Instantaneous power absorbed by the system:

$$P(t) = F_0 \cos(\omega t)\dot{x}(t)$$

$$= -|z_0| F_0 \cos(\omega t)\omega \sin(\omega t + \phi)$$

Average power over one cycle:

$$< P > = -\frac{F_0 \omega |z_0| \sin\phi}{2}$$

$$< P >= r f_0^2 \frac{\omega^2}{(\omega_0^2 - \omega^2)^2 + 4\beta^2\omega^2}$$

$$< \cos^2 \omega t > \equiv \frac{1}{T} \int_0^T dt \ \cos^2 \omega t$$

$$= \frac{1}{2T} \int_0^T dt (1 + \cos 2\omega t) \ = \frac{1}{2}$$

$$< \sin \omega t \cos \omega t >= 0$$

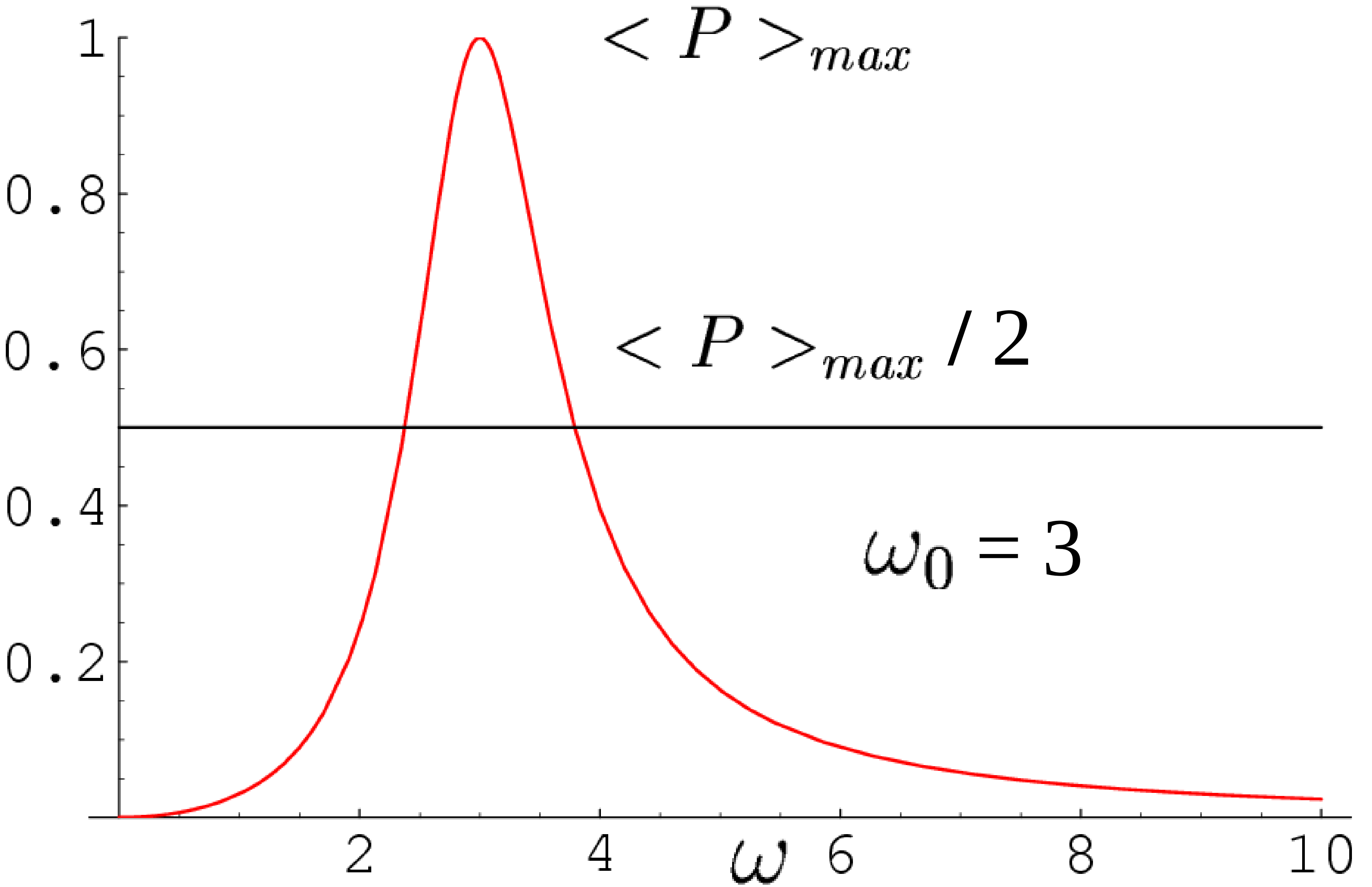
Peak Power: $\omega^2 = \omega_0^2$

$$< P >_{max} = \frac{r f_0^2}{4\beta^2} = \frac{F_0^2}{4r}$$

Width at half peak power $= 2\beta$

$$\omega = \sqrt{\omega_0^2 + \beta^2} \pm \beta$$

Averaged power absorbed = < P >



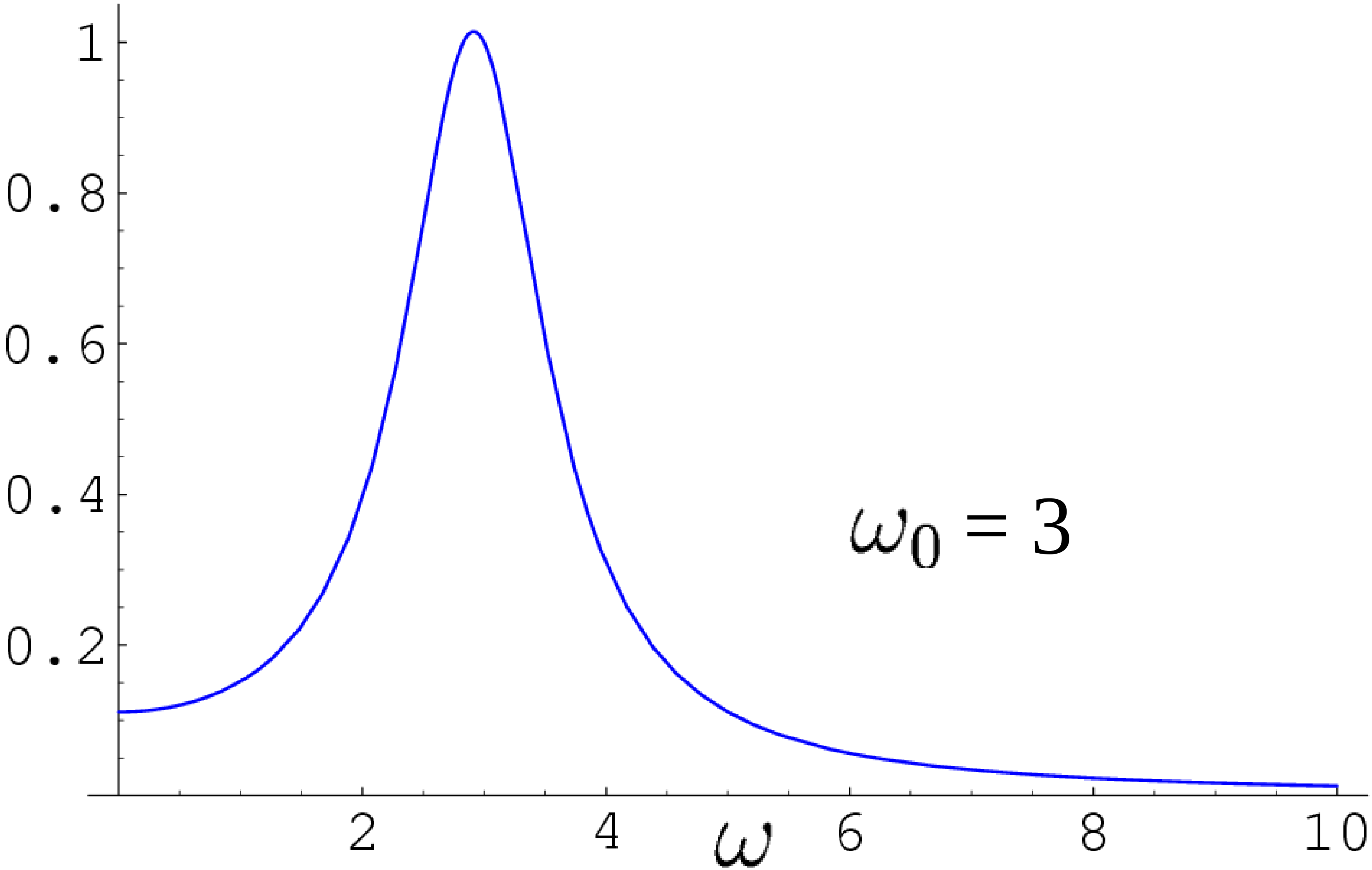
Stored energy:

$$< E >= \frac{m}{4}(\omega^2 + \omega_0^2)|z_0|^2$$

$$< E >= \frac{mf_0^2}{4} \frac{(\omega^2 + \omega_0^2)}{[(\omega_0^2 - \omega^2)^2 + 4\beta^2\omega^2]}$$

Problem: What is the peak value and for what driving frequency?

Stored energy: < E >



Resonant quality factor:

$$Q_0 = |z_0|_{res} / |z_0|_{st}$$

$$Q_0 = \frac{\omega_0}{2\beta}$$

Example 1: The galvanometer

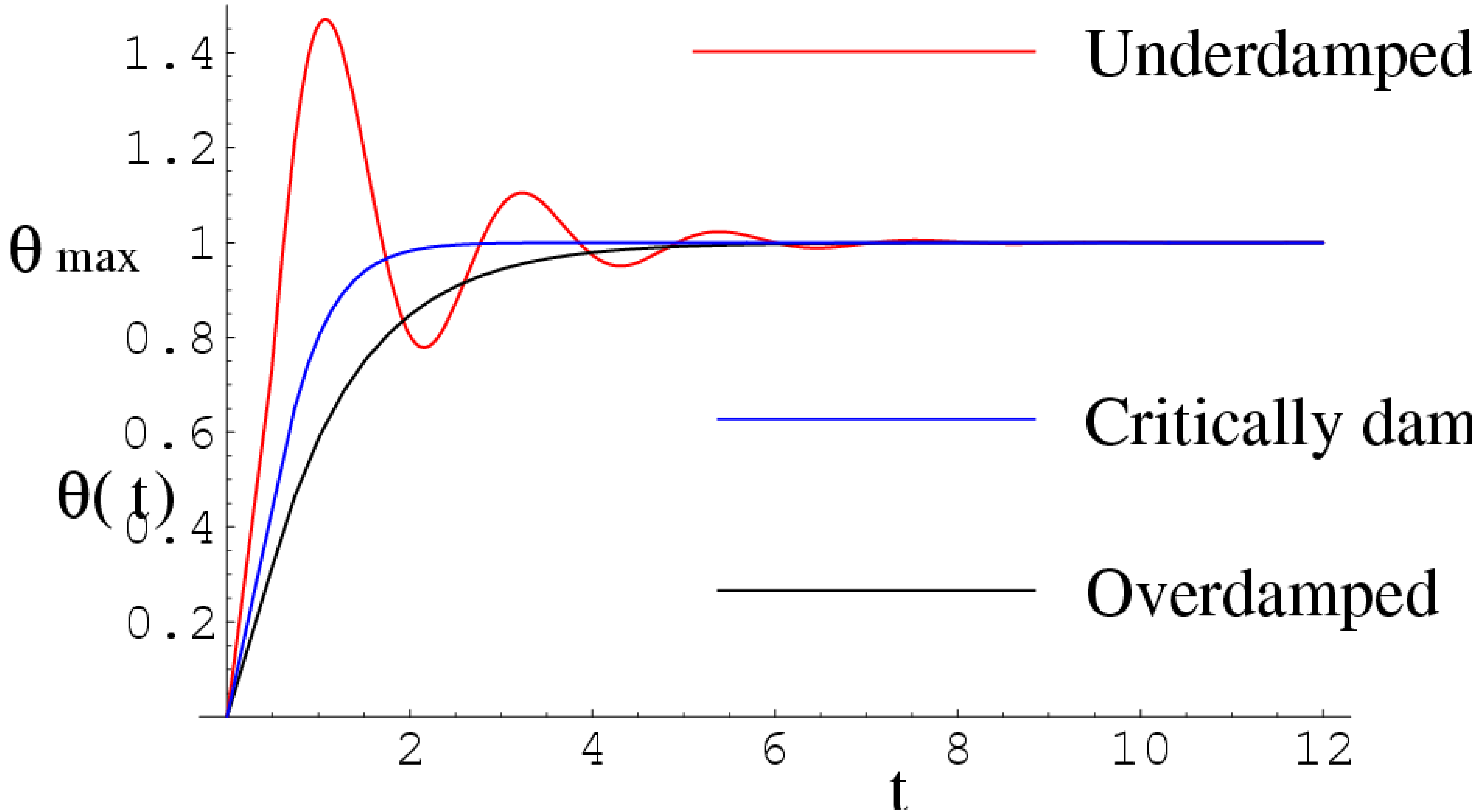
A galvanometer is connected through a switch with a direct-current source of constant EMF. At time t=0, the switch is closed. After a sufficiently long time the galvanometer deflection reaches its final value θ_{max}.

What is its motion between the initial position of rest, $\theta = 0$, $d\theta/dt = 0$, *and the final position* $\theta = \theta_{max}$?

Example 1: The galvanometer

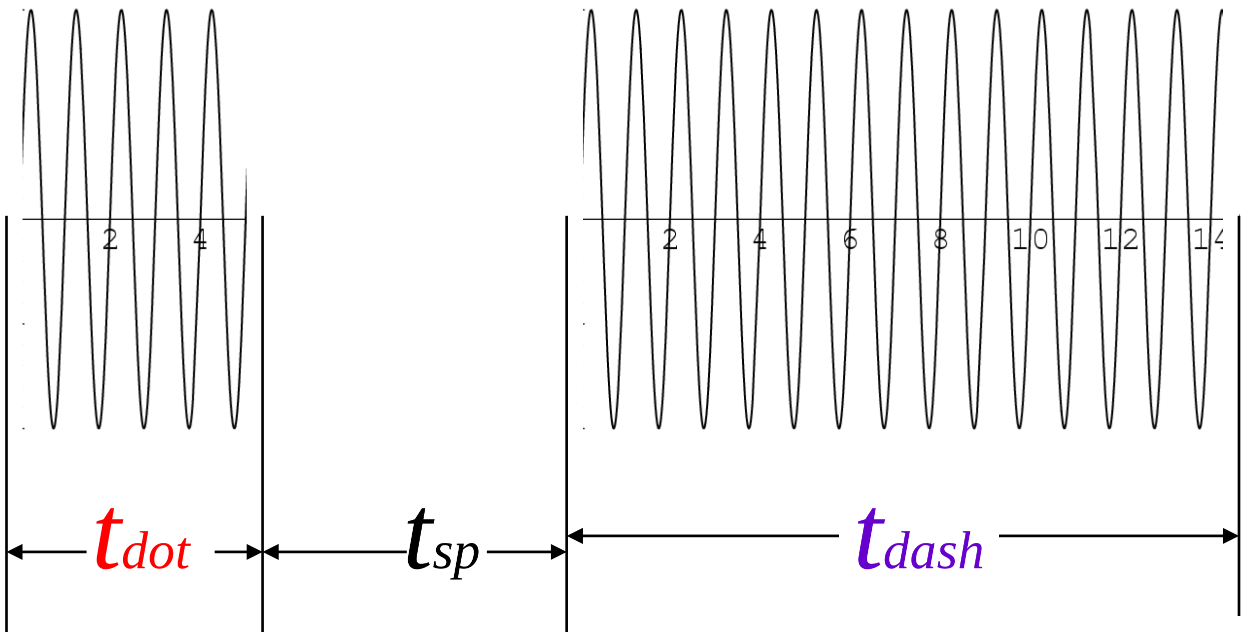
Take damping torque proportional to angular velocity. Distinguish and explain graphically underdamped, critically damped and overdamped cases.

Galvanometer



Example 2: The Telegraph

A radio receiver receives radio telegraph signals in Morse code in the form of sinusoidal wave packets.



a) The inductance of the circuit is 100 μH, the capacitance is 250 pF and the resistance is 0.2 ohm. Find the interval between the impulses t_{sp} *needed to prevent two adjacent signals from merging.*

b) Assuming the duration of the 'dot' signal to be $t_{dot} = 1.5\, t_{sp}$ *and that of the 'dash'* $t_{dash} = 4.5\, t_{sp}$ *find the maximum amount of information that can be transmitted per unit time.*

t_{sp} should be at least twice the relaxation time.

$$t_{sp} = 2\tau = 2/\beta = 4L/R$$

$$= 2\ msec$$

N= maximum number of pulses/sec

$$N\,t_{sp} + N\,t_{dot}/2 + N\,t_{dash}/2 = 1\ sec$$

$$N=125$$