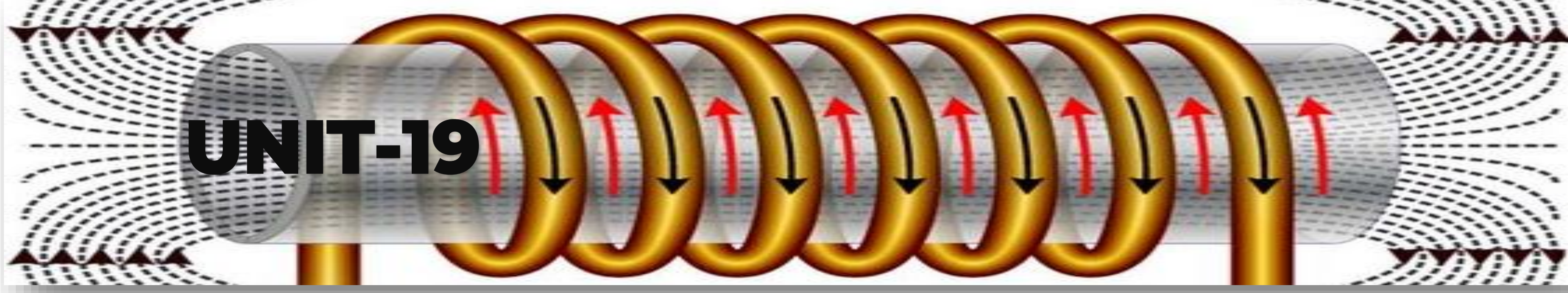


ELECTROMAGNETIC INDUCTION

1 **Two coils are placed adjacent to each other, and a change in current in the first coil induces an emf of 0.5 V in the second coil. If the mutual inductance is 0.2 H, calculate the rate of change of current in the first coil. (2.5A/s).**

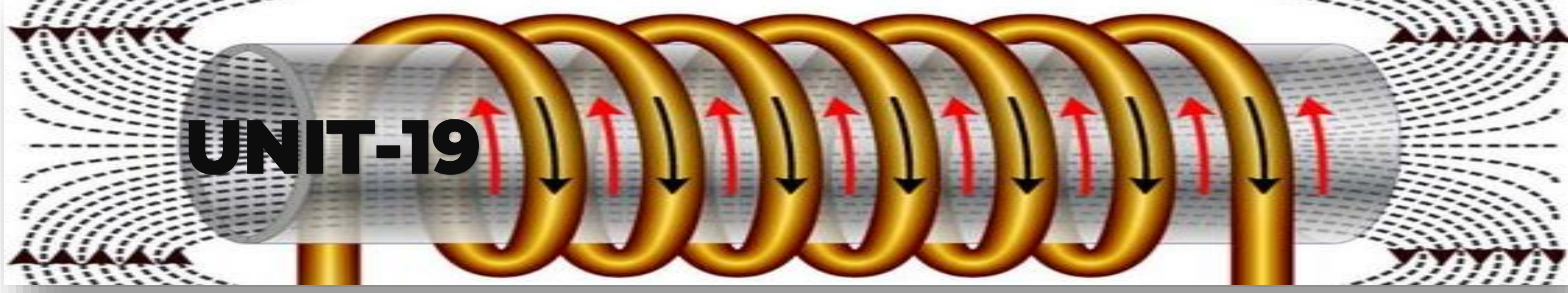
Data:	**SOLUTION:**
$(emf)_S = (\varepsilon_S) = 0.5\ \text{V}$ $M = 0.2\ \text{H}$ $\frac{\Delta I_P}{\Delta t} = ?$	$\varepsilon_S = M\left(\frac{\Delta I_P}{\Delta t}\right)$ $\left(\frac{\Delta I_P}{\Delta t}\right) = \frac{\varepsilon_S}{M}$ $\left(\frac{\Delta I_P}{\Delta t}\right) = \frac{0.5}{0.2}$ $\left(\frac{\Delta I_P}{\Delta t}\right) = 2.5\ A/s$

2 **A coil with an inductance of 0.5 H experiences a rate of change of current of 2 A/s. Calculate the induced EMF in the coil.**

Data:	**SOLUTION:**
$M = 0.5\ \text{H}$ $\frac{\Delta I_P}{\Delta t} = 2\ \text{A/s}$ $(emf)_S = ?$	$(emf)_s = -M\left(\frac{\Delta I_P}{\Delta t}\right)$ $(emf)_s = -(0.5)\,(2)$ $(emf)_s = -1.0\ V$

3 **Two coils are placed close to each other. If a change in current of 3 A/s in the first coil induces an EMF of 4 V in the second coil, calculate the mutual inductance.**

Data:	**SOLUTION:**
$M = 0.5\ \text{H}$ $\frac{\Delta I_P}{\Delta t} = 2\ \text{A/s}$ $(emf)_S = ?$	$(emf)_s = -M\left(\frac{\Delta I_P}{\Delta t}\right)$ $(emf)_s = -(0.5)\,(2)$ $(emf)_s = -1.0\ V$



3 **Two coils are placed close to each other. If a change in current of 3 A/s in the first coil induces an EMF of 4 V in the second coil, calculate the mutual inductance.**

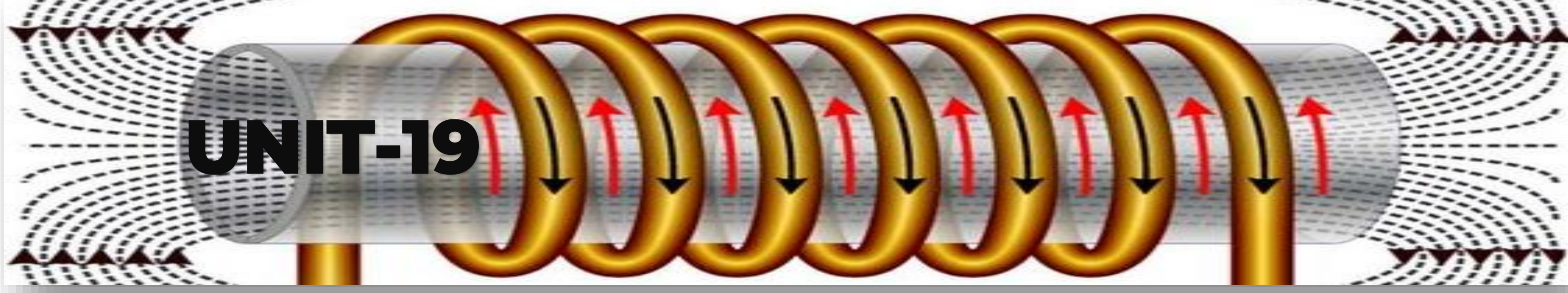
Data:	SOLUTION:
$\frac{\Delta I_P}{\Delta t} = 3\ A/s$ $(emf)_S = 4\ V$ $M = ?$	$(emf)_s = M\left(\frac{\Delta I_P}{\Delta t}\right)$ $4 = M\ (3)$ $M = \frac{4}{3}$ $M = 1.33\ H$

4 **A transformer has 200 turns in the primary coil and 400 turns in the secondary coil. If the primary voltage is 120 V, calculate the secondary voltage for a step-up transformer.**

Data:	SOLUTION:
$N_P = 200$ turns $N_S = 400$ turns $V_P = 120$ To-determine $V_S = ?$	$\frac{V_S}{V_P} = \frac{N_S}{N_P}$ $\frac{V_S}{120} = \frac{400}{200}$ $V_S = \frac{400}{200} \times 120$ $V_S = 240\ V$

5 **An inductor with an inductance of 0.02 H has a current flowing through it of 2 A. Calculate the energy stored in the inductor.**

Data:	SOLUTION:
$L = 0.02$ H $I = 2$ A To-determine $E = ?$	$E = \frac{1}{2} L\ I^2$ $E = \frac{1}{2}(0.02)\ (2)^2$ $E = 0.04\ J$



6 A coil stores energy in the form of electric potential energy of 0.2 J when it carries a current of 2A. Calculate the inductance of the coil.

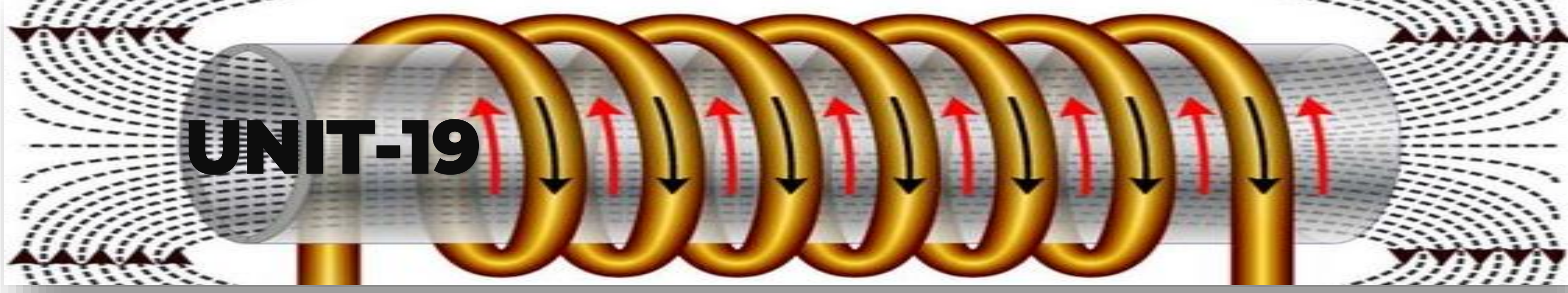
Data:	SOLUTION:
$E = 0.2\ \text{J}$ $I = 2\ \text{A}$ To-determine $L = ?$	$E = \frac{1}{2} L I^2$ $0.2 = \frac{1}{2} \times L \times (2)^2$ $L = 0.1\ H$

7 An AC generator produces an alternating current with a maximum voltage of 240 V. If The frequency of the generated AC is 50 Hz. Calculate the peak value of the voltage.

Data:	SOLUTION:
$V_{max} = V_{rms} = 240\ \text{V}$ $f = 50\ \text{Hz}$ To-determine $V_{peak} = ?$	The root mean square voltage for an AC generator is given by: $V_{rms} = \frac{V_{peak}}{\sqrt{2}}$ $V_{peak} = \sqrt{2}\ V_{rms}$ $V_{peak} = \sqrt{2}\ (240)$ $V_{peak} = 399.4\ V$

8 A transformer has 1000 turns in its primary coil and 200 turns in its secondary coil. If The primary voltage is 120 V. Calculate the secondary voltage for a step-down transformer.

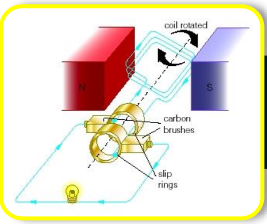
Data:	SOLUTION:
$N_P = 1000$ turns $N_S = 200$ turns $V_P = 120\ V$ To-determine $V_S = ?$	$\frac{V_S}{V_P} = \frac{N_S}{N_P}$ $\frac{V_S}{120} = \frac{200}{1000}$ $V_S = \frac{200}{1000} \times 120$ $V_S = 24\ V$



ELECTROMAGNETIC INDUCTION

9 **A conductor of length 0.4 m moves at a velocity of 5 m/s perpendicular to a magnetic field of 0.3 T. Calculate the motional EMF induced in the conductor.**

Data:	**SOLUTION:**
$L = 0.4\ \text{m}$ $v = 5\ \text{m/s}$ $B = 0.3\ \text{T}$ To-determine $emf = ?$	$emf = BvL$ $emf = 0.3 \times 5 \times 0.4$ $emf = 0.6\ V$



WORKED EXAMPLES

1 **A coil with 200 turns and an area of 0.03 square meters is placed in a uniform magnetic field of 0.4 Tesla. The coil is quickly pulled out of the magnetic field in 0.2 seconds. Calculate the induced electromotive force (emf) in the coil and determine the direction of the induced current.**

Data:	**SOLUTION:**
$N = 200\ \text{turns}$ $A = 0.03\ \text{m}^2$ $B = 0.4\ \text{T}$ $\Delta t = 0.2\ \text{s}$ To-determine $emf = ?$	Magnetic flux is given by $\Phi_1 = BA$ $\Phi_1 = (0.4)(0.03) = 0.012\ Wb$ $\Phi_2 = 0$ $emf = -N\dfrac{\Delta\Phi}{\Delta t} = -N\dfrac{\Phi_2 - \Phi_1}{\Delta t}$ $emf = -(200)\left(\dfrac{0 - 0.012}{0.2}\right)$ $emf = 12\ V$

2 **Suppose a step-up transformer has 200 turns in the primary coil and 800 turns in the secondary coil. If the voltage in the primary coils is 120 volts, calculate the voltage in the secondary coil.**

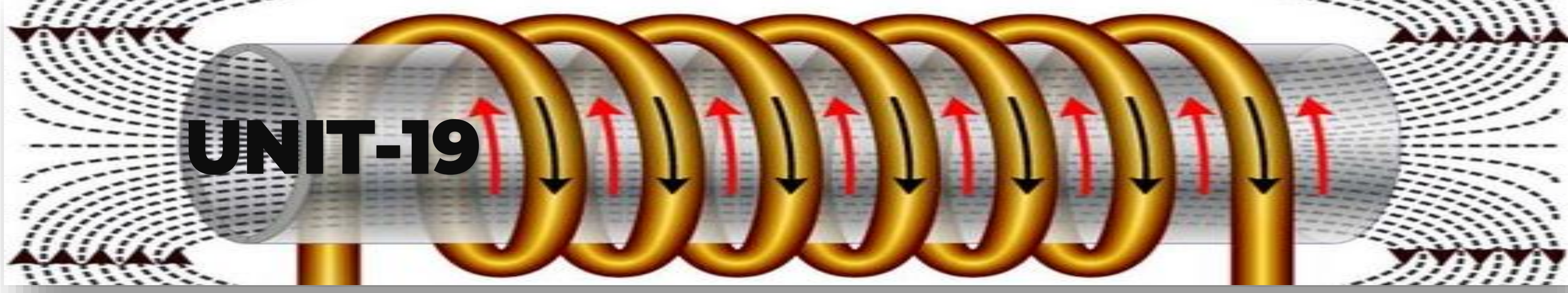
Data:	SOLUTION:
$N_P = 200$ turns $N_S = 800$ turns $V_P = 120\ V$ To-determine $V_S = ?$	$\frac{V_S}{V_P} = \frac{N_S}{N_P}$ $\frac{V_S}{120} = \frac{800}{200}$ $V_S = \frac{800}{200} \times 120$ $V_S = 480\ V$

3 **Let a step-down transformer have 600 turns in the primary coil and 150 turns in the secondary coil. The voltage in the primary coil is 240 volts. Calculate the voltage in the secondary coil.**

Data:	SOLUTION:
$N_P = 600$ turns $N_S = 150$ turns $V_P = 240\ V$ To-determine $V_S = ?$	$\frac{V_S}{V_P} = \frac{N_S}{N_P}$ $\frac{V_S}{240} = \frac{150}{600}$ $V_S = \frac{150}{600} \times 240$ $V_S = 60\ V$

4 **A straight conductor of length L = 0.5 meters moves at a velocity of 2 m/s perpendicular to a magnetic field B = 0.1 Tesla. Calculate the motional emf induced in the conductor.**

Data:	SOLUTION:
$L = 0.5$ m $v = 2$ m/s $B = 0.1$ T To-determine $emf = ?$	$emf = Bv\,L$ $emf = 0.1 \times 2 \times 0.5$ $emf = 0.1\ V$



5 An AC generator consists of a coil of 800 turns and a cross-sectional area of 2.5 m^2. The coil is placed in a uniform magnetic field of 0.05 T, and it is rotated with an angular speed of 50 rad/sec. If the resistance of the coil is 200 Ω, then find the maximum current produced by the generator:

Data:	SOLUTION:
$N = 800$	$emf_{max} = NBA\omega$
$A = 2.5\ \text{m}^2$	$I_{max} \times R = NBA\omega$
$B = 0.05\ \text{T}$	$I_{max} = \dfrac{NBA\omega}{R}$
$\omega = 50\ \text{rad/s}$	$I_{max} = \dfrac{(800)(0.05)(2.5)(50)}{200}$
$R = 200\ \Omega$	$I_{max} = \dfrac{5000}{200}$
To-determine	$I_{max} = 25\ A$
$I_{max} = ?$	

6 What is the mutual inductance of a pair of coils if a current change of 6 amperes in one coil causes the flux in the second coil of 2000 turns to change by 12 x10^{-4} wb?

Data:	SOLUTION:
$\Delta I_P = 6\ A$	We know,
$N_S = 2000\ turns$	$(emf)_S = -M\dfrac{\Delta I_p}{\Delta t}$
$\Delta\Phi_S = 12 \times 10^{-4}\ Wb$	$-N_S\dfrac{(\Delta\Phi)_S}{\Delta t} = -M\dfrac{\Delta I_p}{\Delta t}$
To-determine	$N_S\,(\Delta\Phi)_S = M\,\Delta I_p$
$M = ?$	$2000 \times 12 \times 10^{-4} = M \times 6$
	$2.4 = M \times 6$
	$M = 0.4\ H \quad or \quad 400\ mH$