Lecture 33, Apr 5, 2023

Transformer EMFs

- In the case of transformer EMFs the surface's relationship with $\vec{B}$ says constant
- $V_{emf} = -N\frac{\partial \Phi}{\partial t} = -N\iint_S \frac{\partial}{\partial t}\vec{B} \cdot \mathrm{d}\vec{s}$
  - The Φ is total flux flowing through the loop; this includes both applied and the flux caused by the induced EMF
  - The induced EMF/current, through self inductance, will also cause its own EMF
  - $V_{emf} = -\frac{\partial \Phi_{net}}{\partial t} = -\frac{\partial}{\partial t}(\Phi_{app} + \Phi_{ind})$
- We can account for the effect of the induced current by including an inductor, $V = L\frac{\mathrm{d}I_{ind}}{\mathrm{d}t}$, so $V_{emf} = RI_{ind} + L\frac{\mathrm{d}I_{ind}}{\mathrm{d}t}$
- In general to actually find the induced current we need to solve a differential equation; but often we will just ignore the effects of the induced current, so $I_{ind} \approx \frac{V_{emf}}{R}$
  - This is a reasonable assumption when the self-inductance L is small or $\frac{\mathrm{d}I}{\mathrm{d}t}$ is small

Important

At lower frequencies, self-inductance can be ignored; however, at higher frequencies, self-inductance must be accounted for through differential equations as they can have major impacts on overall behaviour