Physics 536 - Formula Sheet - v1.0

Kramer's rule:

$$\begin{pmatrix} a & b \\ c & d \end{pmatrix} \begin{pmatrix} i_1 \\ i_2 \end{pmatrix} = \begin{pmatrix} v_1 \\ v_2 \end{pmatrix} \tag{1}$$

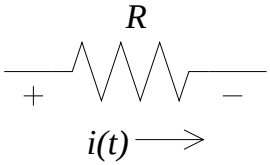
$$i_1 = \begin{vmatrix} v_1 & b \\ v_2 & d \end{vmatrix} \Big/ \begin{vmatrix} a & b \\ c & d \end{vmatrix} = \frac{dv_1 - bv_2}{ad - bc} \tag{2}$$

$$i_2 = \begin{vmatrix} a & v_1 \\ c & v_2 \end{vmatrix} \Big/ \begin{vmatrix} a & b \\ c & d \end{vmatrix} = \frac{av_2 - cv_1}{ad - bc} \tag{3}$$

Definitions:

Voltage gain in dB: $$G = 20 \log_{10}(A) \tag{4}$$

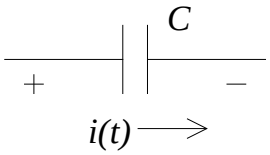
Resistors:



$$\Delta v(t) = i(t)R \tag{5}$$

$$\Delta V = IR \tag{6}$$

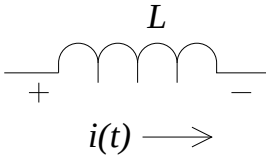
Capacitors:



$$\Delta v(t) = \frac{1}{C}\left(Q_0 + \int_0^t i(t)dt\right) \tag{7}$$

$$\Delta V = \frac{I}{i\omega C} \tag{8}$$

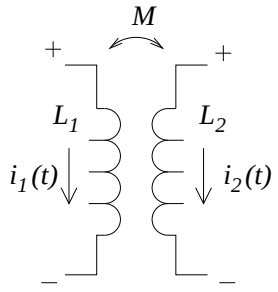
Inductors:



$$\Delta v(t) = L\frac{di}{dt} \tag{9}$$

$$\Delta V = i\omega LI \tag{10}$$

Transformers:



$$\Delta v_1(t) = L_1\frac{di_1}{dt} + M\frac{di_2}{dt} \tag{11}$$

$$\Delta v_2(t) = L_2\frac{di_2}{dt} + M\frac{di_1}{dt} \tag{12}$$

$$\Delta V_1 = i\omega L_1 I_1 + i\omega M I_2 \tag{13}$$

$$\Delta V_2 = i\omega L_2 I_2 + i\omega M I_1 \tag{14}$$

$$M = k\sqrt{L_1 L_2} \tag{15}$$

Transmission lines:

$$\frac{\partial^2 V}{\partial x^2} + \gamma^2 V(x,t) = 0 \tag{16}$$

$$\frac{\partial^2 I}{\partial x^2} + \gamma^2 I(x,t) = 0 \tag{17}$$

$$I(x,t) = Ae^{\gamma x + i\omega t} + Be^{-\gamma x + i\omega t} \tag{18}$$

$$V(x,t) = -Z_0(Ae^{\gamma x + i\omega t} - Be^{-\gamma x + i\omega t}) \tag{19}$$

$$\gamma = \sqrt{(R' + i\omega L')(G' + i\omega C')} = \alpha + i\beta \tag{20}$$

$$v = \frac{\omega}{\beta} \approx \frac{c}{\sqrt{\epsilon_r}} \tag{21}$$

$$Z_0 = \sqrt{\frac{R' + i\omega L'}{G' + i\omega C'}} \tag{22}$$

$$I_+(x,t) = \frac{V_0}{Z_S + Z_0}\frac{e^{-\gamma x}}{1 - \Gamma_S\Gamma_L e^{-2\gamma\ell}} \tag{23}$$

$$I_-(x,t) = \frac{V_0\Gamma_L e^{-2\gamma\ell}}{Z_S + Z_0}\frac{e^{\gamma x}}{1 - \Gamma_S\Gamma_L e^{-2\gamma\ell}} \tag{24}$$

$$\Gamma = \frac{Z - Z_0}{Z + Z_0} \tag{25}$$

$$\tag{26}$$