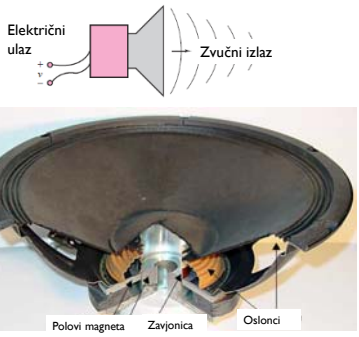
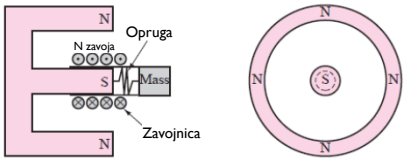
Dinamički zvučnik

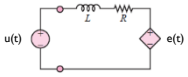
Elektromehanički pretvarač



Načelo rada



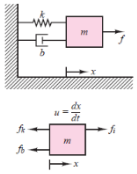
Model električne strane



$$u(t) - L\frac{d\,i(t)}{dt} - Ri(t) - e(t) = 0$$

$$L\frac{d\,i(t)}{dt} + Ri(t) + Blv(t) = u(t)$$

Model mehaničke strane



$$m\frac{d\,v(t)}{dt} = f_i - f_b - f_k = Bli(t) - bv(t) - kx$$

$$-Bli(t) + m\frac{d\,v(t)}{dt} + bv(t) + k\int_{-\infty}^{t} v(t')dt' = 0$$

Svezani sustav jednadžbi (*v*,*i*)

$$L\frac{d\,i(t)}{dt} + Ri(t) + Blv(t) = u(t)$$

$$-Bli(t) + m\frac{d\,v(t)}{dt} + bv(t) + k\int_{-\infty}^{t} v(t')dt' = 0 \quad ; \quad \frac{d}{dt}$$

$$-Bl\frac{d\,i(t)}{dt} + m\frac{d^2\,v(t)}{dt^2} + b\frac{d\,v(t)}{dt} + kd\,v(t) = 0$$

- Idealni zvučnik – konstantan tlak u cijelom čujnom frekvencijskom području 20 Hz do 20 kHz

Analiza u frekvencijskom području

- Pretpostavka: sve se veličine u vremenu mijenjaju sinusno

$$i(t)=\mathrm{Re}\left\{\bar{i}e^{j\omega t}\right\}\ ;\quad v(t)=\mathrm{Re}\left\{\bar{v}e^{j\omega t}\right\}\ \Rightarrow$$
$$\frac{di(t)}{dt}=j\omega\bar{i}e^{j\omega t}\ ;\quad \frac{d^2i(t)}{dt^2}=-\omega^2\bar{i}e^{j\omega t}$$
$$\frac{dv(t)}{dt}=j\omega\bar{v}e^{j\omega t}\ ;\quad \frac{d^2v(t)}{dt^2}=-\omega^2\bar{v}e^{j\omega t}$$

- Uvrstimo u sustav jednadžbi

$$j\omega L\bar{i}+R\bar{i}+Bl\bar{v}=\bar{U}$$
$$-j\omega Bl\bar{i}-\omega^2m\bar{v}+j\omega b\bar{v}+k\bar{v}=0$$

- Time smo sveli diferencijalne na algebarske jednadžbe

Matrični oblik

$$\begin{bmatrix} j\omega L+R & Bl \\ -j\omega Bl & j\omega b-\omega^2m+k \end{bmatrix}\begin{bmatrix}\bar{i}\\ \bar{v}\end{bmatrix}=\begin{bmatrix}\bar{U}\\ 0\end{bmatrix}$$

- Kramerovo pravilo

$$\bar{v}=\frac{\det\begin{bmatrix} j\omega L+R & \bar{U} \\ -j\omega Bl & 0 \end{bmatrix}}{\det\begin{bmatrix} j\omega L+R & Bl \\ -j\omega Bl & j\omega b-\omega^2m+k \end{bmatrix}}$$

- Frekvencijski odziv zvučnika

$$\frac{\bar{v}}{\bar{U}}=\frac{jBl\omega}{kR-(Rm-Lb)\omega^2+j\left[(Rb+kL+B^2l^2)\omega-Lm\omega^3\right]}$$

- Polumjer zavojnice: 0.05m, L=10 mH, R=8Ω, m=0.01 kg, b=22.75Ns^2/m, broj zavoja 47, B=1 T