ECE 2100
Circuit Analysis

Lesson 22
Chapter 6:
Inductance 1, 2

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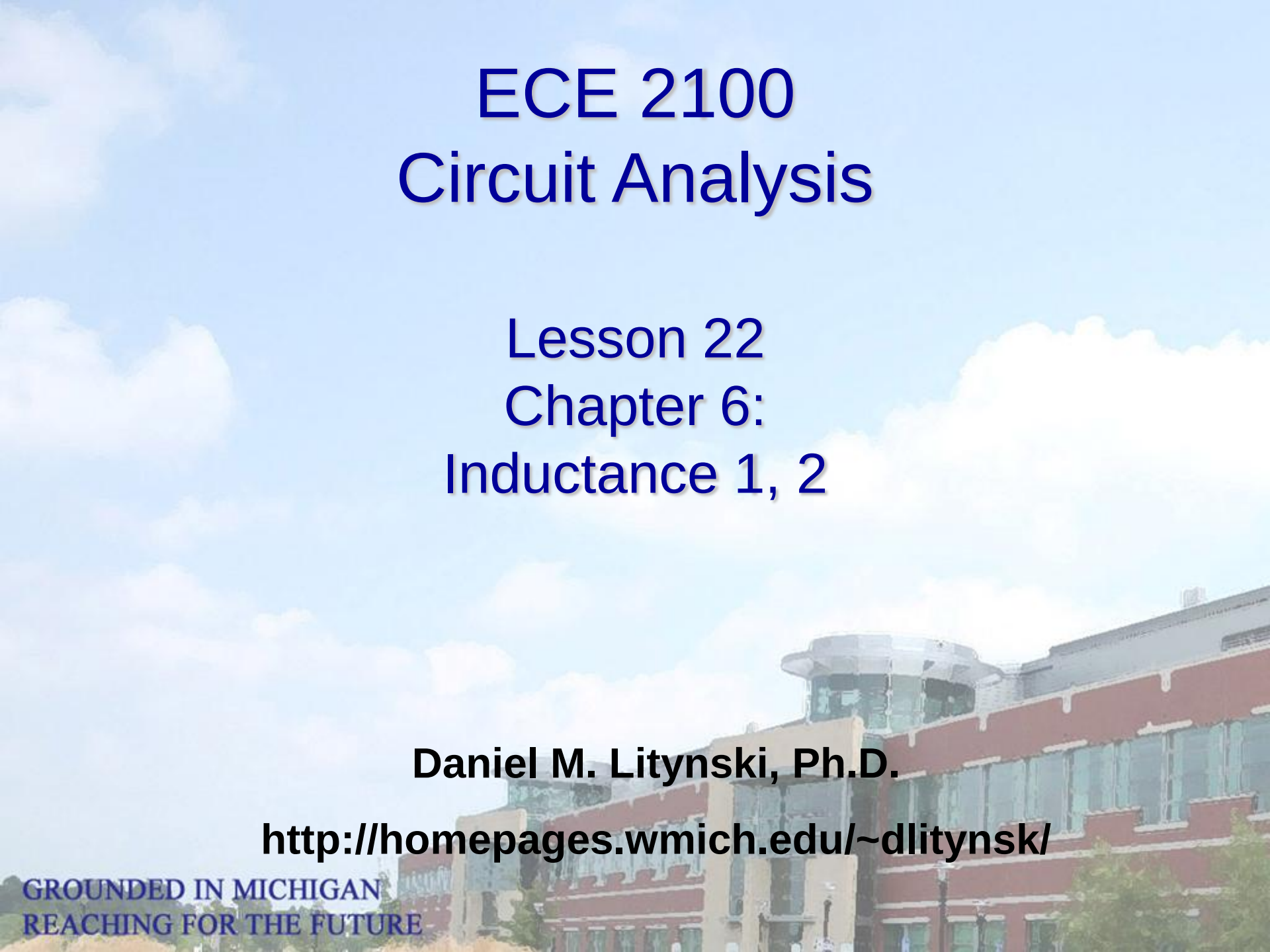

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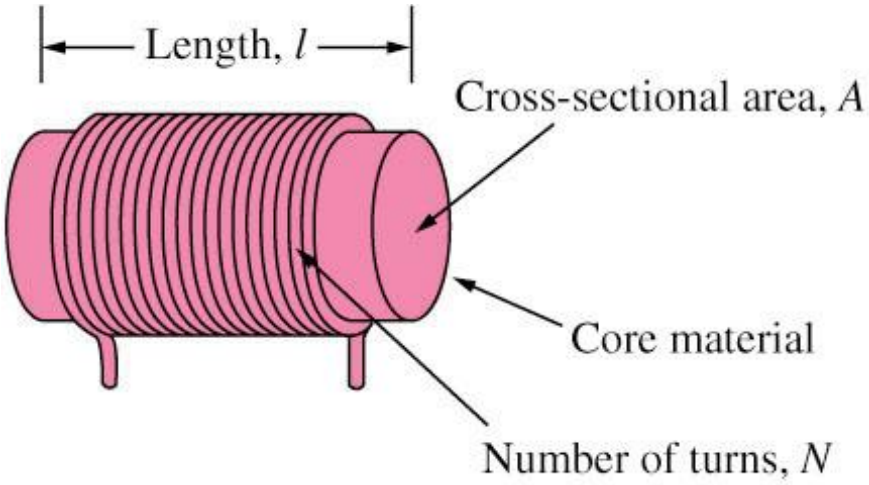
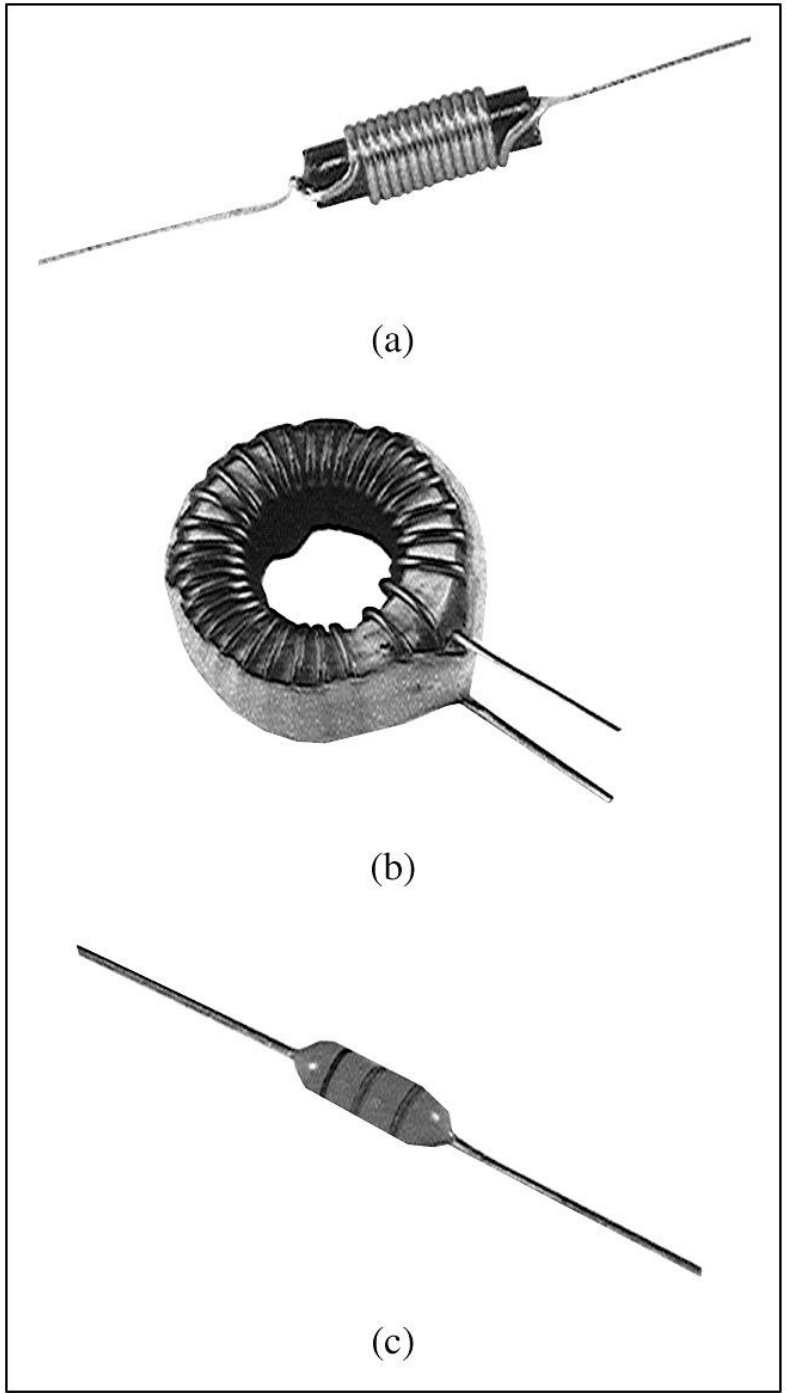
6.3 Inductors (1)

- An inductor is a passive element designed to store energy in its magnetic field.



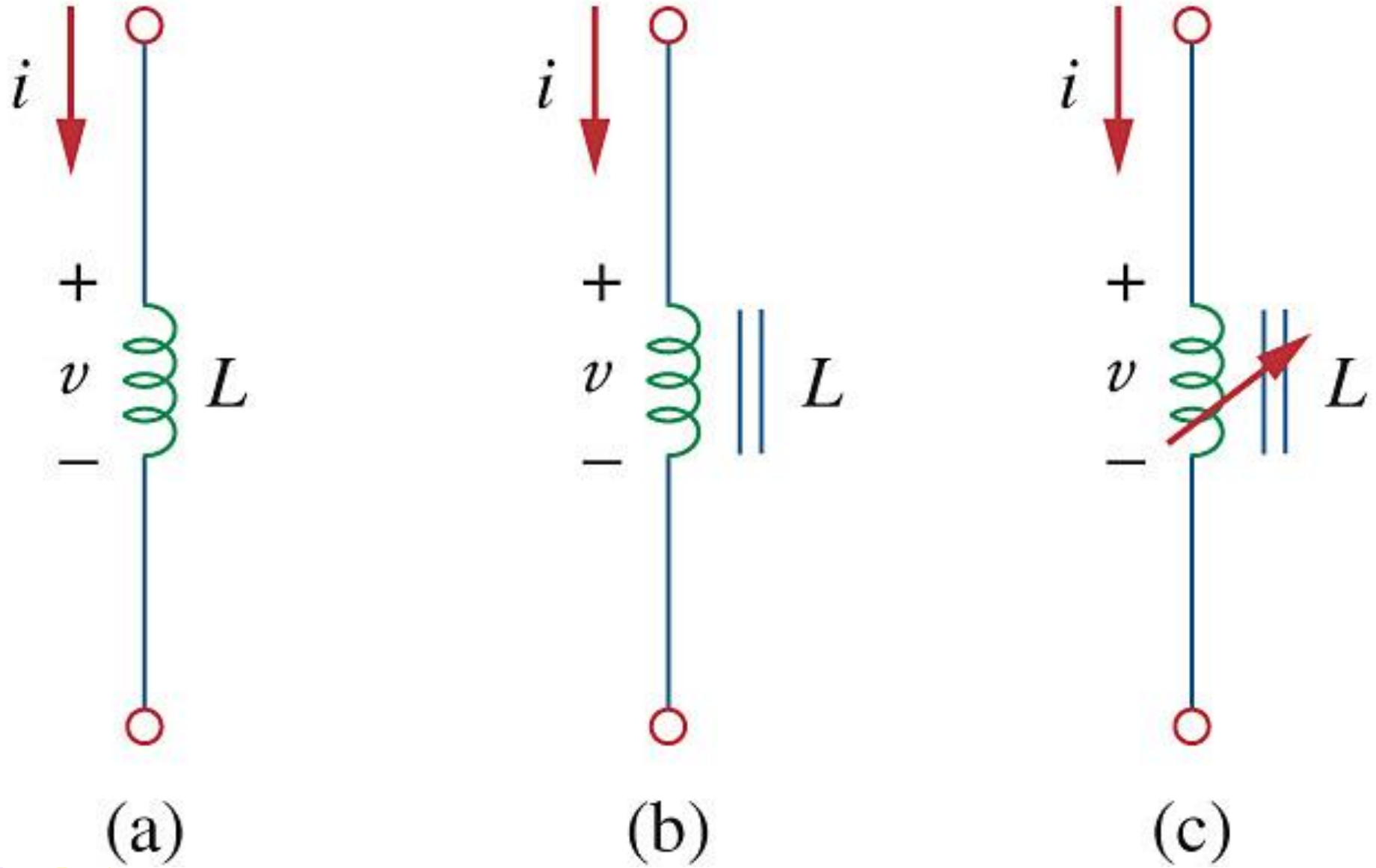
- An inductor consists of a coil of conducting wire.

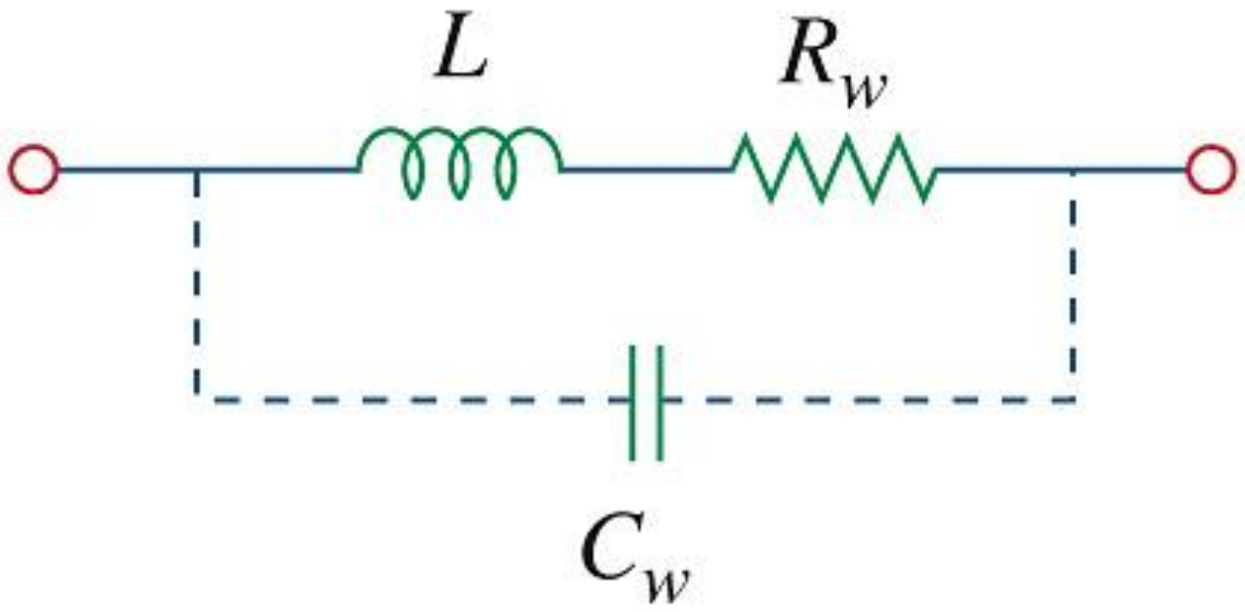


(a)

(b)

(c)





6.3 Inductors (2)

- Inductance is the property whereby an inductor exhibits opposition to the change of current flowing through it, measured in henrys (H).

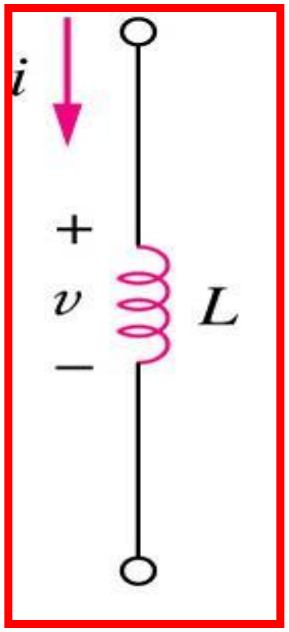
$$v = L\frac{d\,i}{d\,t} \qquad L = \frac{N^2\,\mu\,A}{l}$$

- The unit of inductors is Henry (H), mH (10^{-3}) and μH (10^{-6}).

6.3 Inductors (3)

- The current-voltage relationship of an inductor:

$$i = \frac{1}{L}\int_{t_0}^{t} v(t)\,dt + i(t_0)$$



- The power stored by an inductor:

$$w = \frac{1}{2} L\, i^2$$

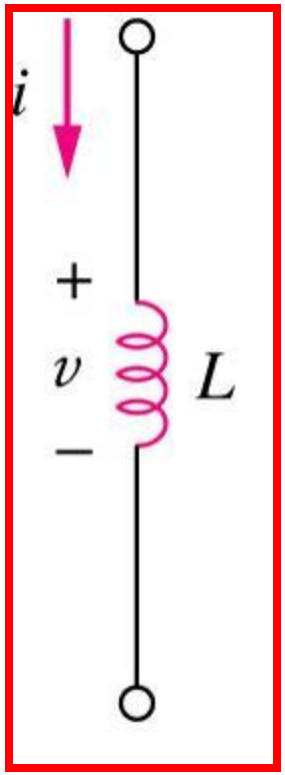
- An inductor acts like a short circuit to dc (di/dt = 0) and its current cannot change abruptly.

6.3 Inductors (4)

Example 5

The terminal voltage of a 2-H inductor is

$$v = 10(1-t)\ V$$



Find the current flowing through it at t = 4 s and the energy stored in it within 0 < t < 4 s.

Assume i(0) = 2 A.

Answer:

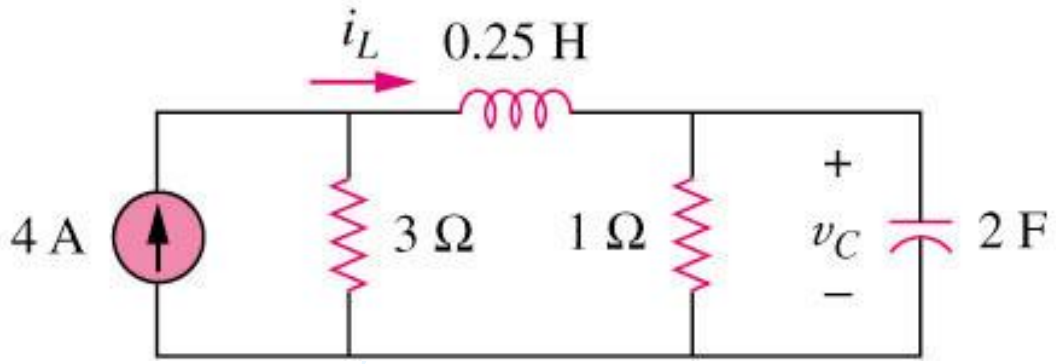
i(4s) = -18V

w(4s) = 320J

6.3 Inductors (5)

Example 6

Determine v_C, i_L, and the energy stored in the capacitor and inductor in the circuit of circuit shown below under dc conditions.



Answer:

i_L = 3A

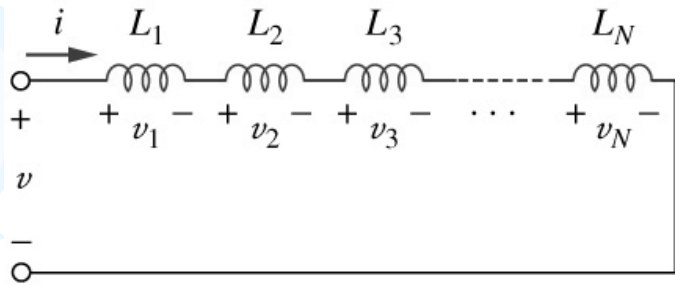
v_C = 3V

w_L = 1.125J

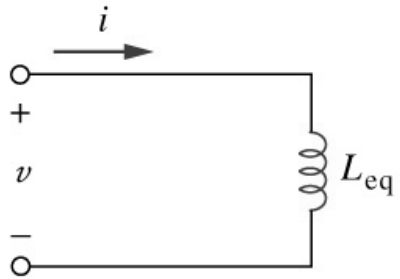
w_C = 9J

6.4 Series and Parallel Inductors (1)

- The equivalent inductance of **series-connected** inductors is the sum of the individual inductances.



(a)

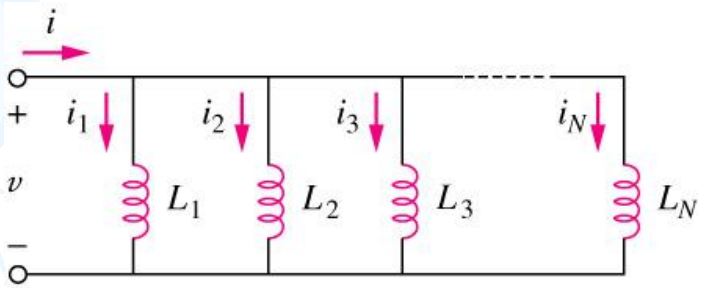


(b)

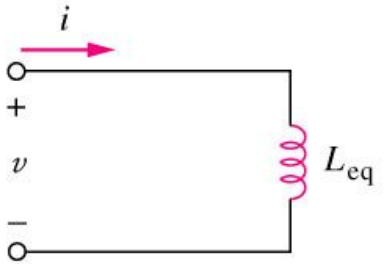
$$L_{eq} = L_1 + L_2 + \ldots + L_N$$

6.4 Series and Parallel Inductors (2)

- The equivalent capacitance of **parallel** inductors is the reciprocal of the sum of the reciprocals of the individual inductances.



(a)



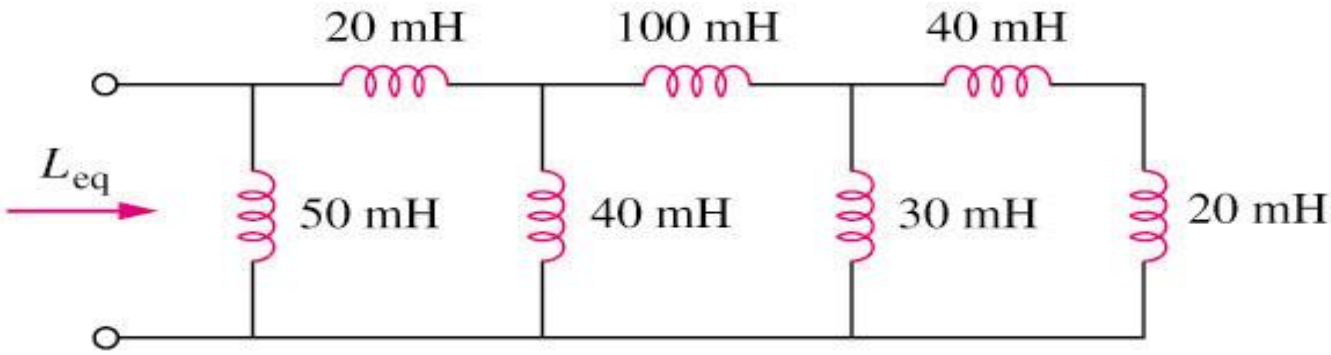
(b)

$$\frac{1}{L_{eq}} = \frac{1}{L_1} + \frac{1}{L_2} + \ldots + \frac{1}{L_N}$$

6.4 Series and Parallel Inductors (3)

Example 7

Calculate the equivalent inductance for the inductive ladder network in the circuit shown below:



Answer:

L_{eq} = 25mH

6.4 Series and Parallel Inductors (4)

- Current and voltage relationship for R, L, C

Circuit element	Units	Voltage	Current	Power
 Resistance	ohms (Ω)	$v = Ri$ **(Ohm's law)**	$i = \frac{v}{R}$	$p = vi = i^2R$
 Inductance	henries (H)	$v = L\frac{di}{dt}$	$i = \frac{1}{L}\int v\,dt + k_1$	$p = vi = Li\frac{di}{dt}$
 Capacitance	farads (F)	$v = \frac{1}{C}\int i\,dt + k_2$	$i = C\frac{dv}{dt}$	$p = vi = Cv\frac{dv}{dt}$

Capacitors and Inductors
Chapter 6

6.1 Introduction

6.2 Capacitors

6.3 Series and Parallel Capacitors

6.4 Inductors

6.5 Series and Parallel Inductors

6.6 Applications