Examination Aid Sheet
Faculty of Applied Science & Engineering
Both sides of the sheet may be used;
must be printed on 8.5" x 11" paper.

Subject: ECE212 : CIRCUIT ANALYSIS

Candidate's name: ARNAV PATIL

Candidate's signature: [redacted]

$R_{Th} = \frac{V_{oc}}{I_{sc}}$ $\quad P_{oc} = \frac{|V_T|^2}{8R_{Th}}$

$P_{max} = \frac{V_{oc} I_{sc}}{4} = \frac{V_{Th}^2}{4R_{Th}}$

Max Signal Transfer $\rightarrow V_{max} = V_{oc}, I_{max} = I_{sc}$

Capacitors $\rightarrow V_c(t) = \frac{1}{C}\int_0^t i(\tau)\,d\tau + V_c(0)$

V lags I $\quad i_c(t) = C\frac{dV_c}{dt}$ $\quad V_R(s) = RI_R(s)$

$V_L(s) = LsI(s) - Li_L(0)$

$P_C = -\frac{\omega C V_A^2}{2}\sin(\omega t)$ $\quad V_c(s) = \frac{1}{Cs}I_c(s) + \frac{V_c(0)}{s}$

$U_c = \frac{CV^2}{2}$ $\quad$ From txtbk, do not doubt

Inductors $\rightarrow V_L(t) = L\frac{di}{dt}$ $\quad i(t) = \frac{1}{L}\int_0^t v(\tau)\,d\tau + i_L(0)$

$P_L = -\frac{\omega L I_A^2}{2}\sin(\omega t)$ $\quad U_L = \frac{LI^2}{2}$

Series RC $\rightarrow R_T C V' + V = V_{Th}$

Parallel RL $\rightarrow \frac{L}{R_T} i' + i = i_{No}$ $\quad \tau = RC = \frac{L}{R}$

$x(0^-) = x(0^+) \rightarrow x(t) = x(\infty) + (x(0^+) - x(\infty))\, e^{-t/\tau}$

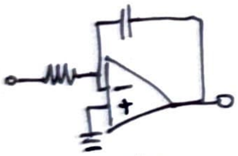
Series RLC $\rightarrow LCV_c'' + R_T C V_c' + V_c = V_{Th}$ $\quad \Delta = \zeta^2 - 1$

Parallel RLC $\rightarrow LC i_L'' + \frac{L}{R} i_L' + i_L = i_{No}$ $\quad \alpha = \zeta\omega_0, \beta = \omega_0\sqrt{\Delta}$

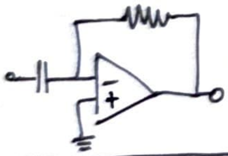
$y'' + 2\zeta\omega_0 y' + \omega_0^2 y = 0 \rightarrow \omega_0^2 = \frac{a_0}{a_2}, 2\zeta\omega_0 = \frac{a_1}{a_2}$

OP AMPs $\rightarrow A \rightarrow \infty, R_{in} \rightarrow \infty, R_{out} \rightarrow 0, V_o = A(V_p - V_n)$

Virtual short ONLY in negative feedback



$V_o = -\frac{1}{RC}\int_{t_0}^{t} V_i\,d\tau + V_o(t_0)$



$V_o = -RC\frac{dV_i}{dt}$

Integrating Factor

$y' + P(x)y = f(x)$

$\hookrightarrow \mu(x) = e^{\int P(x)dx}$

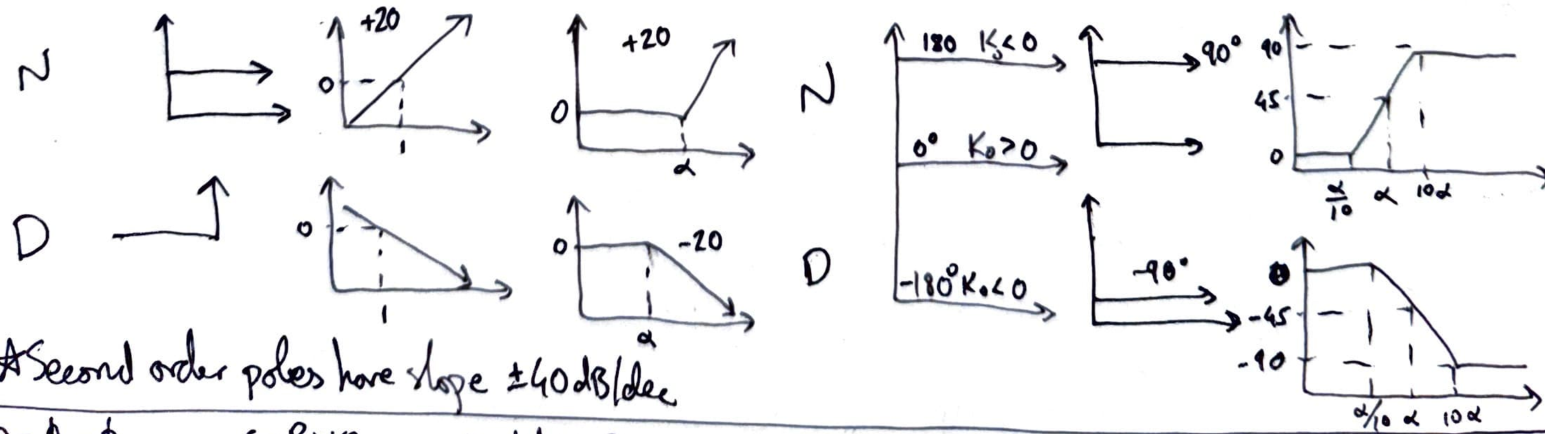
$\mu(x)y = \int \mu(x) f(x)\,dx$

Cramer's Rule

$$\begin{bmatrix} j2^{A} & 4^{B} \\ j6^{C} & j2^{D} \end{bmatrix}\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 10\angle 0^\circ{}^{E} \\ 0^{F} \end{bmatrix}$$

$$I_1 = \frac{\Delta_1}{\Delta} = \frac{\begin{vmatrix} E & B \\ F & D \end{vmatrix}}{\begin{vmatrix} A & B \\ C & D \end{vmatrix}} = \frac{ED - BF}{AD - BC}, \quad I_2 = \frac{AF - EC}{AD - BC}$$

Gain $\quad |K_0|_{dB} \quad |\omega|_{dB} \quad |(1 + j\omega/\alpha)|_{dB}$ $\quad$ Phase $\quad \angle K_0 \quad \pm 90^\circ \quad \tan^{-1}(\omega/\alpha_i)$



★ Second order poles have slope ±40dB/dec

$\theta = \phi_v - \phi_i$ $\quad S = P + jQ$ $\quad Q = |S|\sin\theta$

$P = V_{rms} I_{rms}\cos\theta$ $\quad |S| = V_{rms} I_{rms}$ $\quad S = ZI_{rms}^2 = V_{rms}^2/Z^*$

$Q = V_{rms} I_{rms}\sin\theta$ $\quad S = |S|\angle\theta$ $\quad S = RI_{rms}^2 + jXI_{rms}^2$

$S = VI^*$ (rms) $\quad P = |S|\cos\theta = |S| \times pf$

$Q_L = \omega L I_{rms}^2 = V_{rms}^2/\omega L$ $\quad$ Lag $\rightarrow \theta > 0 \rightarrow$ inductive

$Q_C = -I_{rms}^2/\omega C = -\omega C V_{rms}^2$ $\quad$ Lead $\rightarrow \theta < 0 \rightarrow$ capacitive

Max Power $\rightarrow Z_L = Z_{Th}^*$

$T_V(s) = \frac{V_2(s)}{V_1(s)}$, $T_I(s) = \frac{I_2(s)}{I_1(s)}$ } Transfer Function

$T_Y(s) = \frac{I_2(s)}{V_1(s)}$ } Transadmittance

$T_Z(s) = \frac{V_2(s)}{I_1(s)}$ } Transimpedance

$|T(j\omega_c)| = \frac{T_{max}}{\sqrt{2}}$, $|T(j\omega)|_{dB} = 20\log_{10}|T(j\omega)|$

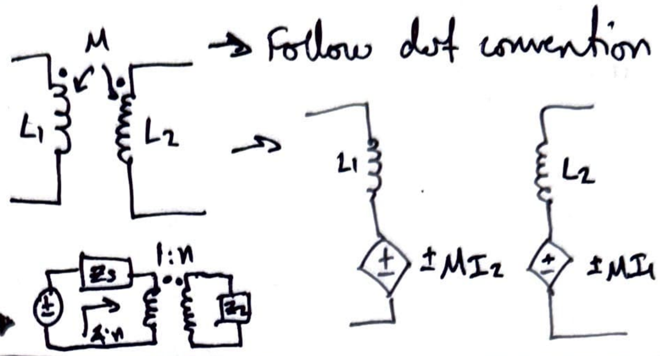
Reflected impedance $\rightarrow Z_{in} = Z_L/n^2$

$$\int_{0^-}^{0^+} (i'' + \cancel{i'}^{\,0} + \cancel{i}^{\,N/A})\,dt = \int_{0^-}^{0^+} \delta(t)\,dt$$

$$i'(0^+) - i(0^-) = 1$$

* when dealing w/ unit step or impulse functions

$\rightarrow$ Follow dot convention



Low-Pass $\rightarrow T(s) = \frac{K}{s+\alpha}$

High-Pass $\rightarrow T(s) = \frac{Ks}{s+\alpha}$

GBW $= A\omega_c$

BANDPASS

$T(s) = T_1(s) \times T_2(s)$

$\hookrightarrow \omega < \alpha_1 < \alpha_2$

$|T(j\omega)| = \frac{|K_1||K_2|\omega}{\alpha_1\alpha_2}$

$\hookrightarrow \alpha_1 < \omega < \alpha_2$

$|T(j\omega)| = \frac{|K_1||K_2|}{\alpha_2}$

$\hookrightarrow \alpha_1 < \alpha_2 < \omega$

$|T(j\omega)| = \frac{|K_1||K_2|}{\omega}$

BANDSTOP

$T(s) = T_1(s) + T_2(s)$

$\hookrightarrow \omega < \alpha_1 < \alpha_2$

$|T(j\omega)| = \frac{|K_2|}{\alpha_2}$

$\boxed{Q = \frac{\omega_0}{B}}$

$\hookrightarrow \alpha_1 < \omega < \alpha_2$

$|T(j\omega)| = 0$

$\hookrightarrow \alpha_1 < \alpha_2 < \omega$

$|T(j\omega)| = |K_1|$

$\omega_c = \sqrt{\omega_{c1}\omega_{c2}}$

$B = \omega_{c2} - \omega_{c1} = R/L$

Series RLC Bandstop $\rightarrow T(s) = \frac{V_2(s)}{V_1(s)} = \frac{Z_{LC}(s)}{R + Z_{LC}(s)}$

Parallel RLC Bandpass $\rightarrow T(s) = \frac{I_2(s)}{I_1(s)} = \frac{1/R}{1/R + Y_{LC}(s)}$

ACTIVE FILTERS $\rightarrow$ * high Q (steep roll-off) * no L * cascade design

LPF $\rightarrow \frac{K}{(s/\omega_0)^2 + 2\zeta\omega_0 s + 1}$ HPF $\rightarrow \frac{K(s/\omega_0)^2}{(s/\omega_0)^2 + 2\zeta\omega_0 s + 1}$

BPF $\rightarrow \frac{K(s/\omega_0)}{(s/\omega_0)^2 + 2\zeta\omega_0 s + 1}$ BSF $\rightarrow \frac{K[(s/\omega_0)^2 + 1]}{(s/\omega_0)^2 + 2\zeta\omega_0 s + 1}$

Capacitors $\rightarrow 10X \Rightarrow 10^X$ pF, Inductors $\rightarrow 10X \Rightarrow 10^X$ μH

COLOR	1	2	3	MULT	TOL
BLACK	0	0	0	1	
BROWN	1	1	1	10	1%
RED	2	2	2	100	2%
ORANGE	3	3	3	1K	
YELLOW	4	4	4	10K	
GREEN	5	5	5	100K	0.5%
BLUE	6	6	6	1M	0.25%
VIOLET	7	7	7	10M	0.10%
GREY	8	8	8	100M	0.05%
WHITE	9	9	9	1G	
GOLD				0.1	5%
SILVER				0.01	10%

741 OP AMP Pinout