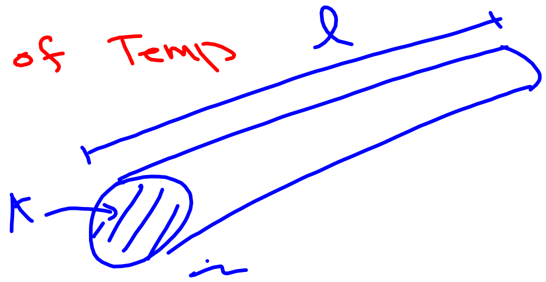
Resistivity, RMS and Transformers

Resistivity (ρ)

$$R = \frac{\rho(T) \cdot l}{A}$$

$\rho(T)$ ← function of Temp



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list of ρ and α ← temp coefficient

$$f(x) = a_0 + a_1 x + a_2 x^2 + a_3 x^3 + \ldots = \sum_{n=0}^{\infty} a_n x^n$$

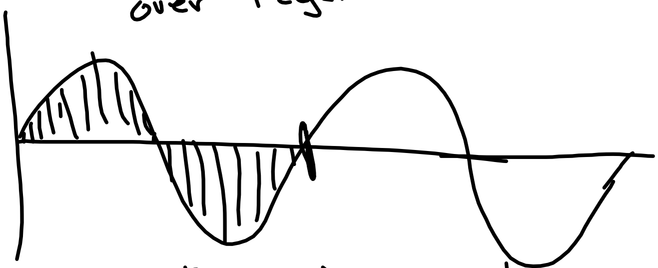
$$e^x = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \ldots$$

$$\rho(T) = \rho_0 + a_1 T + a_2 T^2 + a_3 T^3 + \ldots$$

$$= \rho_0 (1 + \alpha T) + \ldots \text{ higher order}$$

OR $= \rho(T_0)\left(1 + \alpha(T - T_0)\right)$, where $T - T_0 = \Delta T$

Root-Mean-Square



$$\varepsilon_{ave} = \frac{\sum_{i=1}^{n} \varepsilon_i}{n} = ☺$$

area under curve

$$\varepsilon_{ave} = \frac{\int \varepsilon \, dt}{t} = ☺$$

rms ⇒ root-mean-square

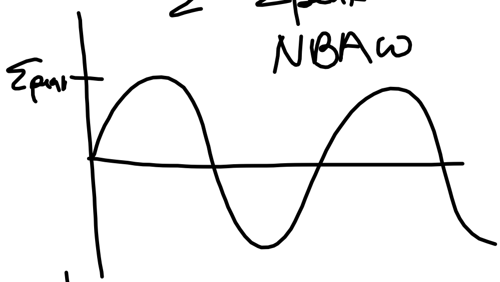
$$\varepsilon_{rms} = \sqrt{(\varepsilon^2)_{ave}}$$

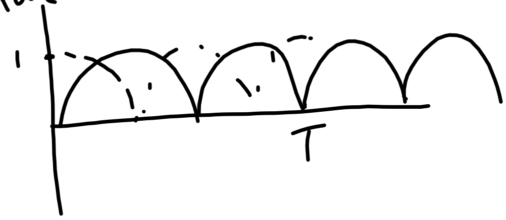
$$= \sqrt{(\varepsilon_{peak}^2 \sin^2 \omega t)_{ave}}$$

$$= \varepsilon_{peak} \sqrt{\underbrace{(\sin^2 \omega t)_{ave}}_{\frac{1}{2}}}$$

$\varepsilon = \varepsilon_{peak} \sin \omega t$

NBAω





$$\varepsilon_{rms} = \frac{\varepsilon_{peak}}{\sqrt{2}} = 120V \text{ in NA}$$

$\varepsilon_{peak} \approx 170V$

$$(\sin^2 \theta + \cos^2 \theta)_{ave} = 1 \quad \forall \theta$$

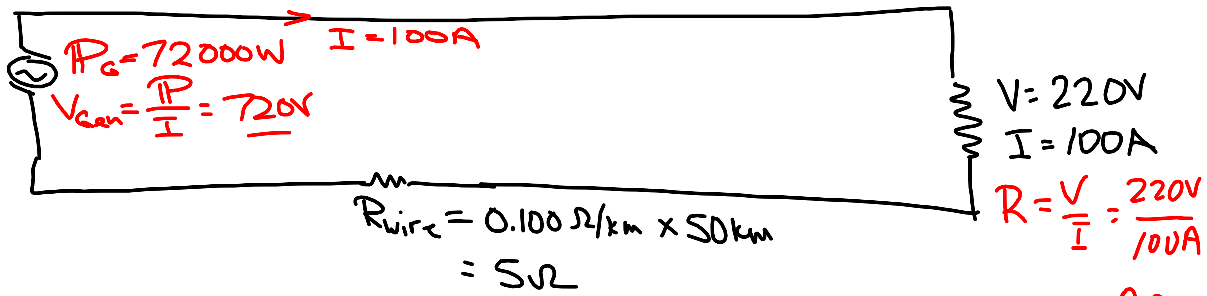
ωt

$$2(\sin^2 \theta)_{ave} = 1$$

$$(\sin^2 \theta)_{ave} = \frac{1}{2}$$

Example:

A generator is used to power a device at 220 V and 100 A 25 km away. Assume the resistance of the wires is 0.100 Ω/km. Compare the power loss and voltage required from the generator with and without 1000:1 step up and step down transformers.



$P_{loss} = I^2 R_{wire}$

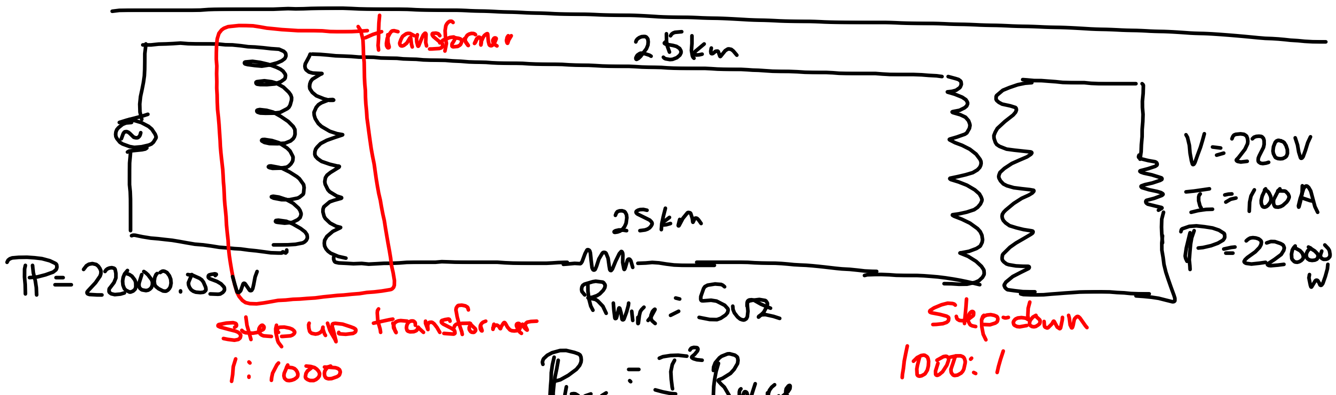
$= (100A)^2 (5\Omega)$

$= 50\ 000\ W$

$P_{delivered} = VI$

$= (220)(100)$

$= 22000W$



$P_{loss} = I^2 R_{wire}$

$= (0.1)^2 (5\Omega)$

$= 0.05W$

$\frac{I_1}{I_2} = \frac{N_2}{N_1}$) $\frac{1}{1000}$

$I_1 = (100A)(1/1000)$

$= 0.1A$