PHYSICS 571 – Master's of Science Teaching

"Electromagnetism and Light" Lecture 6 – Generators, Transformers and Worked Problems

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Outline

Homework Help
Generators
    Constant B, rotating A
Transformers

Worked Problems (#6, HW 6)

6) A 5.0-cm-diameter coil has 20 turns and a resistance of 0.50 Ohms. A magnetic field perpendicular to the coil is $B(t)=4t-2t^2$ where B is in Tesla and time is in seconds.

What is the current induced in the loop at 0, 1 and 2 seconds? Some of your answers will be negative. What do you think is the physical interpretation of a negative current?

Worked Problems (#7, HW 6)

7) A 100-turn, 2.0-cm-diameter coil is at rest in a horizontal plane.

a) At t=0, a uniform magnetic field 60 degrees from vertical exists in the region of the coil. What is the magnetic flux through the coil at this time?

b) At t=0.6 s, this uniform magnetic field has the same direction but has increased in strength to 1.50 Tesla. What is the magnetic flux through the coil now?

c) What is the voltage (EMF) induced in the coil between 0 and 0.6 seconds?

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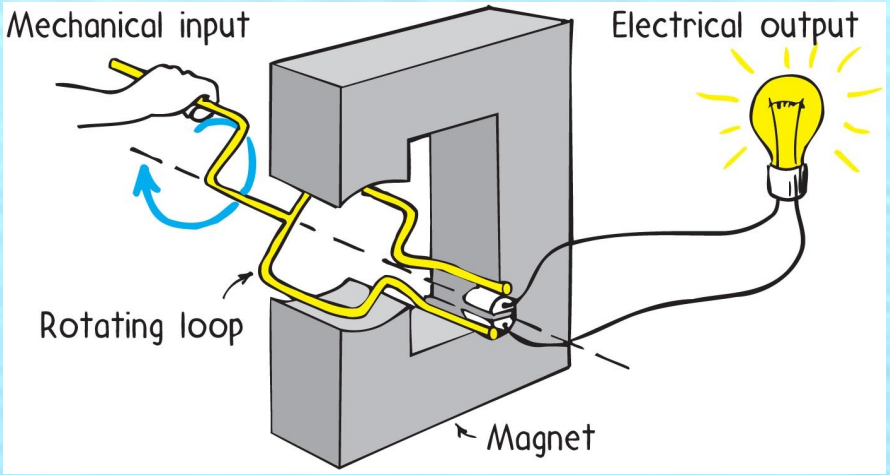
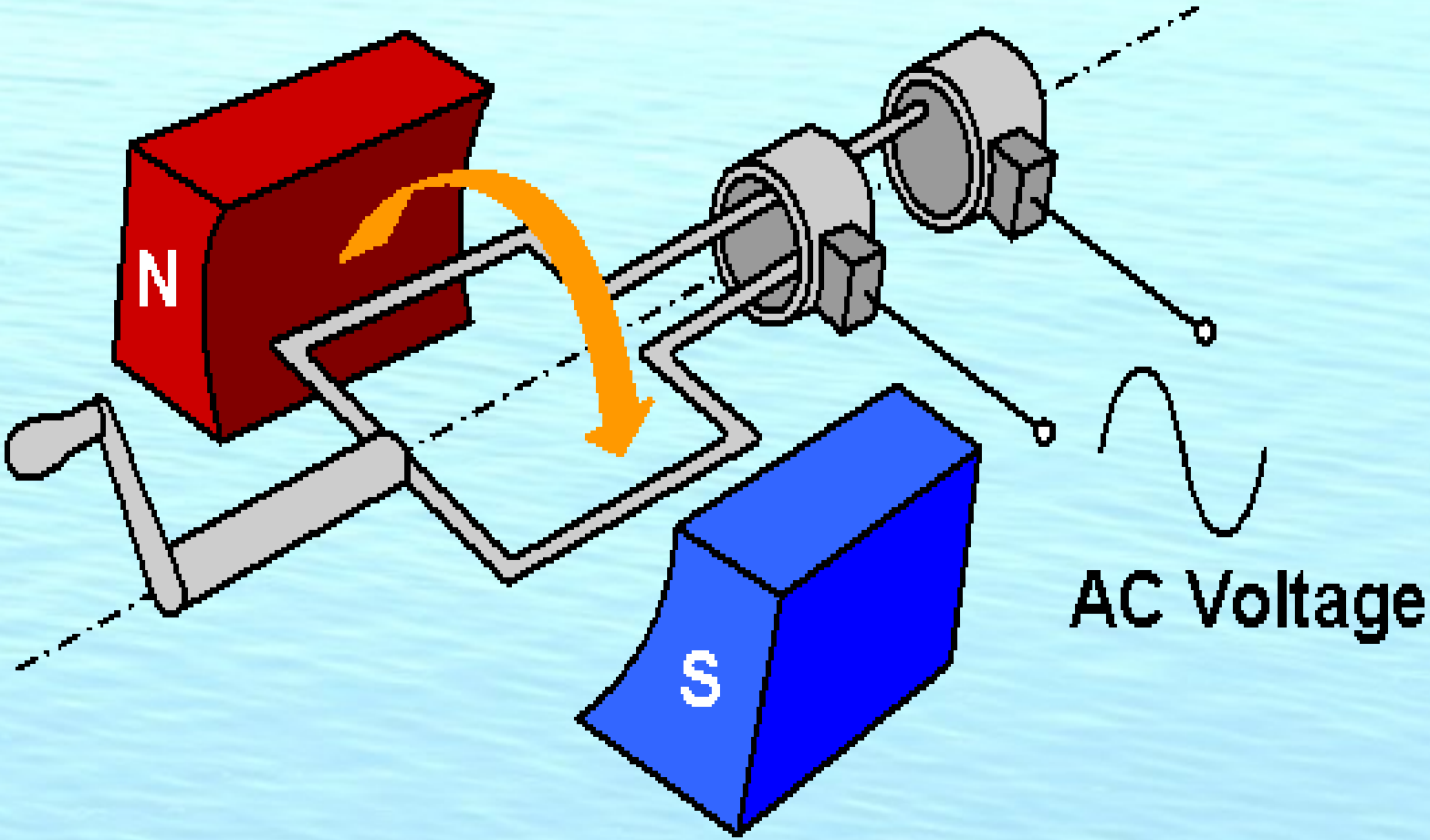
Generators and Alternating Current

Generator

- opposite of a motor
- converts mechanical energy into electrical energy via coil motion
- produces alternating voltage and current



Changing flux by rotating loop



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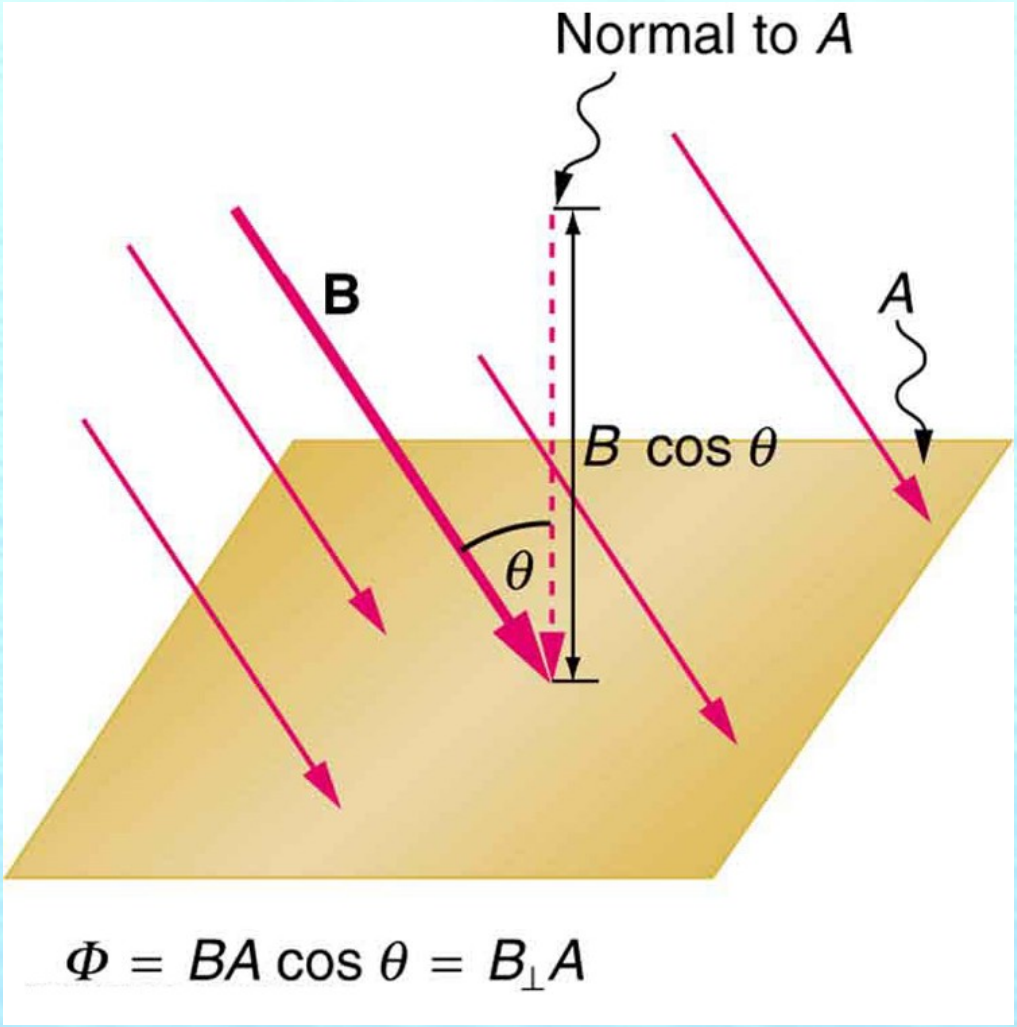


$$\Phi(\theta) = BA\cos(\theta)$$

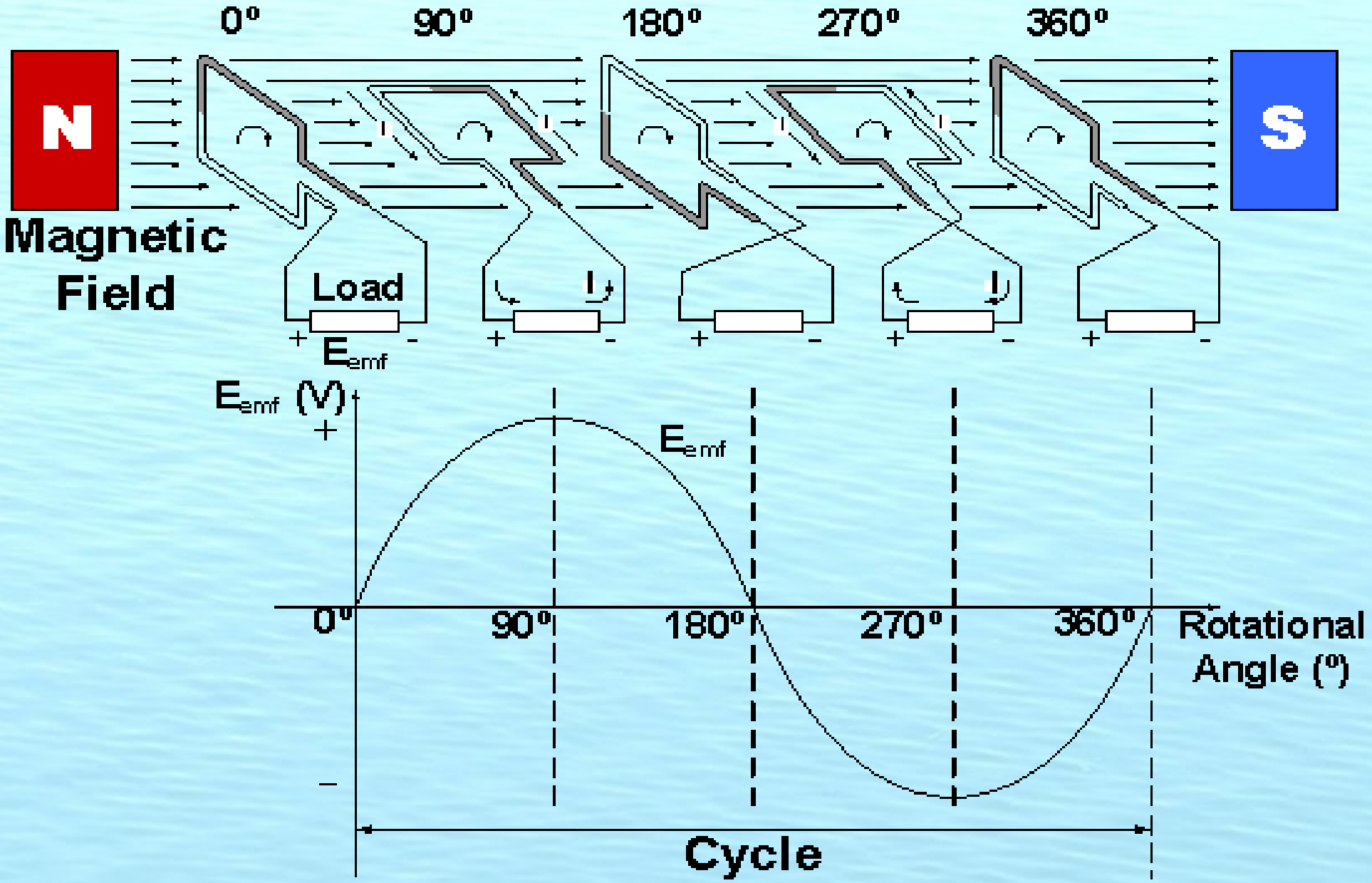
$$\theta = \omega t = 2\pi f t$$

$$\Phi(t) = BA\cos(\omega t)$$

$$\frac{d\Phi}{dt} = \ldots$$

You can do problems 10, 11 of the homework EXACTLY this way.

Changing flux by rotating loop



Clicker

How can you describe the flux through a generator with "N" loops each of area "A" in a field "B" and rotating 60 times a second

[A] $\Phi(t) = BA\cos(2\pi 60t)$

[B] $\Phi(t) = NBA\cos(60t)$

[C] $\Phi(t) = 60\cos(NABt)$

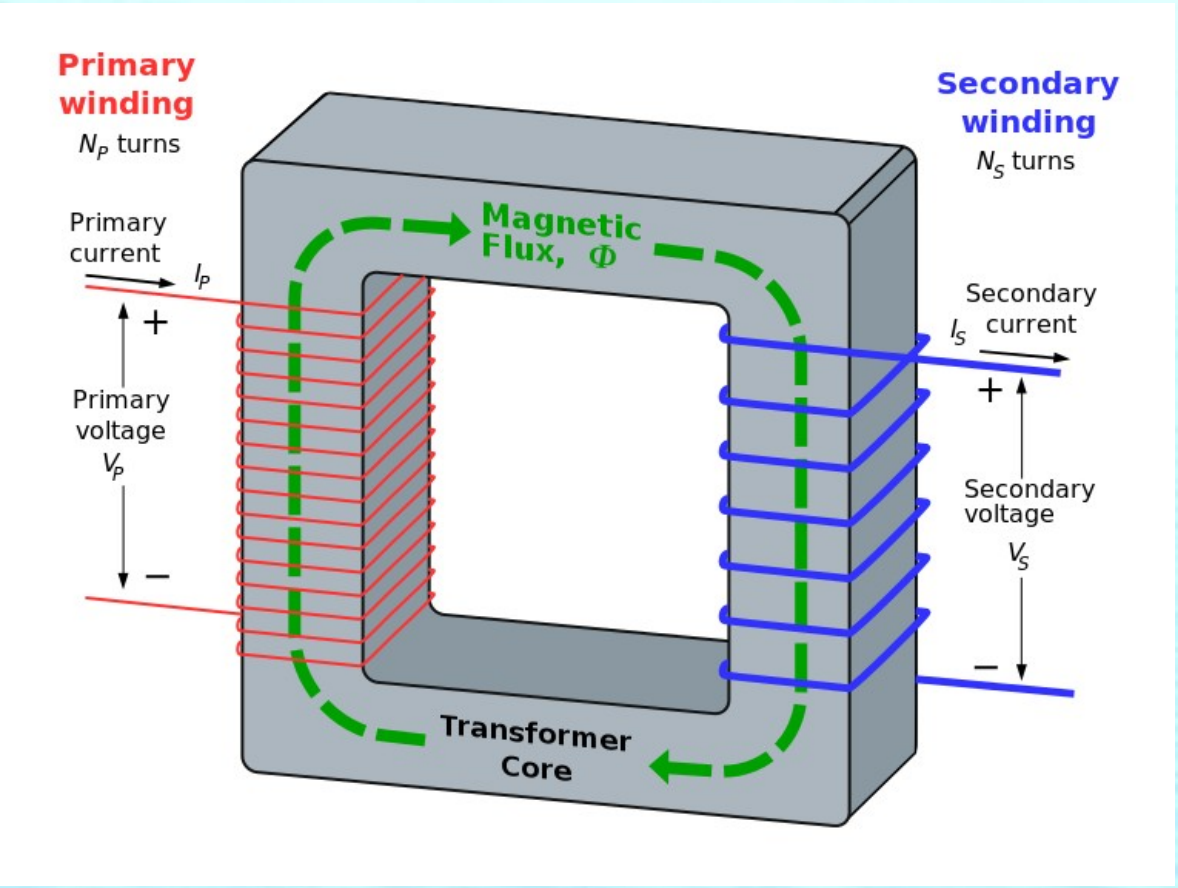
[D] $\Phi(t) = NBA\cos(2\pi 60t)$

How a transformer works

Transformers convert voltages.
They take 120 V from the wall and convert it to 12 V or 5 V for your computer.
They take 100,000 V from a transmission line and convert to 120 V at your house.

Faraday's law, generators and transformers

http://phet.colorado.edu/en/simulation/faraday



How a transformer works

Current comes in the "primary" coil and makes
A magnetic field.
Changes in that current change the field.
A "secondary" coil
Sees these changes
As changing flux and
Makes a new EMF.

Deriving the Transformer Equation

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

Homework Problem 13

13) A transformer for a laptop computer converts a 120-V input to a 24 V output.

a) If the primary coil (the one that goes to the 120 V supply) has 50 turns, how many turns does the secondary have?

b) If the laptop uses 1.8 Amps at 24 V, and the transformer does not itself consume power, how much current is drawn from the 120 V outlet?

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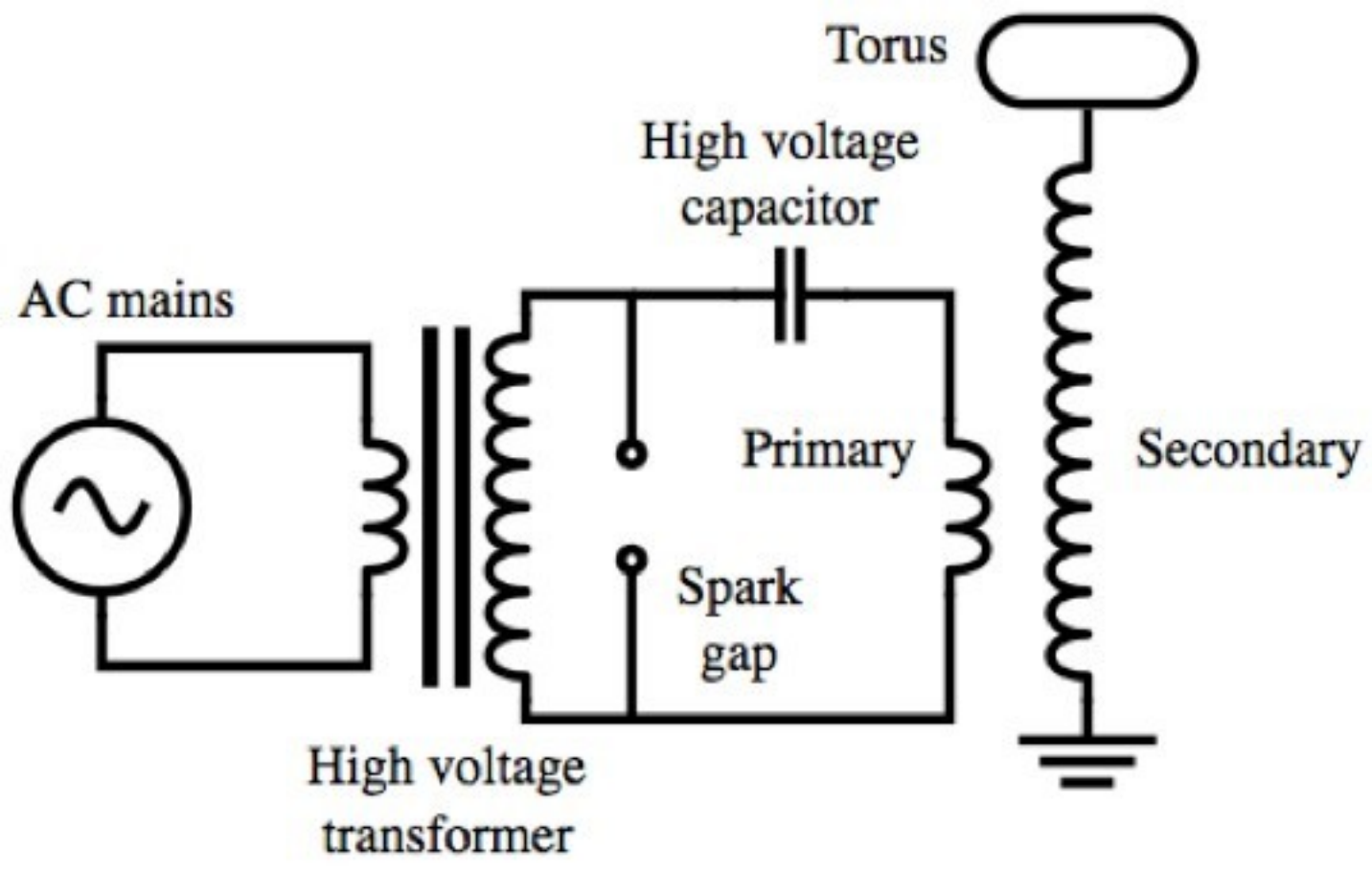
Tesla Coil


Torus
High voltage
capacitor
AC mains
Primary
Secondary
Spark
gap
High voltage
transformer

Next Time

Connection between Electromagnetism and waves