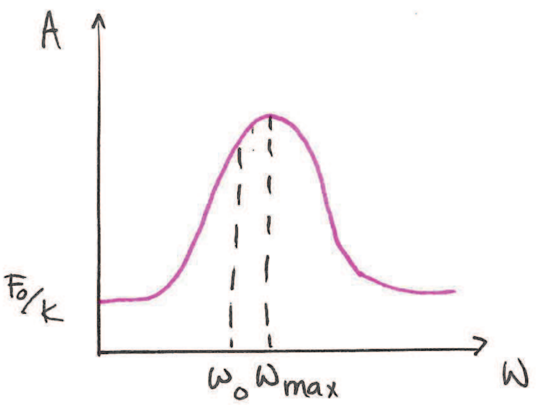
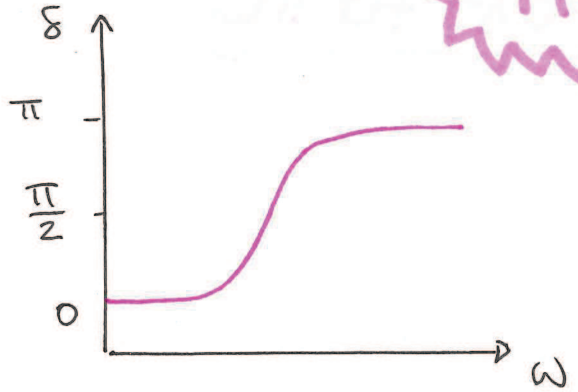
Tis LV4





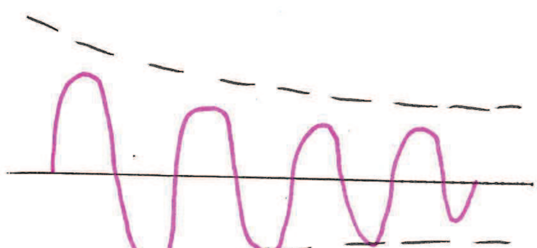
Q-fakter

Dämpad oscillation $$Q = \frac{\omega_0}{\gamma}$$

Påtvingad oscillation $$\omega_{max} = \omega_0\left(1 - \frac{\gamma^2}{2\omega_0^2}\right)^{1/2} =$$

$$= \omega_0\left(1 - \frac{1}{2Q^2}\right)^{1/2}$$

$$A_{max} = \frac{aQ}{\left(1 - \frac{1}{4Q^2}\right)^{1/2}}$$



svag dämpning

$Q >> 1$

$Q \simeq 100$

$\left.\begin{array}{l}\omega_{max} = \omega_0 \\ A = aQ\end{array}\right\}$ i alla praktiska sammanhang

Effektöverföring vid påtvingade svängningar

Energi: $E = Pt$ [J]

Effekt: $P = \frac{dE}{dt}$ $\left[\frac{\text{Watt}}{\cancel{}}\right] = \left[J/s \right]$

Ⓐ Ingen dämpning $\longrightarrow$ inga förluster

Tillförd effekt $= 0$

Ⓑ Dämpning $D = -bV = -b\dot{x}$ $\left(\dot{x} = \frac{\partial x}{\partial t}\right)$

$$P = \frac{dE}{dt} = (-bV)V \qquad x = A(\omega)\cos(\omega t - \delta)$$

$$V = \dot{x} = \underbrace{-A(\omega)\omega}_{V_0} \sin(\omega t - \delta) = V_0 \sin(\omega t - \delta)$$

$$V_0 = A(\omega) = \frac{a\omega_0/\gamma}{\left(1 - \gamma^2/4\omega_0^2\right)^{1/2}}$$

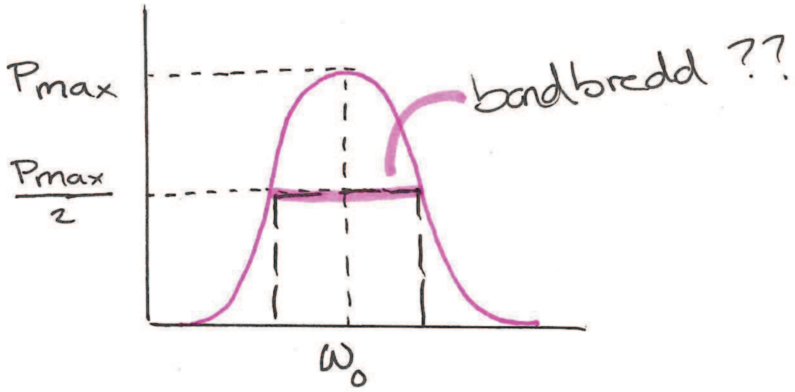
$$V_0 = \frac{a\omega_0^2}{\left(\left(\frac{\omega_0}{\omega} - \frac{\omega}{\omega_0}\right)^2 \omega_0^2 + \gamma^2\right)^{1/2}} \quad \left\} \begin{array}{ll} \omega \to 0 & V \to 0 \\ \omega \to \infty & V \to 0 \end{array} \right.$$

$$V_0 = V_{0,max} = \frac{a\omega^2}{\gamma}$$

$$P = p(t) = b\left(V_0(\omega)\right)^2 \sin^2(\omega t - \delta)$$

Medeleffekt: $\overline{P} = \frac{1}{T}\int_0^T p(t)\,dt = \frac{b\left(V_0(\omega)\right)^2}{2}$

$$\overline{P} = \frac{\omega^2 F_0^{\,2} \gamma^2}{2\omega\left(\left(\omega_0^2 - \omega^2\right) + (\omega\gamma)^2\right)^{1/2}} \quad \left.\begin{array}{ll} \omega \to 0 & \overline{P} \to 0 \\ \omega \to \infty & P \to 0 \end{array}\right\}$$



Resonans $\omega = \omega_0$

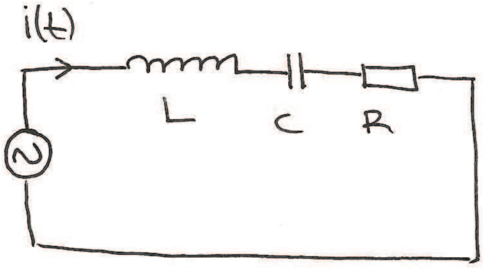
$$Q = \frac{\omega_0}{\gamma} = \frac{\omega_0}{\underbrace{\omega_{fwhh}}_{\text{bandbredd}}} = \frac{f_0}{\Delta f}$$

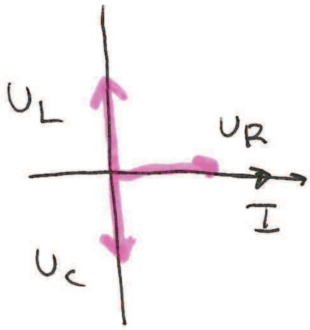
$$\overline{P}(\omega) = \frac{F_0^{\,2}}{2\omega\omega_0 Q\left(4\left(\frac{\Delta\omega}{\omega_0}\right)^2 + \frac{1}{Q^2}\right)}$$

effekt som funktion av ω

Resonans i el-kretsar

Serieresonans





$$\bar{Z} = R + jX$$

$$Z = R + X_C + X_L$$

Kirchhofs

$$L \frac{\partial^2 q}{\partial t^2} + R \frac{\partial q}{\partial t} + \frac{q}{C} = V_0 \cos \omega t$$

$$i = \frac{dq}{dt}$$

$$m\ddot{x} + b\dot{x} + kx = F_0 \cos \omega t$$

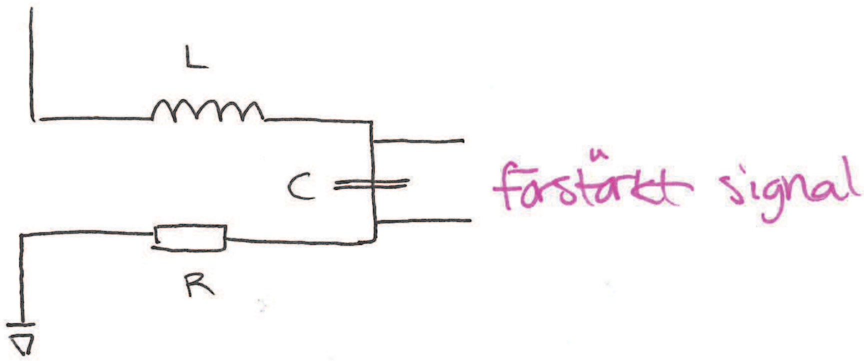
$$q = q_0(\omega) \cos(\omega t - \delta)$$

$$\omega_0 = \frac{1}{\sqrt{LC}} \qquad \gamma = \frac{L}{R} \qquad Q = \frac{\omega_0}{\gamma} = \frac{1}{R}\sqrt{\frac{L}{C}}$$

$$q = \frac{V_0}{\omega \underbrace{\left(\left(\frac{1}{\omega C} - \omega L \right)^2 + R^2 \right)^{1/2}}_{|Z|}} \qquad i(t) = \frac{dq}{dt}$$

$\longrightarrow$ $i(t) = i_{max}$ då $\omega = \omega_0$

Grunden för mottagare och sändare



Kap. 4: Kopplade oscillatorer

Två kopplade oscillatorer

Varje system svänger i sina normala moder som alstrar normala frekvensen

Normala moder

2 pendlar kopplade med fjäder

1. Samma förflyttning ~~och~~ åt samma håll

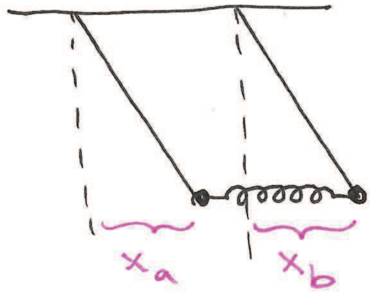
$x_a = x_b$

$x_a = A\cos \omega_1 t$

$x_b = A\cos \omega_1 t$

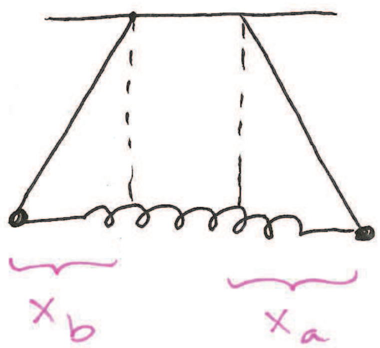
$\omega_1 = \sqrt{\frac{g}{L}}$

$\varphi = 0$



2. Svänger mot varandra: $x_a = -x_b$

$$m\ddot{x}_a = -\frac{mg}{L}x_a - 2kx_a$$



$$\ddot{x} = \omega_2^2 x_a = 0$$

$$\omega_2^2 = \sqrt{\frac{g}{L} + \frac{2k}{m}}$$