SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)

COIMBATORE-35

Accredited by NBA-AICTE and Accredited by NAAC – UGC with A+ Grade

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19EEB102 / ELECTRIC CIRCUIT ANALYSIS

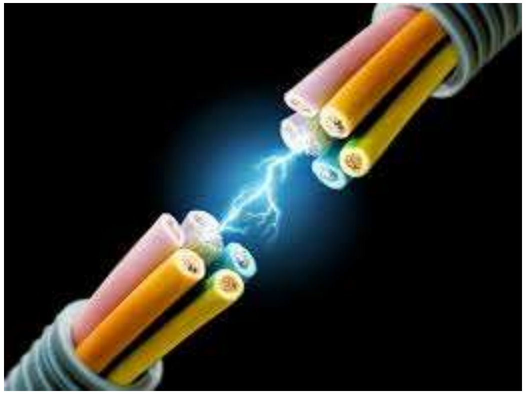
I YEAR / II SEMESTER

UNIT-IV: RESONANCE and COUPLED CIRCUITS

COEFFICIENT OF COUPLING

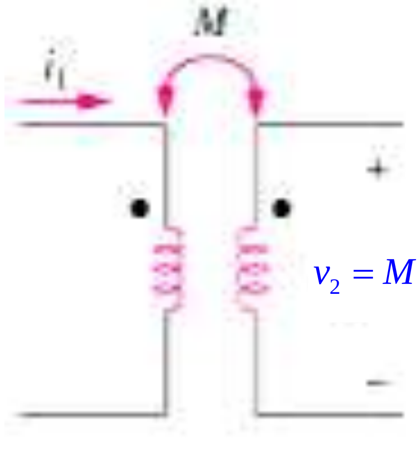
TOPIC OUTLINE

- Dot Convention
- Coefficient of Coupling
- Problems



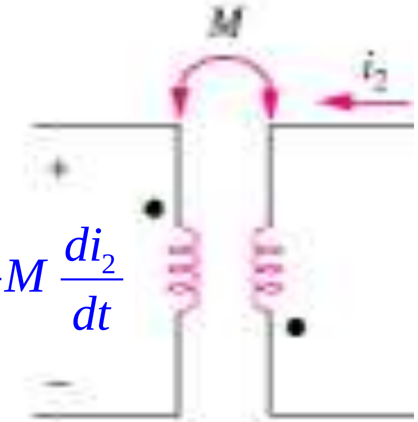
Dot Convention

- **If the current ENTERS the dotted terminal of one coil, the reference polarity of the mutual voltage in the second coil is POSITIVE at the dotted terminal of the second coil.**
  If the current LEAVES the dotted terminal of one coil, the reference polarity of the mutual voltage in the second coil is NEGATIVE at the dotted terminal of the second coil.



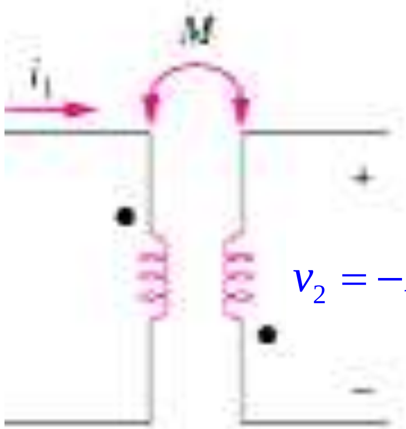
$$v_2 = M\frac{di_1}{dt}$$

(a)



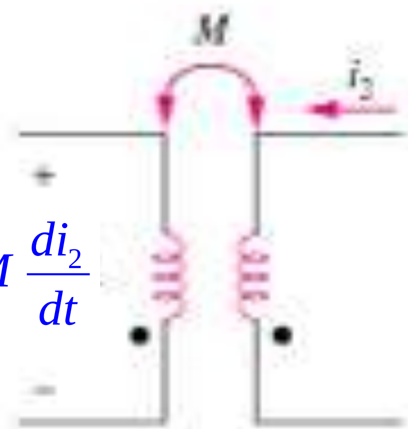
$$v_1 = -M\frac{di_2}{dt}$$

(c)



$$v_2 = -M\frac{di_1}{dt}$$

(b)



$$v_1 = M\frac{di_2}{dt}$$

(d)

Dot Convention

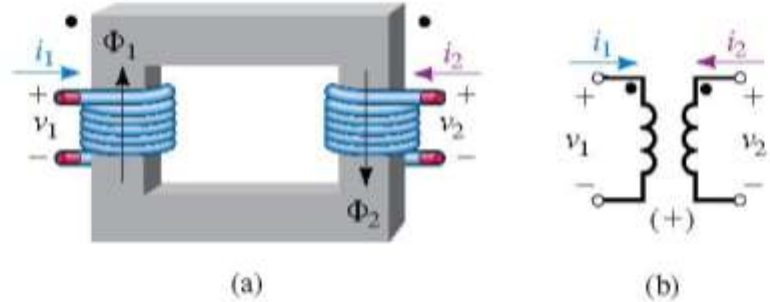


FIGURE 24–52 When both currents enter dotted terminals, use the + sign for the mutual term in Equation 24–15.

therefore, the voltage across coil 1 is the sum of that produced by i_1 and i_2. That is,

$$v_1 = L_1 \frac{di_1}{dt} + M \frac{di_2}{dt} \tag{24–15a}$$

Similarly, for coil 2,

$$v_2 = M \frac{di_1}{dt} + L_2 \frac{di_2}{dt} \tag{24–15b}$$

Now consider Figure 24–53. Here, the fluxes oppose and the flux linking each coil is the *difference* between that produced by its own current and that produced by the current of the other coil. Thus, the sign in front of the mutual voltage terms will be negative.

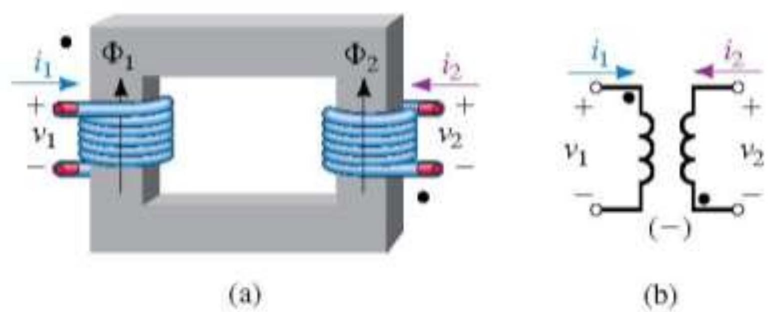
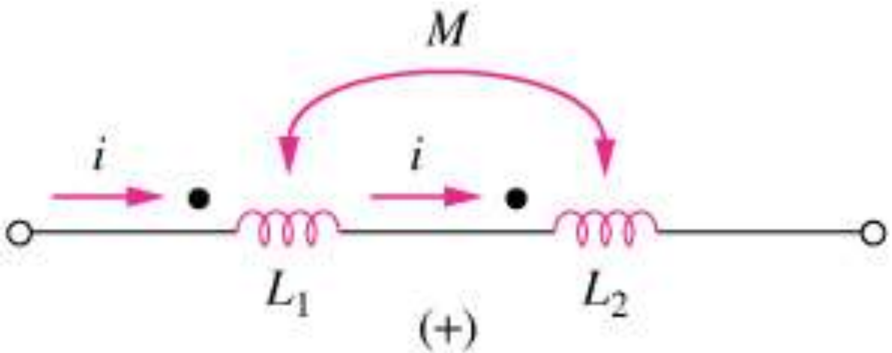
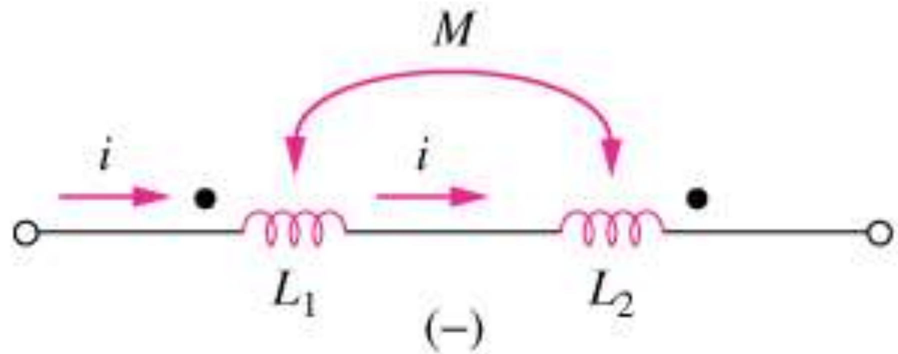


FIGURE 24–53 When one current enters a dotted terminal and the other enters an undotted terminal, use the − sign for the mutual term in Equation 24–15.

Coils in Series

➢ The total inductance of two coupled coils in series depend on the placement of the dotted ends of the coils. The mutual inductances may add or subtract.



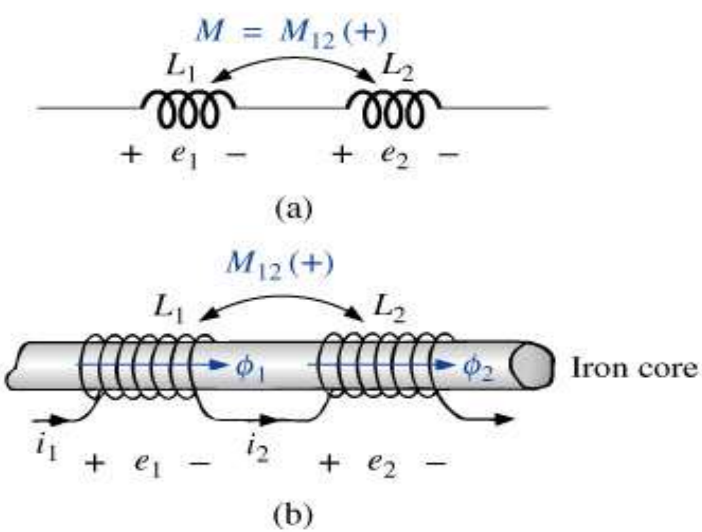


a) Series-aiding connection.

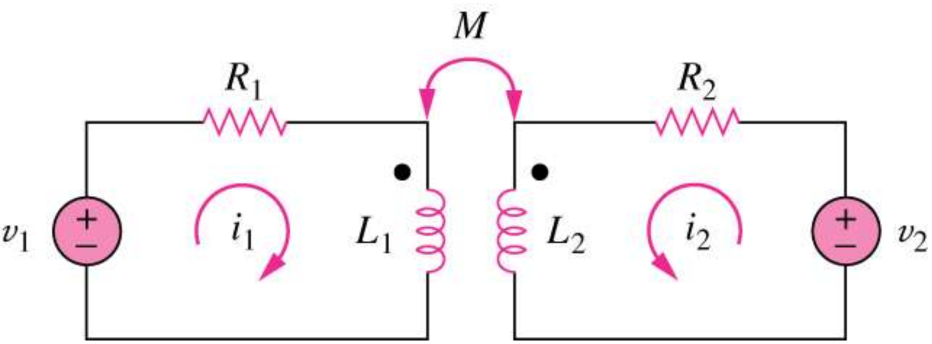
$L=L_1+L_2+2M$

b) Series-opposing connection.

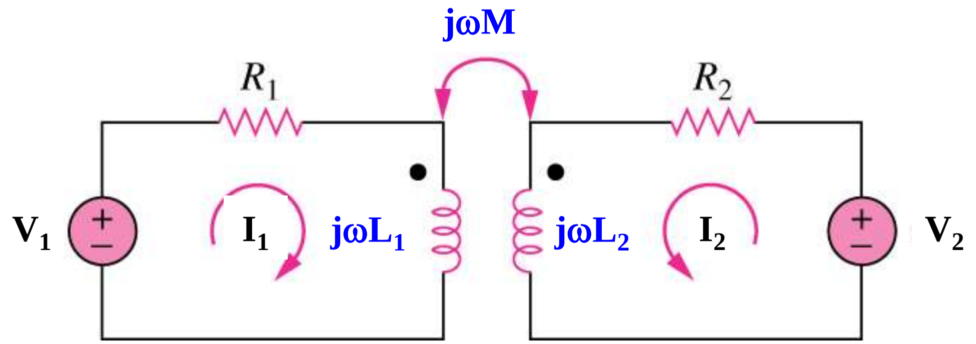
$L=L_1+L_2-2M$



Time-domain and Frequency-domain Analysis



a) Time-domain circuit



b) Frequency-domain circuit

Time Domain

$$v_1 = i_1 R_1 + L_1 \frac{di_1}{dt} + M \frac{di_2}{dt}$$

$$v_2 = i_2 R_2 + L_2 \frac{di_2}{dt} + M \frac{di_1}{dt}$$

Frequency Domain

$$V_1 = (R_1 + j\omega L_1) I_1 + j\omega M I_2$$

$$V_2 = j\omega M I_1 + (R_2 + j\omega L_2) I_2$$

Energy in a Coupled Circuit

- The total energy *w* stored in a mutually coupled inductor is:
- **Positive sign** is selected if both currents ENTER or LEAVE the dotted terminals.
- Otherwise we use Negative sign.

$$w = \frac{1}{2} L_1 i_1^{\ 2} + \frac{1}{2} L_2 i_2^{\ 2} \pm M i_1 i_2$$

Coupling Coefficient

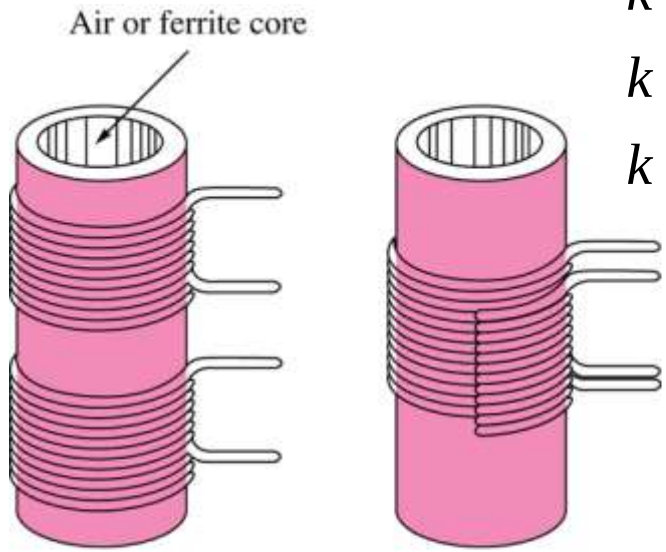
- The Coupling Coefficient k is a measure of the magnetic coupling between two coils

$$0 \le k \le 1$$

$k = 1$ Perfect Coupling

$k < 0.5$ Loosly Coupling

$k > 0.5$ Tightly Coupling



a) Loosely coupled coil b) Tightly coupled coil

$$0 \le k \le 1$$

$$k = \frac{M}{\sqrt{L_1 L_2}}$$

Circuits

Thank you