General Physics I

Mechanics, optics, thermal dynamics, and other basic fundamental things.

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Review:

A **conservative force** is a force whose work done is *independent* of the path taken and depends *only* on the *initial and final positions*.

Review:

Curl-less field. The following conditions are equivalent

(a) $\overrightarrow{\nabla} \times \overrightarrow{F} = 0$, everywhere

(b) $\int_a^b \overrightarrow{F} \cdot d\vec{l}$ is indecent of path, for any given end points

(c) $\oint \overrightarrow{F} \cdot d\vec{l} = 0$, for any closed loop

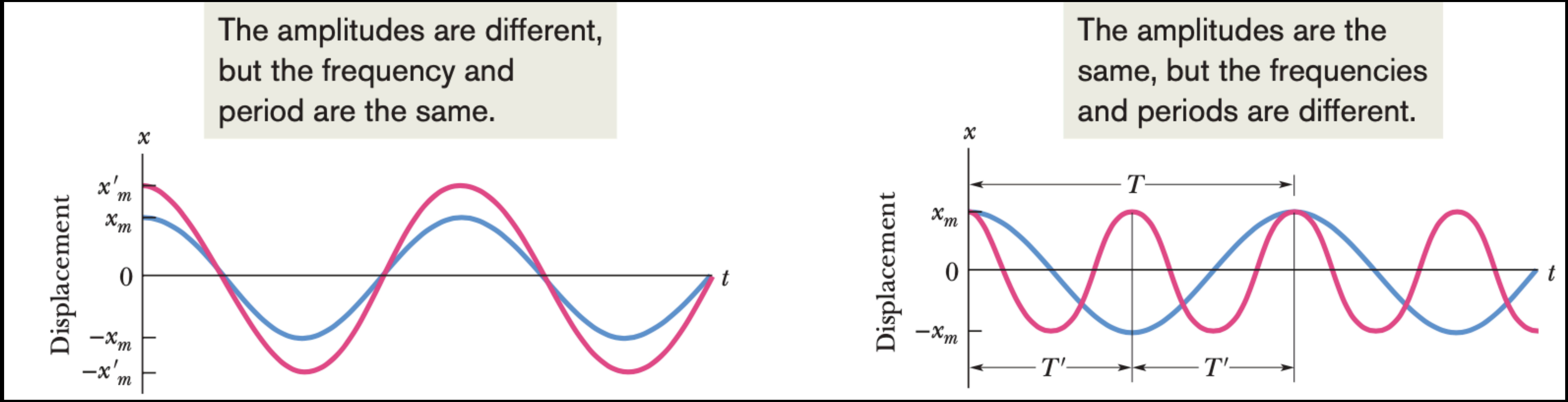
(d) $\overrightarrow{F}$ is the gradient of some scalar, $\overrightarrow{F} = -\overrightarrow{\nabla} U$

U is the scalar potential of the field $\overrightarrow{F}$

Lecture VI : simple harmonic motion

The period of revolution T : considering the $s = 2\pi r$

$T = \dfrac{1}{f}$ The frequency: f $\qquad x(t) = x_m \cos(\omega t + \phi)$



Lecture VI : simple harmonic motion

The period of revolution T : considering the $s = 2\pi r$

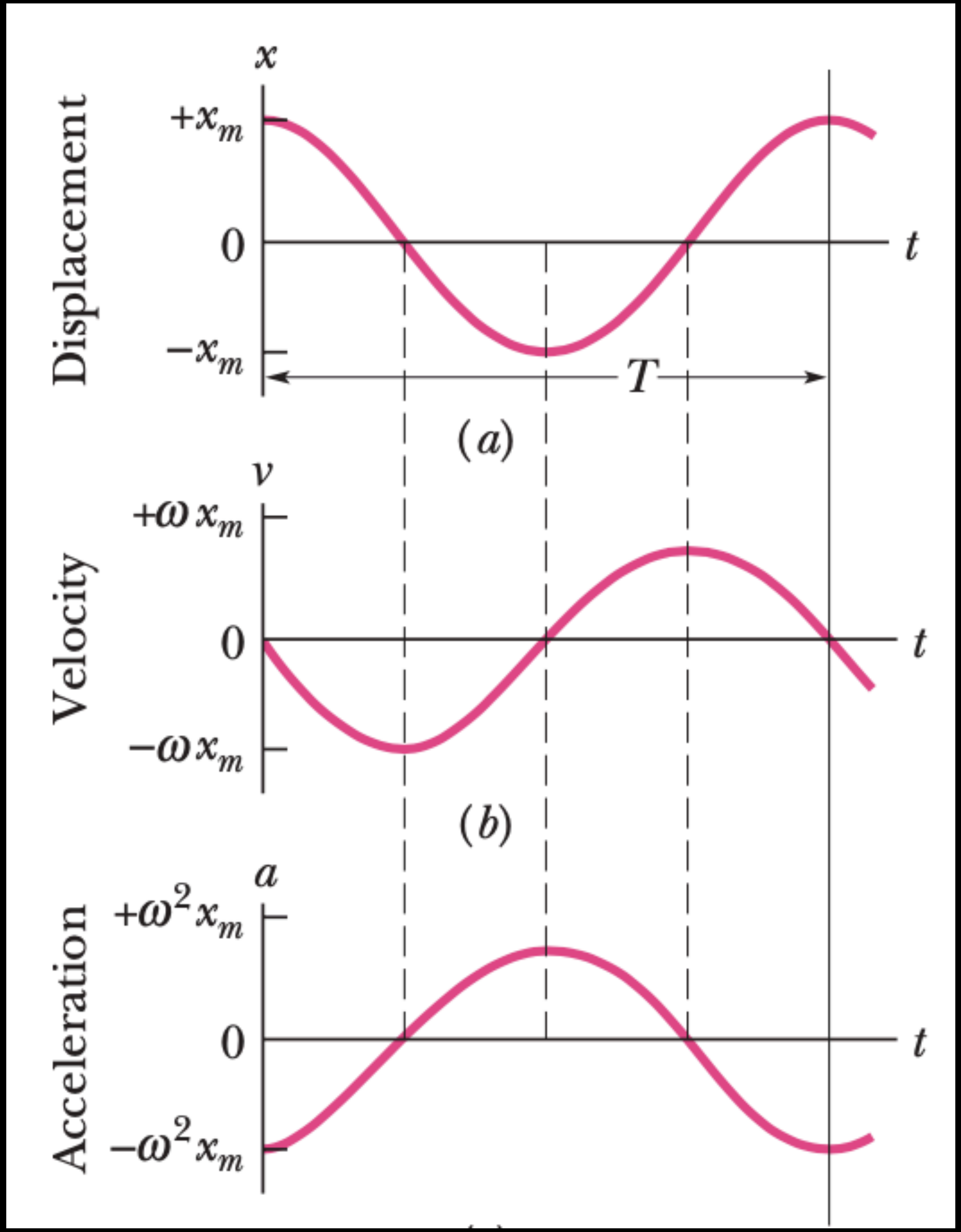
$$x(t) = x_m \cos(\omega t + \phi) \rightarrow x_m \cos(\omega t + \omega T)$$

$$= x_m \cos(\omega t)$$

$$\omega T = 2\pi$$

$$\omega = \frac{2\pi}{T} = 2\pi f$$

Lecture VI : simple harmonic motion

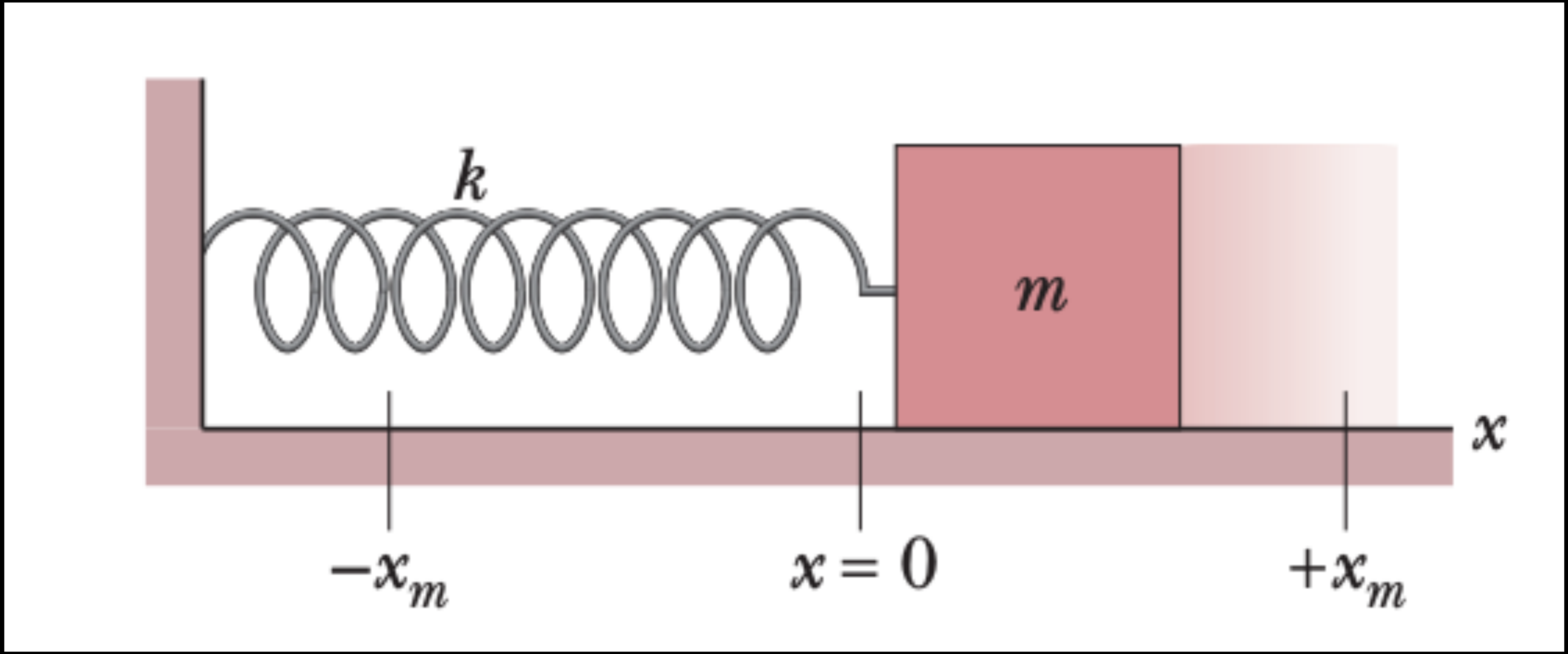


$$x(t) = x_m \cos(\omega t + \phi)$$

$$v(t) = -x_m \omega \sin(\omega t + \phi)$$

$$a(t) = -x_m \omega^2 \cos(\omega t + \phi)$$
$$= -\omega^2 x(t)$$

Lecture VI : simple harmonic motion



Hooke's law $F = -kx$

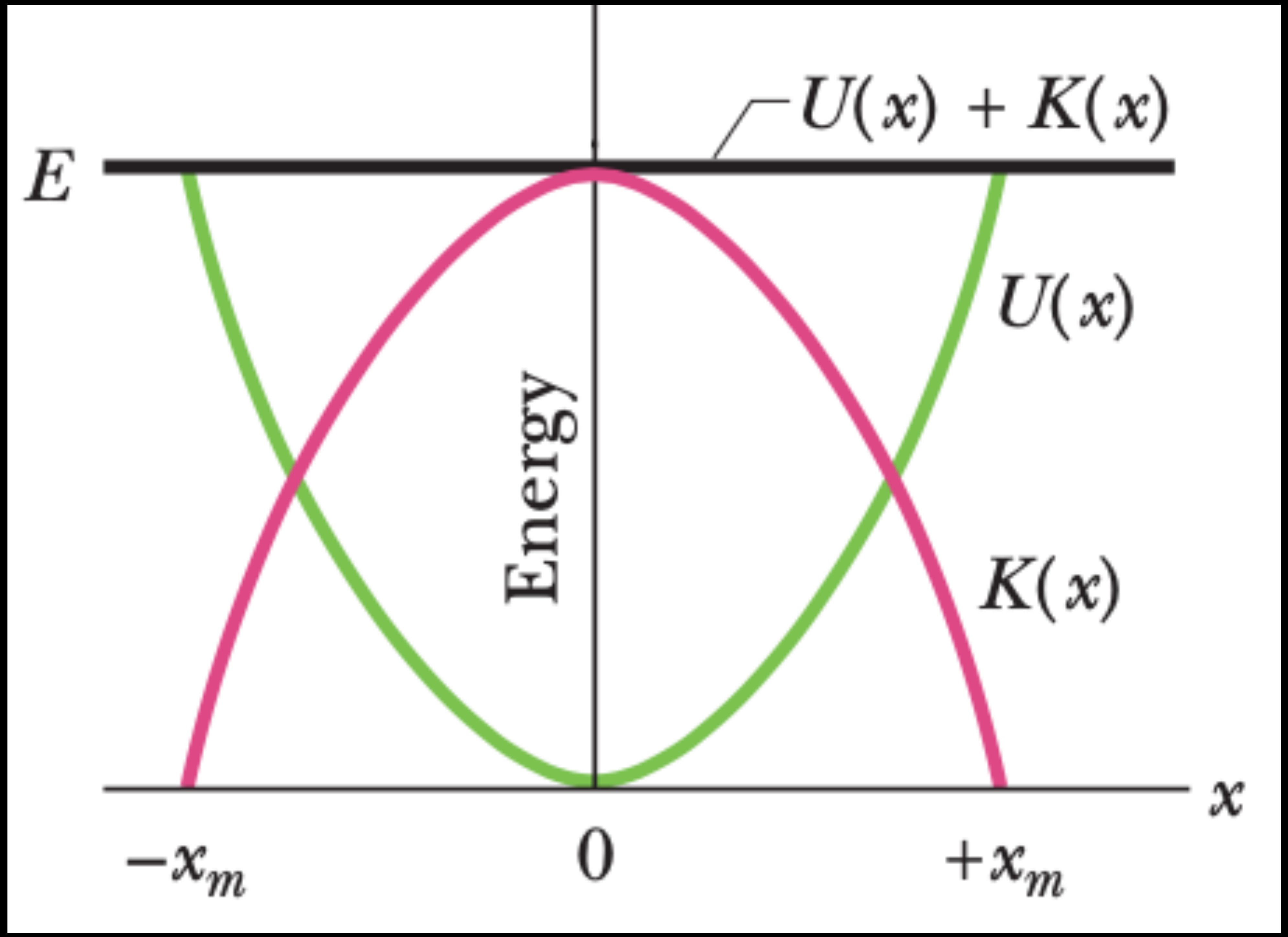
Lecture VI : Energy of SHM

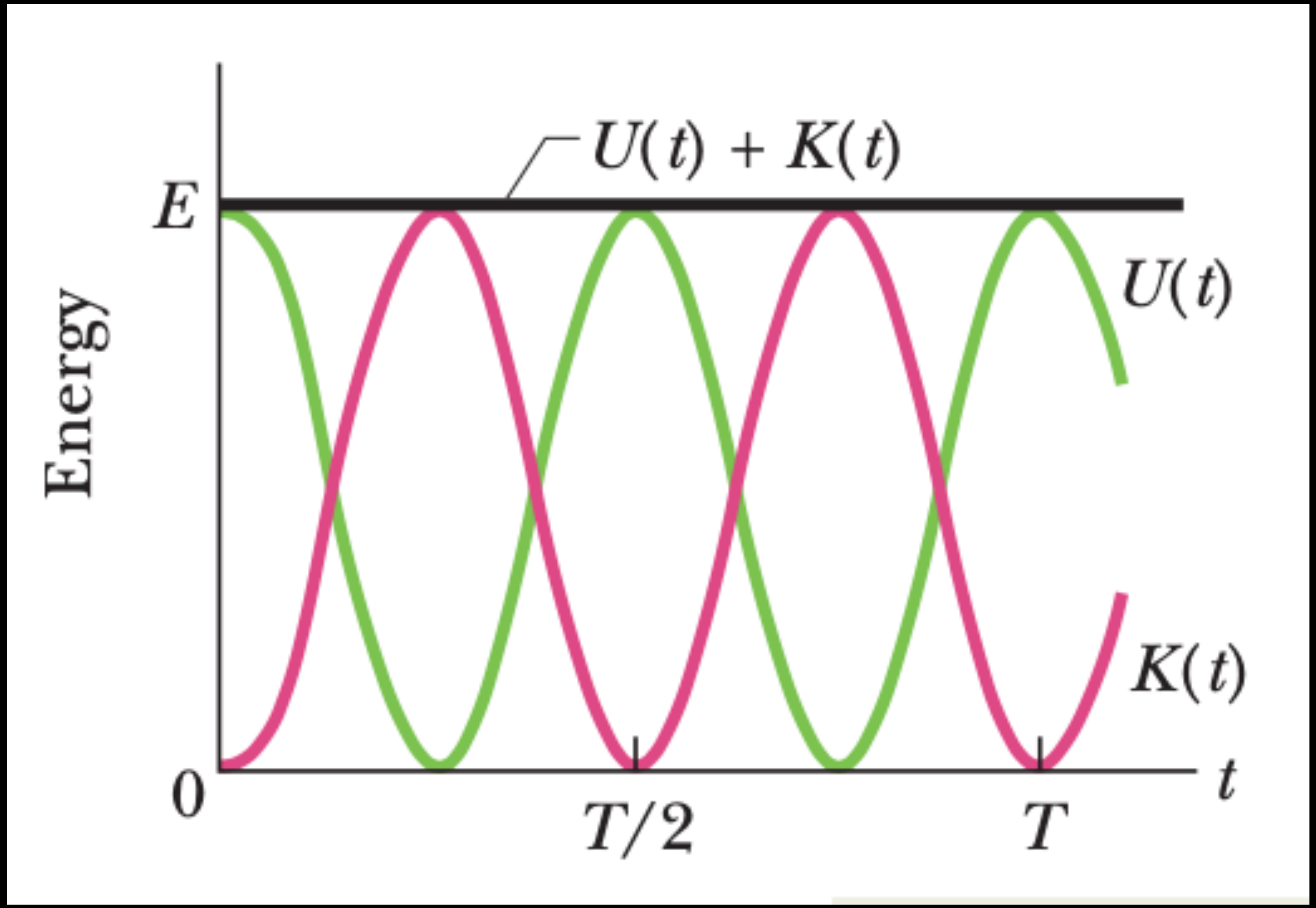
Hooke's law

$F = -kx$

$x(t) = x_m \cos(\omega t + \phi)$ $\quad v(t) = -x_m \omega \sin(\omega t + \phi)$

$a(t) = -x_m \omega^2 \cos(\omega t + \phi)$





Lecture VI : Torsion pendulum

$$\tau = -k\theta$$

$$-k\theta = I\ddot{\theta}$$

$$\theta = A\cos\left(\sqrt{\frac{k}{I}}t - \phi\right)$$

$$\omega = \sqrt{\frac{k}{I}} = 2\pi f$$

$$f = \frac{1}{2\pi}\sqrt{\frac{k}{I}} \qquad T = 2\pi\sqrt{\frac{I}{k}}$$

Lecture VI : Pendulum

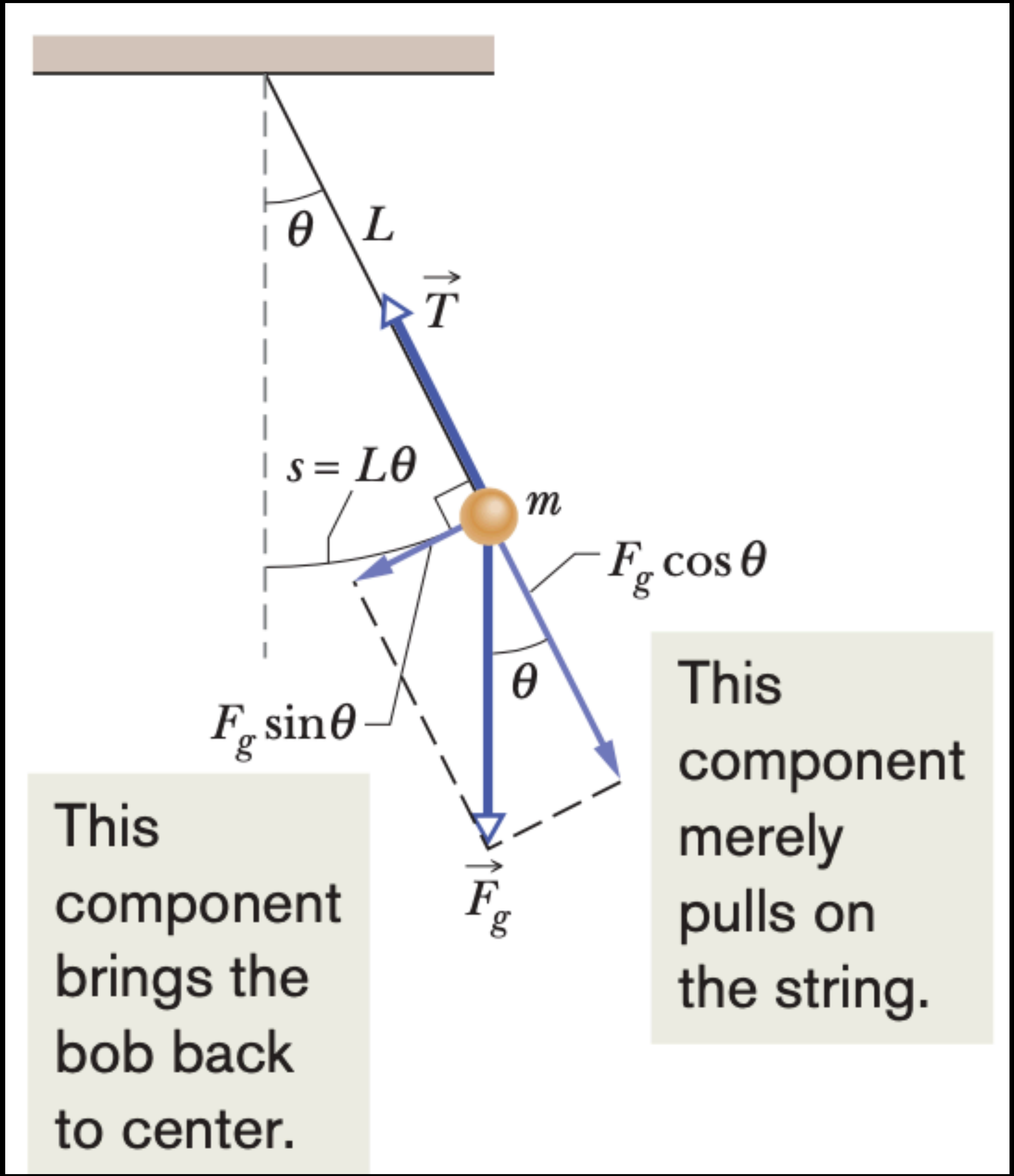
$$\tau = -L(F_g \sin\theta)$$

$$-L(mg\sin\theta) \sim -L(mg\theta) = I\ddot{\theta}$$

$$\theta = A\cos\left(\sqrt{\frac{mgL}{I}}t - \phi\right)$$

$$\omega = \sqrt{\frac{mgL}{I}} = 2\pi f$$

$$f = \frac{1}{2\pi}\sqrt{\frac{mgL}{I}} \qquad T = 2\pi\sqrt{\frac{I}{mgL}}$$



Lecture VI : Forced oscillation

Consider a external force $\overrightarrow{F}_{ex}(t)$ acts on the system

$$ma = \sum \overrightarrow{F} = -kx - \overrightarrow{F}_{ex}(t)$$

$$\overrightarrow{F}_{ex}(t) = F_o \cos(\omega t)$$

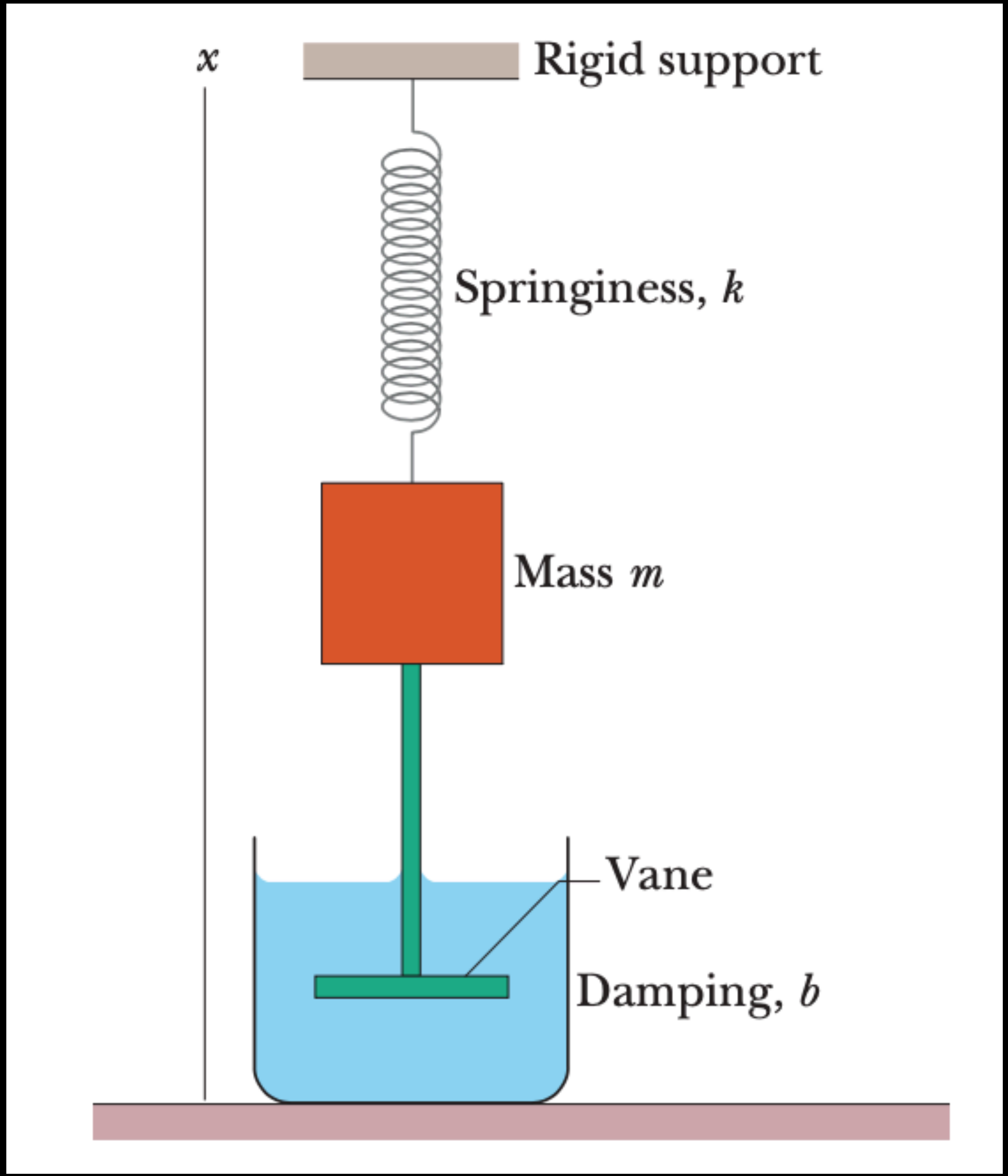
$$m\ddot{x} = -kx - F_o \cos(\omega t) \qquad x(t) = A_o \cos(\omega t + \phi)$$

$$m\omega^2 A_o \cos(\omega t) = -kA_o \cos(\omega t) - F_o \cos(\omega t)$$

$$k = m\omega_o^2 \qquad A_o = \frac{F_o}{m(\omega_o^2 - \omega^2)}$$

Lecture VI : damped motion

$$ma = \overrightarrow{F} = -kx - bv$$



Lecture VI : Forced damped motion

$$ma = \sum \overrightarrow{F} = -kx - bv - \overrightarrow{F}_{ex}$$

$$\overrightarrow{F}_{ex}(t) = F_o \cos(\omega t)$$