British Middle East Center
for Studies and Research

Electronics Wave

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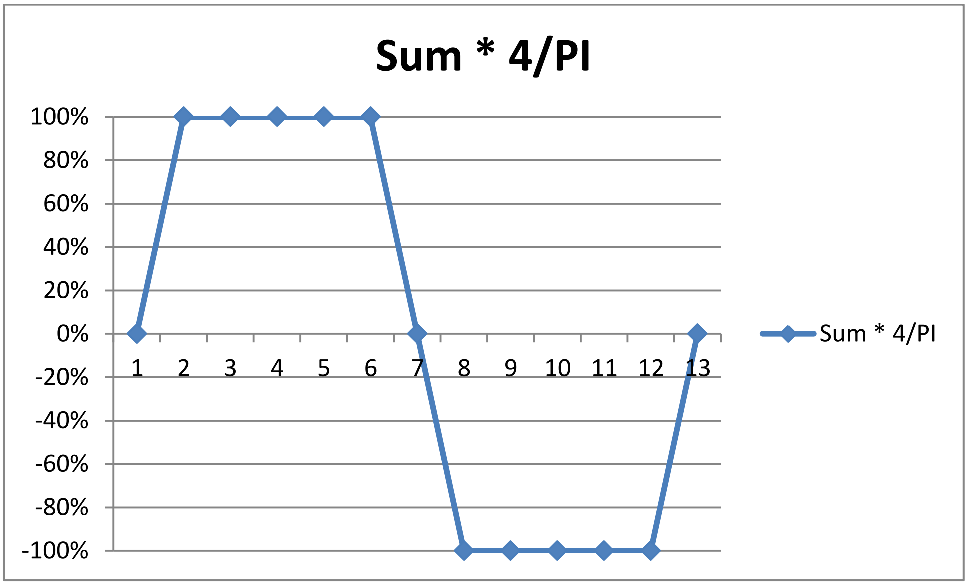
Square wave

Angle	sin (x)	sin (3x) / 3	sin (5x) / 5	sin (7x) / 7	sin (9x) / 9	sin (11x) / 11	Sum	Sum * 4/PI
0	0	0	0	0	0	0	0	0
30	0.5	0.33333333	0.1	-0.0714286	-0.1111111	-0.0454545	0.70533911	0.89806564
60	0.8660254	0	-0.1732051	0.12371791	0	-0.0787296	0.73780866	0.93940716
90	1	-0.3333333	0.2	-0.1428571	0.11111111	-0.0909091	0.74401154	0.94730492
120	0.8660254	0	-0.1732051	0.12371791	0	-0.0787296	0.73780866	0.93940716
150	0.5	0.33333333	0.1	-0.0714286	-0.1111111	-0.0454545	0.70533911	0.89806564
180	0	0	0	0	0	0	0	0
210	-0.5	-0.3333333	-0.1	0.07142857	0.11111111	0.04545455	-0.7053391	-0.8980656
240	-0.8660254	0	0.17320508	-0.1237179	0	0.07872958	-0.7378087	-0.9394072
270	-1	0.33333333	-0.2	0.14285714	-0.1111111	0.09090909	-0.7440115	-0.9473049
300	-0.8660254	0	0.17320508	-0.1237179	0	0.07872958	-0.7378087	-0.9394072
330	-0.5	-0.3333333	-0.1	0.07142857	0.11111111	0.04545455	-0.7053391	-0.8980656
360	0	0	0	0	0	0	0	0



A square wave is a waveform that rises quickly to particular amplitude and remains constant for a time period and drops fast at the end. In digital systems, square waves are the norm, because they represent a binary digit (0 or 1). Square waves can also be generated in musical synthesizers and have a raspy sound. Using Fourier expansion with cycle frequency *f* over time *t*, we can write an ideal square wave as an infinite series of the form

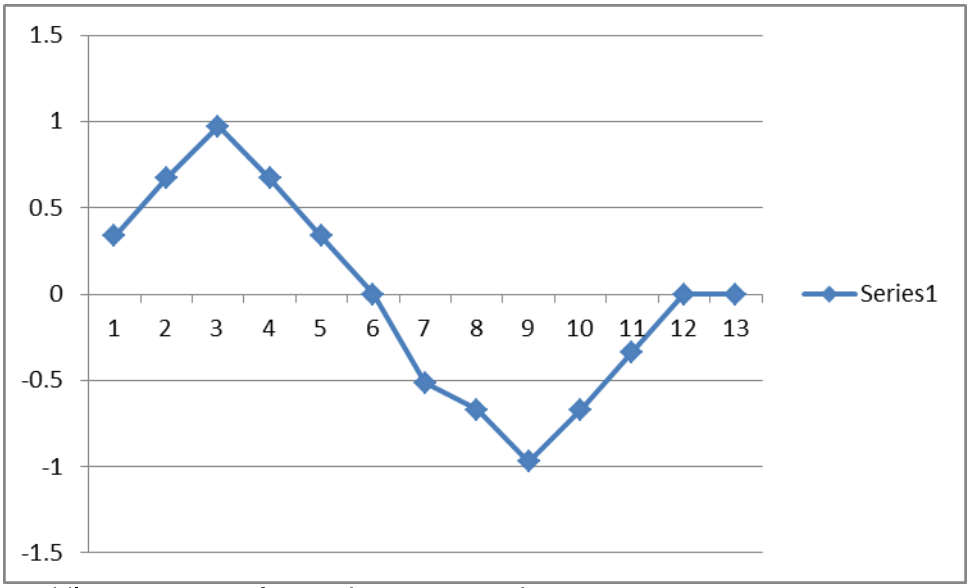
$$\begin{aligned} x_{\text{square}}(t) &= \frac{4}{\pi}\sum_{k=1}^{\infty}\frac{\sin\left(2\pi(2k-1)ft\right)}{(2k-1)} \\ &= \frac{4}{\pi}\left(\sin(2\pi ft) + \frac{1}{3}\sin(6\pi ft) + \frac{1}{5}\sin(10\pi ft) + \cdots\right) \end{aligned}$$

A triangle wave is a non-sinusoidal waveform named for its triangular shape. It is a periodic, piecewise linear, continuous real function. Like a square wave, the triangle wave contains only odd harmonics. However, the higher harmonics roll off much faster than in a square wave (proportional to the inverse square of the harmonic number as opposed to just the inverse). It is possible to approximate a triangle wave with additive synthesis by adding odd harmonics of the fundamental, multiplying every (4n−1)th harmonic by −1 (or changing its phase by π), and rolling off the harmonics by the inverse square of their relative frequency to the fundamental. This infinite Fourier series converges to the triangle wave:

$$x_{\mathrm{triangle}}(t) = \frac{8}{\pi^2}\sum_{k=0}^{\infty}(-1)^k \frac{\sin((2k+1)\omega t)}{(2k+1)^2}$$
$$= \frac{8}{\pi^2}\left(\sin(\omega t) - \frac{1}{9}\sin(3\omega t) + \frac{1}{25}\sin(5\omega t) - \cdots\right)$$

Where ω is the angular frequency.

angle	sin x	-1/9 sin 3x	1/25 sin 5x	-1/49 sin 7x	1/81 sin 9x	-1/121 sin 11x	1/169 sin 13x	Sum of	Sum * (8/PI^2)
0	0	0	0	0	0	0	0	0	0
30	0.5	0.111111111	0.02	-0.010204082	-0.01234568	-0.004132231	0.00295858	0.4138381	0.335444531
60	0.866025404	0	-0.034641016	0.017673988	0	-0.007157235	0.00512441	0.82599205	0.669523934
90	1	-0.111111111	0.04	-0.020408163	0.012345679	-0.008264463	0.00591716	1.19804658	0.971099977
120	0.866025404	0	-0.034641016	0.017673988	0	-0.007157235	0.00512441	0.82599205	0.669523934
150	0.5	0.111111111	0.02	-0.010204082	-0.01234568	-0.004132231	0.00295858	0.4138381	0.335444531
180	0	0	0	0	0	0	0	0	0
210	-0.5	0.111111111	-0.02	0.010204082	0.012345679	0.004132231	-0.0029586	-0.6360603	-0.51557108
240	-0.866025404	0	0.034641016	-0.017673988	0	0.007157235	-0.0051244	-0.825992	-0.669523934
270	-1	0.111111111	-0.04	0.020408163	-0.01234568	0.008264463	-0.0059172	-1.1980466	-0.971099977
300	-0.866025404	0	0.034641016	-0.017673988	0	0.007157235	-0.0051244	-0.825992	-0.669523934
330	-0.5	-0.111111111	-0.02	0.010204082	0.012345679	0.004132231	-0.0029586	-0.4138381	-0.335444531
360	0	0	0	0	0	0	0	0	0

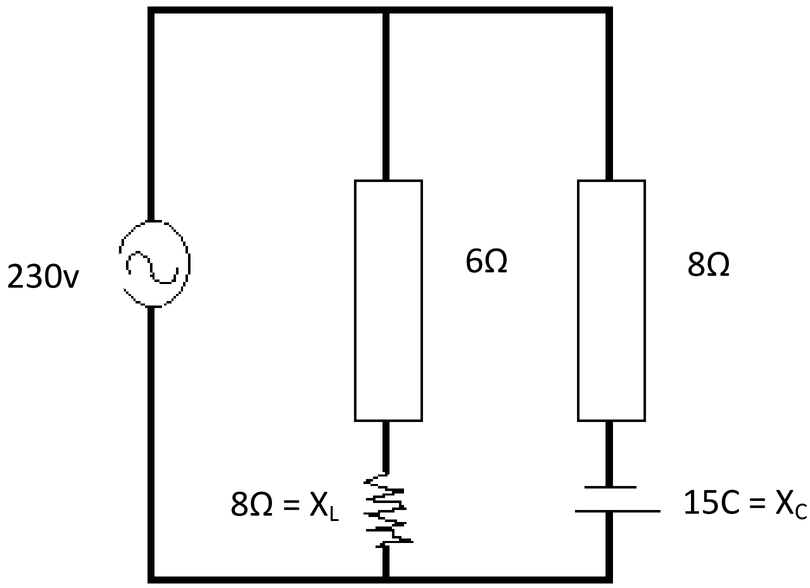


Task 2

V = 230v

R = 6

XL = 8



$$Z = \sqrt{100} = 10$$

$$I = \frac{V}{Z} I = \frac{230}{10} = 23\ AMPS$$

$$Phase\ Angle:$$

$$Tan^{-1}\left(\frac{8}{6}\right) = 53.13°$$

$$From\ (X) line, the\ angle\ is - 53.13°$$

$$\cos 53.13 = \frac{adj}{23}$$

$$adj = \cos 53.13 \times 23$$

$$adj = 13.8\ AMPS$$

$$\sin -53.13 = \frac{opp}{23}$$

$opp = sin - 53.13 \times 23$

$opp = -18.4\ AMPS$

$V = IR$

$Horizontal$:

$\cos(a) = \frac{adj}{hyp}$

$Virtical$:

$\sin(a) = \frac{opp}{hyp}$

$Right\ Hand\ Side$:

$Z = \sqrt{15^2 + 8^2}$

$Z = \sqrt{289} = 17$

$I = \frac{V}{Z}$

$I = \frac{230}{17} = 13.53$

$Tan^{-1}\left(\frac{15}{8}\right) = 61.93°$

$\cos 61.93 = \frac{adj}{13.53}$

$adj = \cos 61.93 \times 13.53$

$adj = 6.367\ AMPS$

$$\sin 61.93 = \frac{opp}{13.53}$$

$$opp = \sin 61.93 \times 13.53$$

$$opp = 11.94\ AMPS$$

$$Vertical = 11.94 - 18.4$$

$$Vertical = -6.46$$

$$Horizontal = 13.8 + 6.367$$

$$Horizontal = 20.167$$

$$tan^{-1}\left(\frac{-6.46}{20.167}\right) = -17.76°$$

$$\frac{-6.46}{hyp} = sin - 17.76$$

$$hyp = \frac{-6.46}{sin - 17.76} = 21.078$$

$$Vector\ form: (21.078, -17.76°)$$

$$Terms\ and\ equations:$$

$$XC = reactance\ for\ capacitor$$

$$XL = reactance\ of\ inductor$$

$$Z = Impedance\ of\ Circuit$$

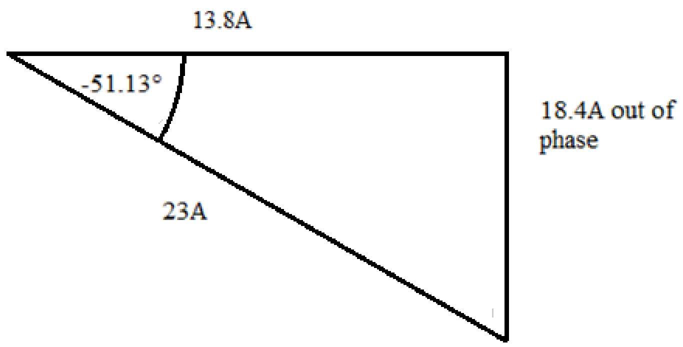
$$\omega = 2\pi f$$

$$XC = \left(\frac{1}{\omega c}\right) \times \Omega$$

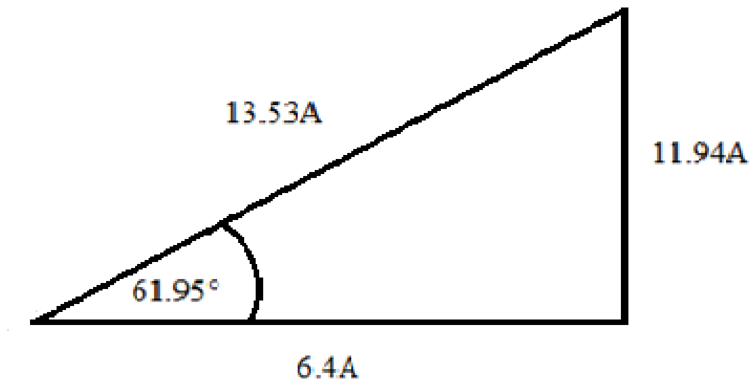
$XL = \omega L \Omega$

$C = capacitance$

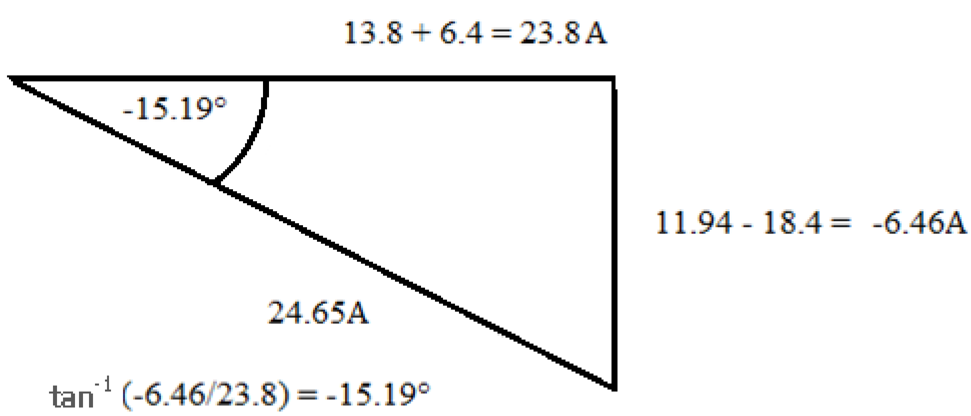
Induction Motor – vector diagram (diagram not to scale)



Synchronous motor – vector diagram (diagram not to scale)



Overall – vector diagram (diagram not to scale)



$$Z = \frac{230}{24.65} = 9.33\, Ohms. Power\ Factor = cos\ \Theta. cos\ 15.19 = 0.965$$

$$Overall\ current = 24.65$$

$$\frac{Voltage}{Amps} = Ohms$$

$$\frac{230}{24.65} = 9.33\ \Omega$$

Task 3.1

$$\frac{N_P}{N_S} = \frac{E_P}{E_S} = \frac{I_S}{I_P} = \sqrt{\frac{Z_P}{Z_S}}$$

N = number of turns

E = voltage

I = current in amperes

P = primary coil

S = secondary coil

Z = impedance in ohms

$$\frac{NP}{NS} = \sqrt{\frac{ZP}{Zs}}$$

$$\frac{NP}{NS} = \sqrt{\frac{16}{300}}$$

$$\frac{NP}{NS} = 0.231$$

Or a 1: 0.231 ratio.

When the resistance of the source is equal to the resistance of the load the maximum power is transferred from the source to the load. The efficiency factor is based on the percentage of the total power generated by the source that is delivered to the load.

To arrange a maximum power transfer we must find the internal resistance. This is the resistance found by looking back into the two load terminals of the source with no load connected. Also we must find the open circuit voltage or the short circuit current of the source between the two load terminals with no load connected. According to the maximum power transfer theorem, the load receives maximum power from a source when its resistance is equal to the internal resistance of the source. The source will needs to be in a form of either Thévenin or Norton equivalent circuit, have a simple solution to solve it but if the circuit is not in the form of Thévenin or Norton equivalent circuit, Thévenin's or Norton's must be obtained to the equivalent circuit.

Task 3.2

An ideal transformer would have no losses and that would be 100% efficient. In large transformers have more efficient and those rated for electricity distribution usually perform better than 98%. A small transformer such like a plug in wall wart power adapter commonly used for low power consumer electrical devices may be as low as 20% efficient with considerable energy loss even when not supplying any power to the device.

- Small power transformers are designed to be in the power range of 5 to 40 MVA with a maximum of use of voltage of 115 kV. These small power transformers are mostly used as network transformers in distribution network. These types of transformers are normally a 3 phase application and designed according to national and international standard. A foil or layer windings should be designed as a low voltage windings and layer or disc execution should be used for the high voltage windings including transposed conductors. Normally the cooling type of small power transporters is oil natural air natural or oil natural air forced. The tapping could be designed with no load or on load tap changers.

- Larger power transformer are designed to be in the power range of over 200 MVA, generator and network intertie transformer with off load or on load tap changers or both combination can be used which might be better. They both can be designed as multi winding power transformer or autotransformers in 3 phases or even 1 phase versions depending on the onsite requirements.

The reason why they have such a great difference in efficiency is because of the scaling factor. Because as we increase the size of the transformer the efficiency will also increase. So the physical size of a transformer has a profound effect upon its efficiency, power output, relative cost and temperature rise. If we consider the scaling factor that if the transformer is doubled its size the transformer will triple its output therefore to conclude this happens because as the size of the transformer is increase the internal resistance inside the transformer decreases so the efficiency of the transformer will increase.