# MADE EASY

## ELECTRICAL ENGINEERING

### Transformer , Synchronous

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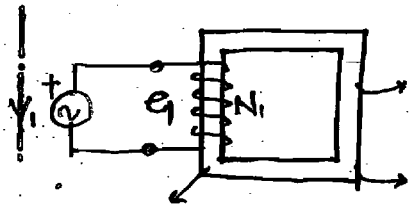
- Theory
- Explanation
- Derivation
- Example
- Shortcuts
- Previous Years Question With Solution

# Electrical Machine

- devices capable of continuous electro-mechanical energy conversion is called Machine.
- Transformer is not a machine.
- Transformer is a static device, that transfer elec power at const frequency diff volt level.
- where voltage level doesn't change, is called isolation transformer




Shouldn't be there, it increases reluctance and flux decreases.

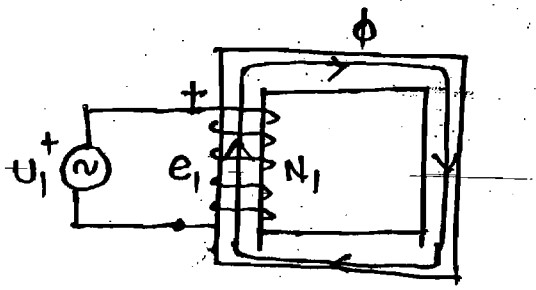
- Ideal Transformer → Permeability ↑, No losses. ($\infty$).

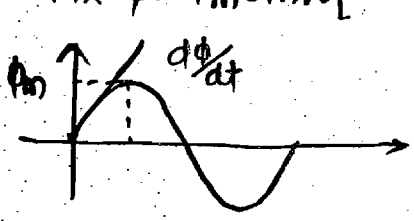
→ for flux to be flow, if permeability is '$\infty$' there is no need of excitation.

$$\phi = \frac{NI}{S}$$

$$I = \frac{\phi}{N} \times \frac{l}{\mu A}$$

$= 0$ at $\mu = \infty$




$$e_1 = \pm \frac{d\lambda_1}{dt}$$

Suppose $\frac{d\phi}{dt} = 50$ mwb/s

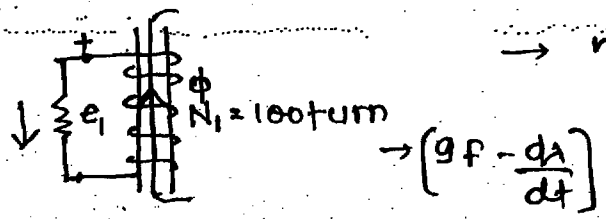
$N_1 = 100$ turn

then flux linkage $= N_1\phi$

$$e_1 = \pm N_1 \frac{d\phi}{dt}$$

(voltage is meaningless without polarity, current without direction)

➢ According to lenz law the dirn of induced emf is such that if it is allowed to cause a current by short circuiting the coil, then the current so produced would have an effect that opposes the cause. i.e. $e = \pm d\lambda/dt$ where the sign depends on lenz law and which terminal is taken as +ve.




→ with this polarity voltage leads by 90°.

$\rightarrow \left[ 9f - \frac{d\lambda}{dt} \right]$

$e_1 = -100 \times (50 \times 10^{-3})$

$= -5V$ [so, polarity is changed]

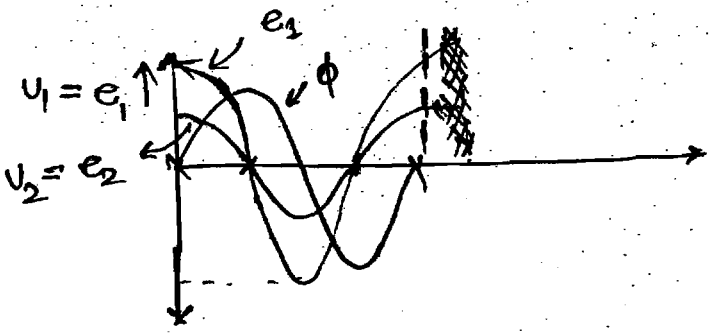
So, we have to take $\frac{+d\lambda}{dt}$

$$e_1 = +N_1 \frac{d\phi}{dt}$$

$$= N_1 \frac{d}{dt}(\phi_m \sin \omega t)$$

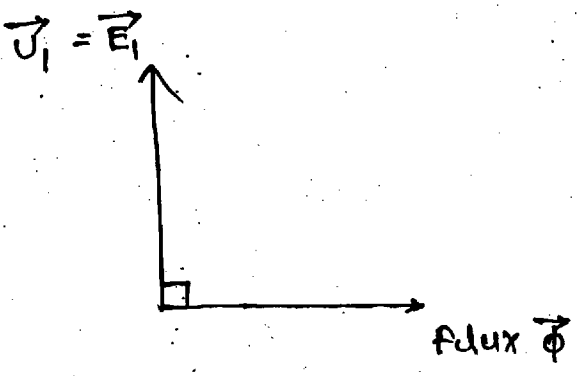
$$\Rightarrow \boxed{e_1 = N_1 \phi_m \omega \cos \omega t}$$

$$e_1 = N_1 \phi_m \omega \sin(\omega t + 90^\circ)$$ → voltage leads by 90°.

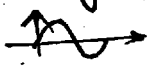


➤ Phasor:-

(IITMADRAS)
(NPTEL)
[Nagrath-kothari]




[Not vector diagram as magnitude changes]



"only phasor diagram".

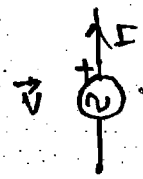
→

$\sum V = 0$

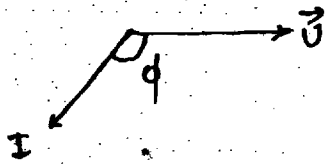
$-V_1 + e_1 = 0$

$\Rightarrow \boxed{V_1 = e_1}$ → $V_1$ is in same phase of $e_1$.

[Phasor diagram must be accompanied with a ckt. diagram and vice versa].

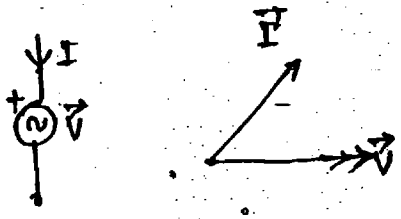



→ when current flows in dir of voltage rise – it is source.

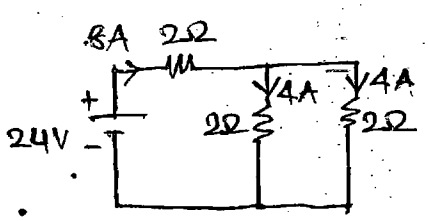


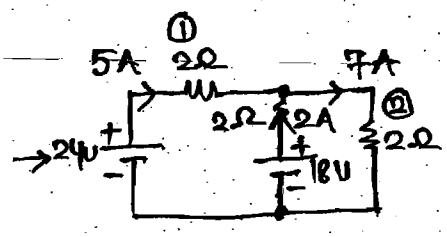

→ Power (-ve)

So, total information can be obtained by circuit + phasor.




→ Power (+ve)

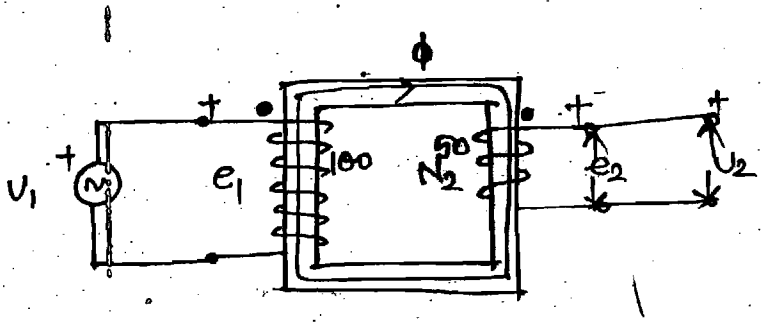



[for 1st observer for ① new voltage is enemy and for 2nd friend]

$$\text{RMS } E_1 = \frac{N_1 \phi_m \omega}{\sqrt{2}} = \frac{N_1 \phi_m (2\pi f)}{\sqrt{2}} = \sqrt{2}\,\pi f \phi_m N_1$$

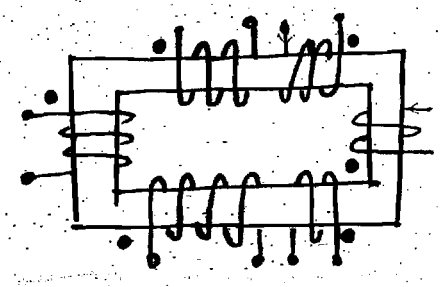
$$\boxed{E_1 = \sqrt{2}\,\pi f \phi_m N_1}$$




➤ Dot convention:-

If the currents enters or leave through the dots simultaneously, the fluxes are additive.

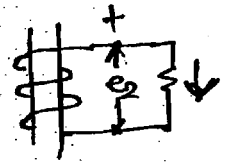
→ only the first dot is assigned. The remaining dots follow automatically depending upon the sense of the winding.



$$e_2 = \pm N_2 \frac{d\phi}{dt}$$

$$= 50 \times (50 \times 10^{-3})$$

$$= +2.5\ V$$




➤ As applied to transformers therefore if the current enters through the dot in one winding then it should leave through the another winding to satisfy lenz law. "In other words the dots have the same inst. polarity".