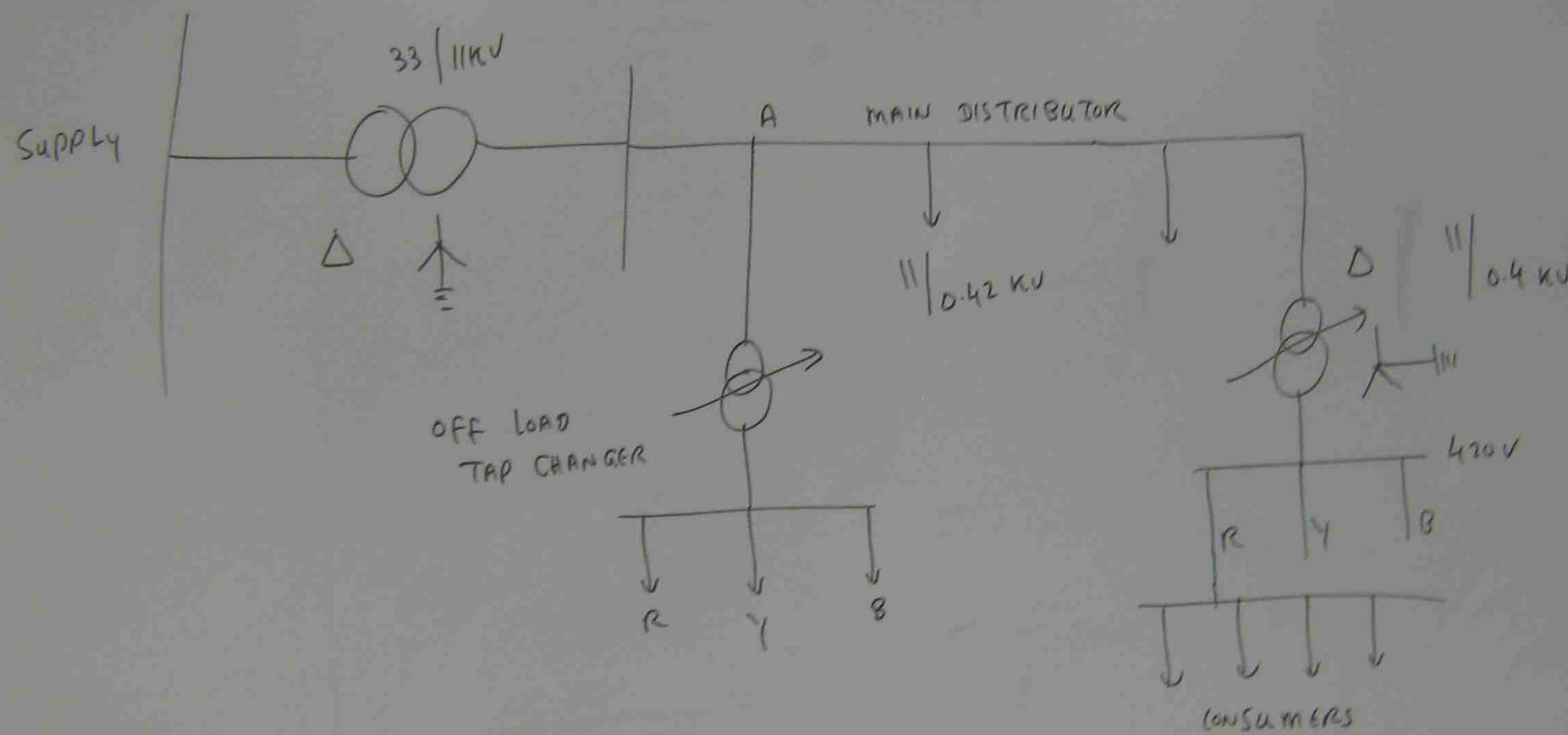
PHASE SHIFT TRANSFORMER

BY THE USE OF TAPPINGS ON THE ENERGIZING TRANSFORMER, SEVERAL VALUE OF PHASE SHIFT MAY BE OBTAINED

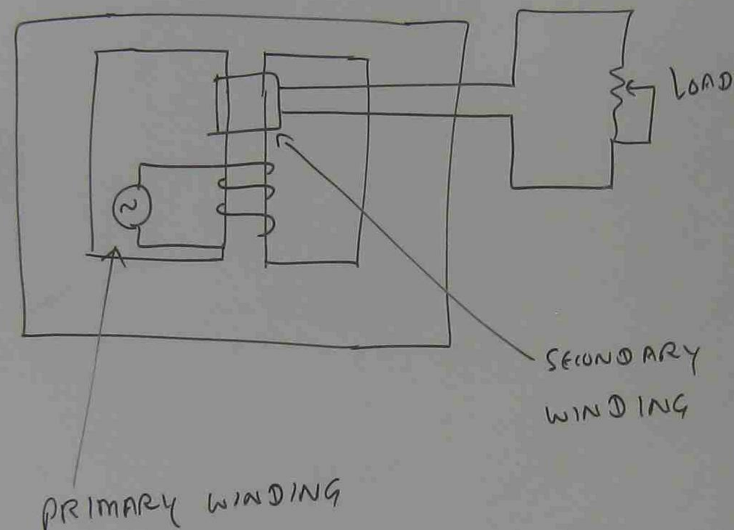




VOLTAGE CONTROL IN DISTRIBUTION NETWORK



CONSTANT CURRENT TRANSFORMER



A CONSTANT CURRENT TRANSFORMER IS DESIGNED TO SATISFY THE CONSTANT CURRENT REQUIREMENT WHILE THE VOLTAGE DROP VARIES WITH THE LOAD.

THE SECONDARY VOLTAGE VARIES DIRECTLY WITH THE LOAD IN A CONSTANT CURRENT TRANSFORMER

REVIEW QUESTIONS (1)

(1) DESCRIBE ALL DAY EFFICIENCY OF TRANSFORMER.

ALL DAY EFFICIENCY IS THE RATIO OF ENERGY OUT PUT IN A GIVEN PERIOD AND ENERGY IN PUT FOR THE SAME PERIOD.

(2) A 1500 KVA 3ϕ TRANSFORMER WITH IRON LOSS 15 KW AND FULL LOAD COPPER LOSS 16 KW HAS THE FOLLOWING LOAD CYCLE

6 HR	FULL LOAD	0.8 PF
9 HR	75% LOAD	0.9 PF
3 HR	50% LOAD	UNITY PF

REMAINING DAY PRIMARY IS ENERGIZED WITH SECONDARY NO LOAD

CALCULATE ALL DAY EFFICIENCY.

OUTPUT KWH

$6 \times 1500 \times 1 \times 0.8 = 7200$ KWH

$9 \times 1500 \times 0.75 \times 0.9 = 9112$ KWH

$3 \times 1500 \times 0.5 \times 1 = 2250$ KWH

18562 KWH

LOSSES

IRON LOSS = $15 \times 24 = 360$ KWH

COPPER LOSS(KWH) = $(\text{LOAD RATIO})^2 \times$ FULL LOAD COPPER LOSS $\times$ HR

$6 \times 16 \times (1)^2 = 96$

$9 \times 16 \times (0.75)^2 = 81$

$3 \times 16 \times (0.5)^2 = 12$

TOTAL LOSSES = 549 KWH

$$\text{ALL DAY EFFICIENCY} = \frac{\text{ALL DAY OUTPUT}}{\text{ALL DAY OUTPUT} + \text{LOSSES}} \times 100$$

$$= \frac{18562}{18562 + 549} \times 100$$

$$= 97.13\%$$

IR

(3) TRANSFORMER A RATED 15 MVA $\% Z_a = 3 + j6\%$

TRANSFORMER B RATED 30 MVA $\% Z_B = 4 + j8\%$

(a) CALCULATE $\% Z$ OF BOTH TRANSFORMERS BASED ON 30 MVA.

(b) % LOAD SHARE TO SUPPLY 12 MVA AT UNITY P.F

$$\boxed{\%Z_2 = \%Z_1 \times \frac{kVA\,2}{kVA\,1}}$$

mER,

$$\%Z_{A(2)} = (3+j6) \times \frac{30}{15}$$

$$= (3+j6) \times 2$$

$$= 6+j12$$

$$\%Z_B = 4+j8$$

$$MVA\ (A) = MVA\ TOTAL \times \frac{\%Z_B}{\%Z_A + \%Z_B} = 12 \times \frac{4+j8}{6+j12+4+j8}$$

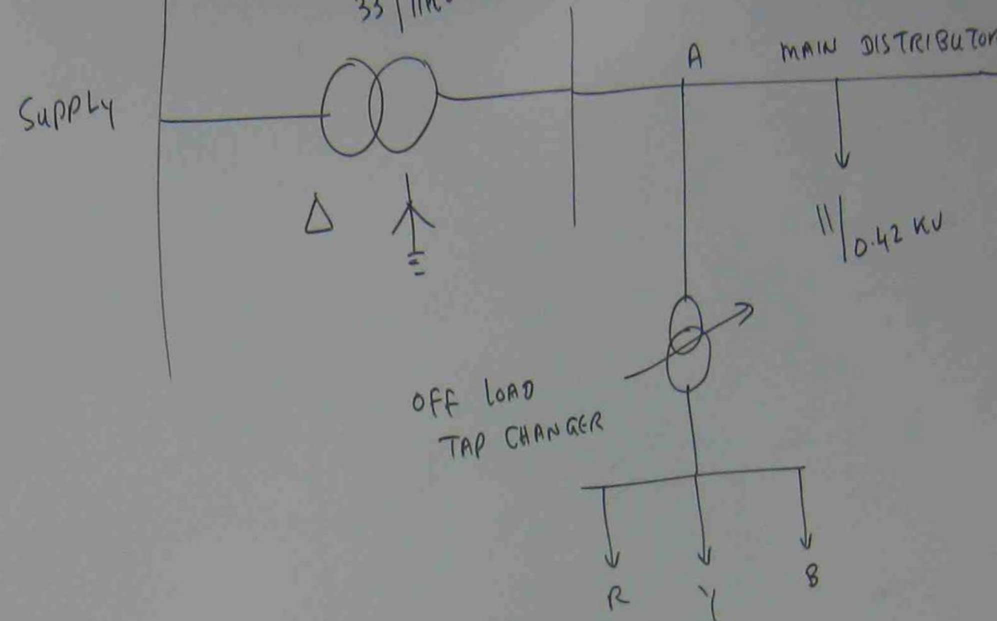
$$= 12 \times \frac{4+j8}{10+j20}$$

$$= \frac{12 \times 4\ \cancel{(1+j2)}}{10\ \cancel{(1+j2)}}$$

$$= 4.8\ MVA$$

$\frac{30}{15}$

2



$$\times \frac{\%Z_B}{\%Z_A + \%Z_B} = 12 \times \frac{4+j8}{6+j12+4+j8}$$

$$= 12 \times \frac{4+j8}{10+j20}$$

$$= \frac{12 \times 4\,\cancel{(1+j2)}}{10\,\cancel{(1+j2)}}$$

$$= 4.8\,MVA$$

$$MVA_{(B)} = MVA_{TOTAL} \times \frac{\%Z_A}{\%Z_A + \%Z_B}$$

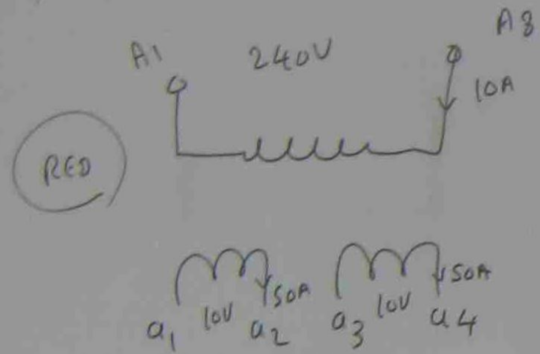
$$= 12 \times \frac{6+j12}{10+j20}$$

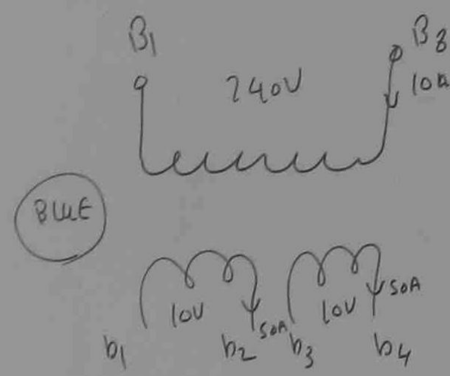
$$= \frac{12 \times 6\,\cancel{(1+j2)}}{10\,\cancel{(1+j2)}}$$

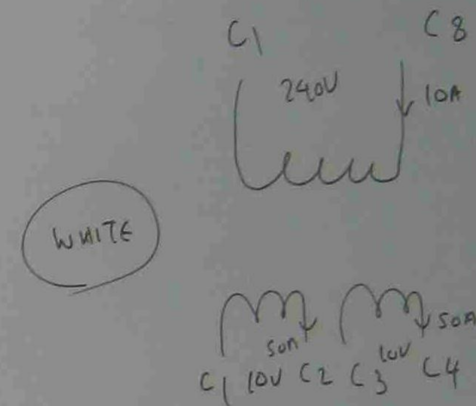
$$= 7.2\,MVA$$

PRACTICAL

CONNECTING VOLTAGE WINDINGS TO SUPPLY REQUIRED VOLTAGE AND CURRENT







CONNECT

(1) PRIMARY = 720V, 10A

SECONDARY = 10V, 300A

(2) PRIMARY = 240V, 30A

SECONDARY = 60V, 50A

(3) PRIMARY = 240V, 30A

SECONDARY = 20V, 150A