INF1411 Formelsamling

Ole-Christian Schmidt Hagenes

Grunnleggende formler

Strøm:	$I = \frac{Q}{t}$	Spenning:	$V = \frac{W}{Q}$
Ohms lov:	$V = RI$	Joule:	$\mathrm{J} = \frac{\mathrm{kg\,m^2}}{\mathrm{s}} = \mathrm{W\,s} = VQ$
Watt:	$P = \frac{\mathrm{J}}{\mathrm{s}}$	Effektloven:	$P = VI$
Kirchoffs 1. lov (KCL):	$\sum_{j=1}^{n} I_j = 0$ i en node	Kirchoffs 2. lov (KVL):	$\sum_{j=1}^{n} V_j = 0$ rundt lukket sti
Ummidelbar effekt:	$P = V_{rms} I_{rms}$		

Motstander

Seriekobling:	$R_{tot} = R_1 + R_2 + \cdots + R_n$	Paralellkobling:	$R_{tot} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_n}}$
Spenningsdeler:	$V_x = \frac{R_x}{R_{tot}} V_s$	Strømdeler:	$I_x = \frac{R_{tot}}{R_x} I_{tot}$

Kondensator

Farad:	$C = \frac{Q}{V}$	Strøm:	$I_c = \frac{dV}{dt} C$
Seriekobling:	$C_{tot} = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \cdots + \frac{1}{C_n}}$	Paralellkobling:	$C_{tot} = C_1 + C_2 + \cdots + C_n$
Reaktans:	$X_c = \frac{1}{2\pi f C} = \frac{1}{\omega C}$	Tidskonstanten:	$\tau = RC$
Oppladining/utladning:	$V = V_F + (V_i - V_F) e^{-\frac{t}{\tau}}$		

RC-ledd

Impedanse:	$\vec{Z} = \vec{R} + \vec{X_c}$	Magnitude:	$\lvert Z \rvert = \sqrt{R^2 + X_c^2}$
Fasen til Z:	$\theta = \arctan\left(\frac{X_c}{R}\right) = \arctan\left(\frac{V_c}{V_R}\right)$	RC-lag V_{out}:	$V_{out} = \frac{X_c}{\lvert Z \rvert} V_{in}$
RC-lag ϕ	$\phi = 90° - \theta$	RC-lead V_{out}:	$V_{out} = \frac{R}{\lvert Z \rvert} V_{in}$
RC-lead ϕ	$\phi = \theta$	Knekkfrekvens:	$f_c = \frac{1}{2\pi RC}$
Demping ved knekkfrekvens:	$V_{out} = \frac{V_{in}}{\sqrt{2}} \Rightarrow 3\mathrm{dB}$		

Spole

Henry:	$L = \frac{N^2 \mu A}{l}$	Spenning:	$V_L = \frac{dI}{dt} L$
Seriekobling:	$L_{tot} = L_1 + L_2 + \cdots + L_n$	Paralellkobling:	$L_{tot} = \frac{1}{\frac{1}{L_1} + \frac{1}{L_2} + \cdots + \frac{1}{L_n}}$
Reaktans:	$X_L = 2\pi f L$	Tidskonstanten:	$\tau = \frac{L}{R}$

RL-ledd

Impedanse:	$\vec{Z} = \vec{R} + \vec{X_L}$	Magnitude:	$\lvert Z\rvert = \sqrt{R^2 + X_L^2}$
Fasen til Z:	$\theta = \arctan\left(\frac{X_L}{R}\right) = \arctan\left(\frac{V_L}{V_R}\right)$	RL-lag V_{out}:	$V_{out} = \frac{R}{\lvert Z\rvert}V_{in}$
RL-lag ϕ	$\phi = \theta$	RL-lead V_{out}:	$V_{out} = \frac{X_L}{\lvert Z\rvert}V_{in}$
RL-lead ϕ	$\phi = 90° - \theta$	Knekkfrekvens:	$f_c = \frac{R}{2\pi L}$
Demping ved knekkfrekvens:	$V_{out} = \frac{V_{in}}{\sqrt{2}} \Rightarrow 3\text{dB}$		

Sinusbølger

Frekvens/periode:	$f = \frac{1}{T} \Leftrightarrow \omega = \frac{2\pi}{T} \Leftrightarrow \omega = 2\pi f$	peak-rms forhold:	$V_p = \sqrt{2}V_{rms} \quad I_p = \sqrt{2}I_{rms}$
Gjennomsnitt:	$V_{avg} = \frac{2}{\pi}V_p$	Faseforskyvning:	$y = \sin(\theta \pm \phi)$
rad til deg:	$\text{rad}\frac{180°}{\pi} = \text{deg}$	deg til rad:	$\text{deg}\frac{\pi}{180°} = \text{rad}$

Bipolar Junction Transistor (BJT)

Strømforsterkning:	$\beta = \frac{I_{out}}{I_{in}}$	Spenningsforsterkning:	$A = \frac{V_{out}}{V_{in}}$
Kollektorstrøm:	$I_C = \beta I_B$	Emmitterstrøm:	$I_E = I_C + I_B$
Emitterspenning:	$V_E = V_B - 0,7\text{V}$	Emittermotstand:	$r_e \cong \frac{25\text{mV}}{I_E}$
Inngangsmotstand (DC):	$R_{in} \cong (r_e + R_E)\beta_{DC}$	Source current:	$I_S = \frac{V_{in}}{Rin(tot)}$
Inngangsmotstand (AC):	$R_{in} \cong (r_e + R_E \lVert X_{C_b})\beta_{AC}$	Inngangsmotstand (Total):	$R_{in(tot)} = R_1 \lVert R_2 \lVert R_{in}$

Common Emitter

Voltage gain:	$A_v = \frac{R_C}{r_e + R_E}$	Current gain:	$A_i = \frac{I_C}{I_S}$
Power gain:	$A_p = A_v A_i$		

Common Collector

Voltage gain:	$A = \frac{R_E}{r_e + R_E}$	Current gain:	$A_i = \frac{I_E}{I_S}$
Power gain:	$A_p \cong A_i$		

Op-Amp

Ikke-inverterende:	$A_{cl} = 1 + \frac{R_f}{R_i}$	Inverterende:	$A_{cl} = -\frac{R_f}{R_i}$
Buffer:	$A_{cl} = 1 \Rightarrow V_{in} = V_{out}$	Slew rate:	$\text{Slew rate} = \frac{\Delta V_{out}}{\Delta t}$
Summasjons-forsterker:	$V_{out} = -\left(\frac{R_f}{R_1}V_{in_1} + \frac{R_f}{R_2}V_{in_2} + \cdots + \frac{R_f}{R_n}V_{in_n}\right)$		