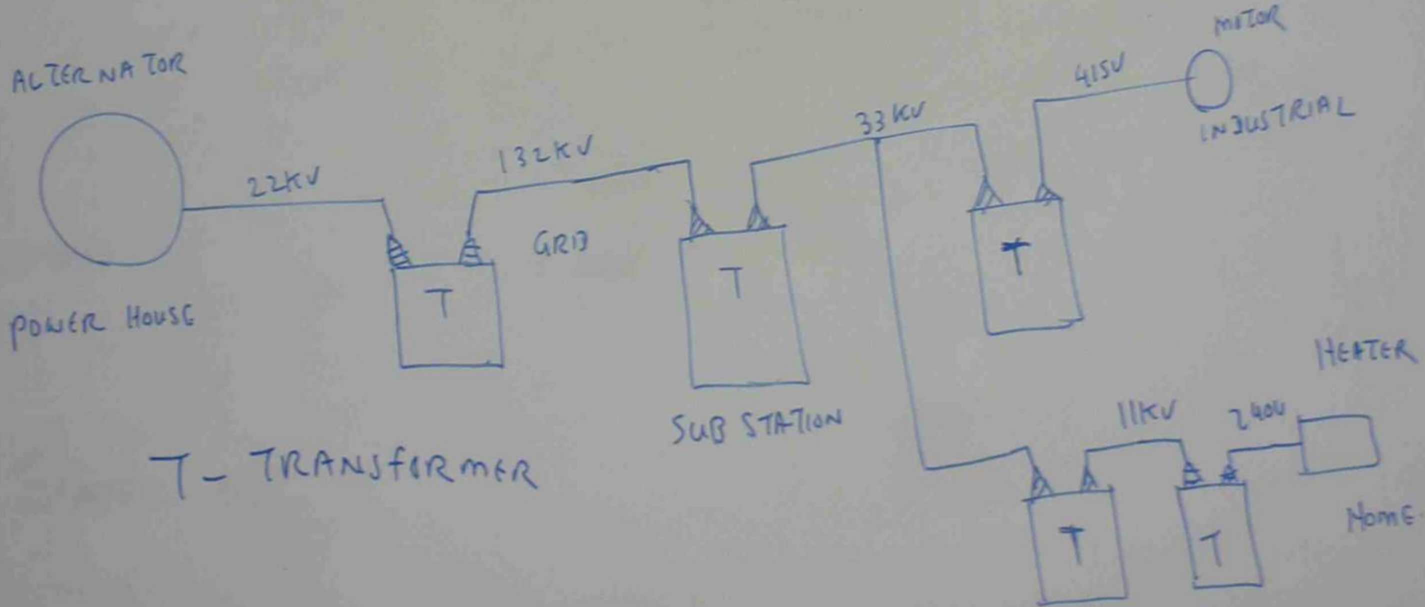
TRANSFORMER

A TRANSFORMER IS A SPECIAL INDUCTOR THAT ALLOWS A CHANGE OF VOLTAGE TO SUIT THE PURPOSE. AN IMPORTANT EXAMPLE IS THAT OF DISTRIBUTION OF ELECTRICAL ENERGY FROM THE POWER STATION TO DOMESTIC AND INDUSTRIAL SITES.

DISTRIBUTION

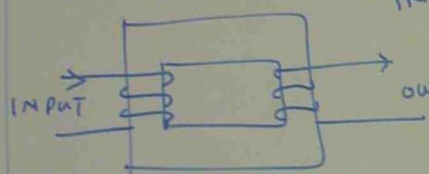
SIMPLIFIED VIEW OF POWER DISTRIBUTION.



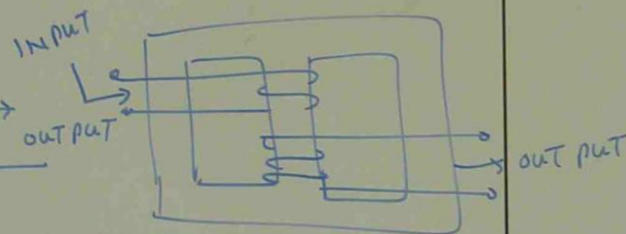
T - TRANSFORMER

CONSTRUCTION

A TRANSFORMER IS CONSTRUCTED OF TWO INDUCTORS. THE INPUT INDUCTOR OF TRANSFORMER IS CALLED PRIMARY WINDING. THE OUTPUT INDUCTOR IS CALLED SECONDARY WINDING. THE TWO WINDINGS ARE MAGNETICALLY COUPLED BY CORE



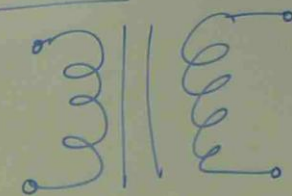
CORE TYPE TRANSFORMER

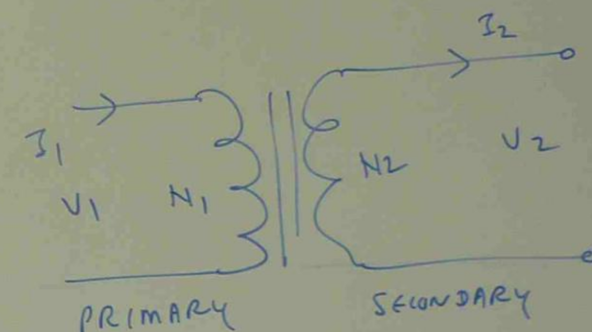


SHELL TYPE TRANSFORMER

THE CORE IS GENERALLY MADE OF LAMINATED IRON AND IS NOT SOLID, BUT IS LAMINATED OF MANY THIN PARTS. THIS IS BECAUSE OF CIRCULATING CURRENT THAT ARE GENERATED BY CORE. THEY ARE CALLED EDDY CURRENT WHICH CAUSES POWER LOSS IN CORE.

SYMBOL



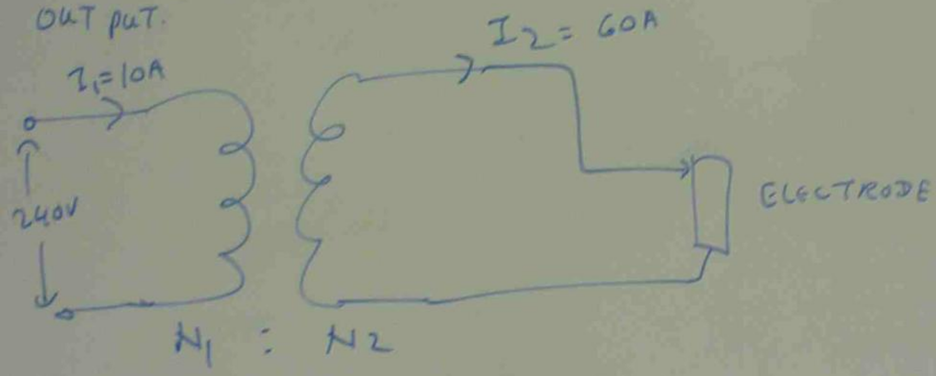


$$\frac{V_1}{V_2} = \frac{N_1}{N_2}$$

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

$$\boxed{\frac{V_1}{V_2} = \frac{N_1}{N_2} = \frac{I_2}{I_1}}$$

pb A WELDER NEEDS TO HAVE 60 Amp OUTPUT AND IS TO BE CONNECTED TO A 240V, 10 A SUPPLY. WHAT TURN RATIO IS NEEDED? WHAT VOLTAGE WOULD BE SUPPLIED TO THE ELECTRODE AT OUTPUT.



$$\frac{N_1}{N_2} = a = \text{TURN RATIO}$$

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

$$\frac{60}{10} = a = 6$$

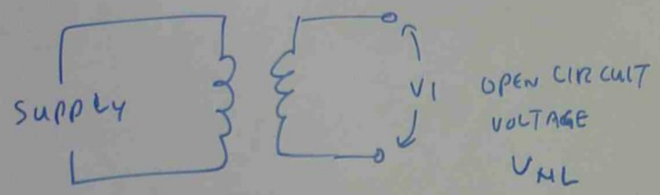
$$\frac{V_1}{V_2} = \frac{N_1}{N_2} = a$$

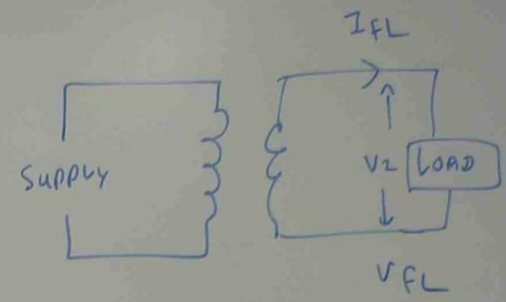
$$\frac{240}{V_2} = 6$$

$$6V_2 = 240$$

$$V_2 = \frac{240}{6} = 40V$$

VOLTAGE REGULATION





VOLTAGE REGULATION $V_R = \dfrac{V_{NL} - V_{FL}}{V_{FL}} \times 100$ %

IF THE SECONDARY VOLTAGE VARIES TOO MUCH, A MOTOR (OR) OTHER LOAD MAY NOT OPERATE PROPERLY. TO ASSESS THIS OUTPUT STABILITY, REGULATION IS CALCULATED.

$$\text{VOLTAGE REGULATION} = \frac{V_{NL} - V_{FL}}{V_{FL}} \times 100\ \%$$

Pb THE SECONDARY VOLTAGE OF A TRANSFORMER IS MEASURED AS 20 VOLT AT FULL LOAD AND 20.9 VOLT AT NO LOAD. WHAT IS THE VOLTAGE REGULATION.

$$V_R = \frac{V_{NL} - V_{FL}}{V_{FL}} \times 100 = \frac{20.9 - 20}{20} \times 100 = \frac{0.9 \times 100}{20} = \frac{90}{20} = 4.5\%$$

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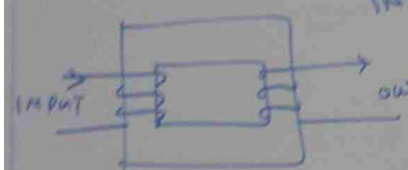
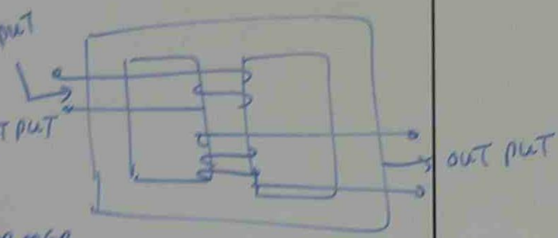


CORE TYPE TRANSFORMER



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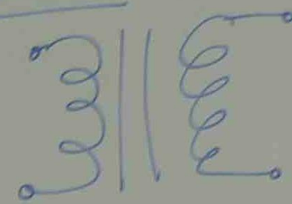

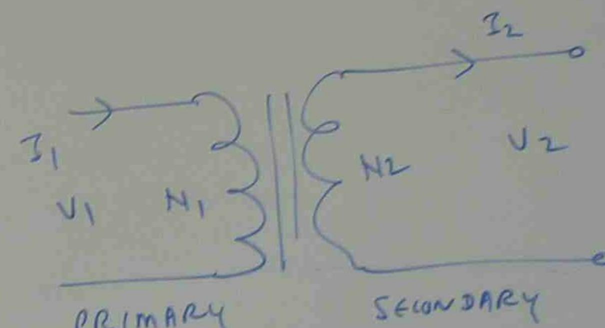

$$\frac{V_1}{V_2} = \frac{N_1}{N_2}$$

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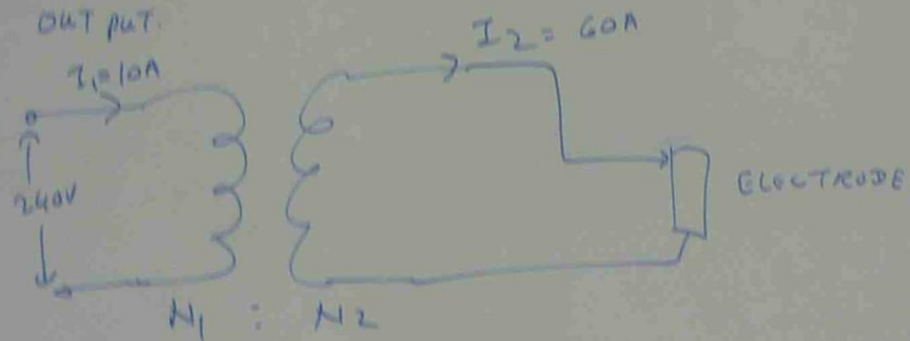

$$\frac{N_1}{N_2} = a = \text{TURN RATIO}$$

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$$\frac{240}{V_2} = 6$$

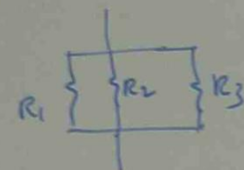
$$6V_2 = 240$$

$$V_2 = \frac{240}{6} = 40V$$

CONNECTION OF RESISTORS, INDUCTORS AND CAPACITORS

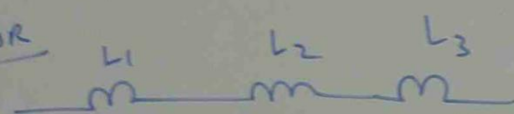
RESISTOR

$$R_T = R_1 + R_2 + R_3$$



$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

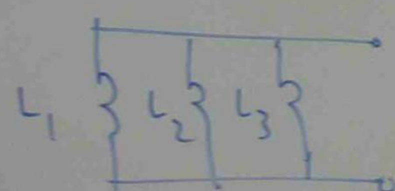
INDUCTOR



$$L_T = L_1 + L_2 + L_3$$

$$X_{L_T} = X_{L_1} + X_{L_2} + X_{L_3}$$

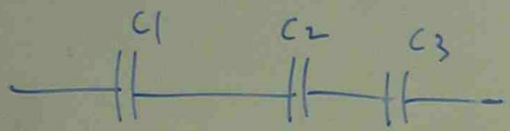
$$X_L = 2\pi f L$$



$$\frac{1}{L_T} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3}$$

$$\frac{1}{X_{L_T}} = \frac{1}{X_{L_1}} + \frac{1}{X_{L_2}} + \frac{1}{X_{L_3}}$$

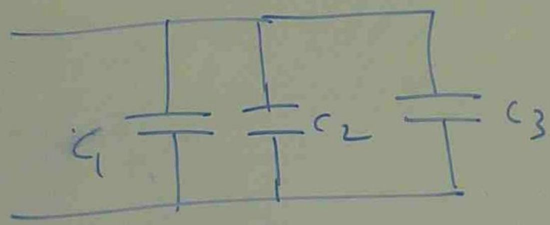
CAPACITOR



$$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

$$\frac{1}{X_{C_T}} = \frac{1}{X_{C_1}} + \frac{1}{X_{C_2}} + \frac{1}{X_{C_3}}$$

$$X_C = \frac{1}{2\pi f C}$$

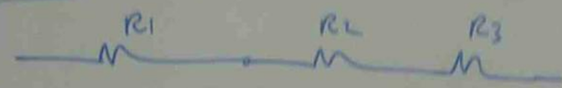


$$C_T = C_1 + C_2 + C_3$$

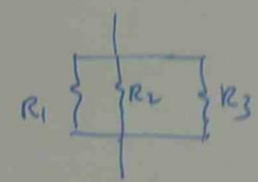
$$X_{C_T} = X_{C_1} + X_{C_2} + X_{C_3}$$

CONNECTION OF RESISTORS, INDUCTORS AND CAPACITORS

RESISTOR

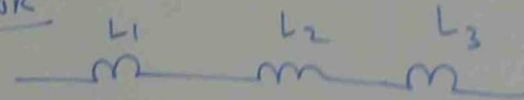


$$R_T = R_1 + R_2 + R_3$$



$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

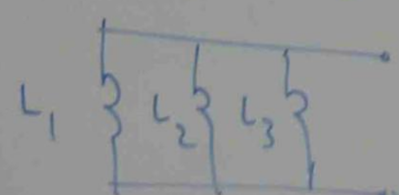
INDUCTOR



$$L_T = L_1 + L_2 + L_3$$

$$X_{L_T} = X_{L_1} + X_{L_2} + X_{L_3}$$

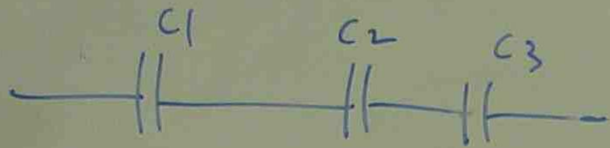
$$X_L = 2\pi f L$$



$$\frac{1}{L_T} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3}$$

$$\frac{1}{X_{L_T}} = \frac{1}{X_{L_1}} + \frac{1}{X_{L_2}} + \frac{1}{X_{L_3}}$$

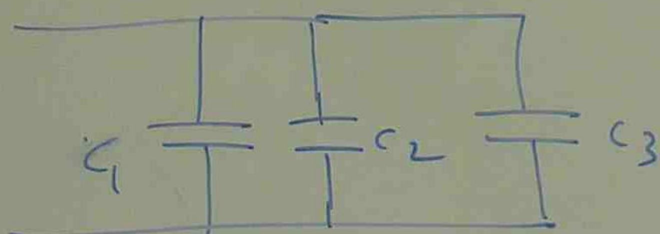
CAPACITOR



$$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

$$\frac{1}{X_{CT}} = \frac{1}{X_{C1}} + \frac{1}{X_{C2}} + \frac{1}{X_{C3}}$$

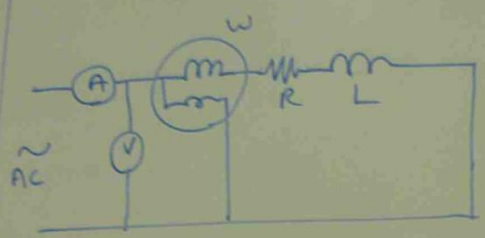
$$X_C = \frac{1}{2\pi f c}$$



$$C_T = C_1 + C_2 + C_3$$

$$X_{CT} = X_{C1} + X_{C2} + X_{C3}$$

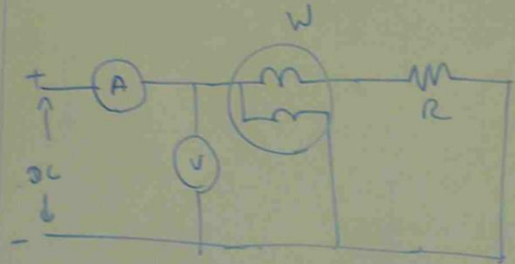
POWER IN COMBINED CIRCUITS



V = 200 V

I = 2 Amp

W = 300 WATT



V = 200 V

I = 2 Amp

W = 400 WATT

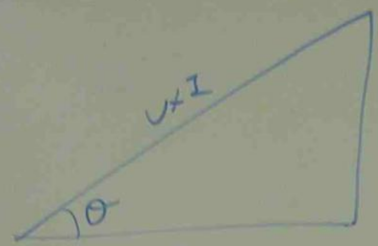
DC power $W = V \times I$

AC power $W < VI$

AC POWER $W = V \times I \times PF$

PF = POWER FACTOR

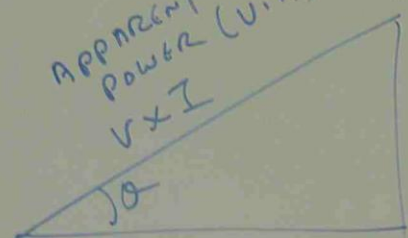
$W = V \times I \times \cos\theta$



W

$$\boxed{\cos\theta = PF = \frac{W}{VI}}$$

APPARENT POWER (V.A)



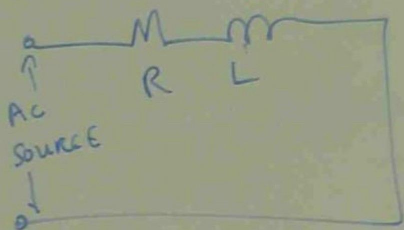
REACTIVE POWER (VAR) $= VI\sin\theta$

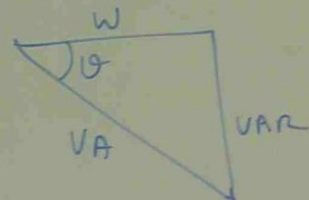
REAL POWER W (WATT) $= VI\cos\theta$

$$(\text{APPARENT POWER})^2 = (\text{REAL POWER})^2 + (\text{REACTIVE POWER})^2$$

LEADING & LAGGING POWER

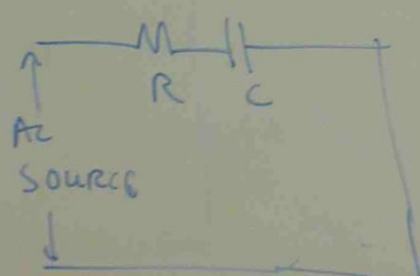
LAGGING

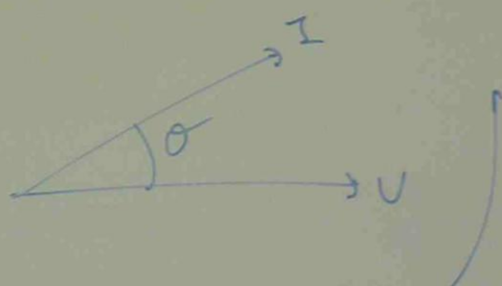




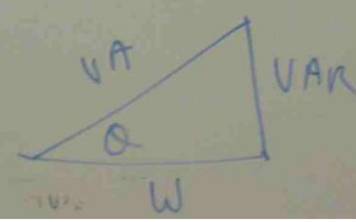
PF = $\cos\theta$ = LAGGING POWER FACTOR

LEADING





PF = $\cos\theta$ = LEADING POWER FACTOR



Pb/ FOR A SUPPLY VOLTAGE OF 240 VOLTS, 2 KW LOAD, CALCULATE THE CURRENT NEEDED FOR

$\phi = 0^\circ, 25^\circ, 60^\circ$

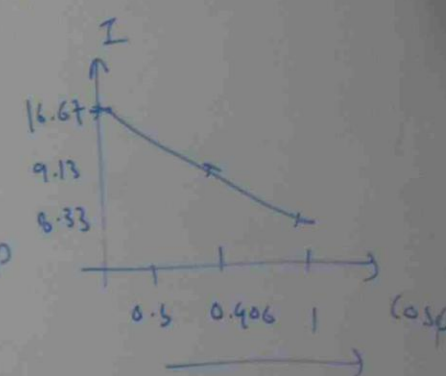
$$W = V I \cos\phi \longrightarrow I = \frac{W}{V\cos\phi}$$

ϕ	$\cos\phi$	I
0	1	8.33
25	0.906	9.13
60	0.5	16.67

$$\phi = 0^\circ \longrightarrow I = \frac{2\times10^3}{240\times\cos 0} = 8.33 \text{ Amp}$$

$$\phi = 25^\circ \longrightarrow I = \frac{2\times10^3}{240\cos 25} = \frac{2000}{240\times0.906} = 9.19 \text{ Amp}$$

$$\phi = 60^\circ \longrightarrow I = \frac{2\times10^3}{240\cos 60} = \frac{2000}{240\times0.5} = 16.67 \text{ Amp}$$



$$I \propto \frac{1}{pf}$$

EFFECT OF POWER FACTOR ON SUPPLY CURRENT

IF THERE ARE A LOT OF INDUCTIVE LOADS, THE POWER FACTOR IS LAGGING AND POOR CAUSING A HIGH CURRENT FLOWS IN LINE.

TO REDUCE THE CURRENT, THE POWER FACTOR NEEDS TO BE INCREASED BY CONNECTING A PARALLEL CAPACITOR.