CASE WESTERN RESERVE UNIVERSITY
Case School of Engineering
Department of Electrical Engineering and Computer Science
ENGR 210. Introduction to Circuits and Instruments (4)

FORMULA SHEET

TRIG IDENTITIES: $\sin(x)=\cos(x-90°)$

$\cos(x+y)=\cos x\cos y-\sin x\sin y$ $\quad$ $\sin(x+y)=\sin x\cos y+\cos x\sin y$

$\sin(2x)=2\sin x\cos x$ $\quad$ $\cos(2x)=2\cos^2 x-1=1-\sin^2 x$

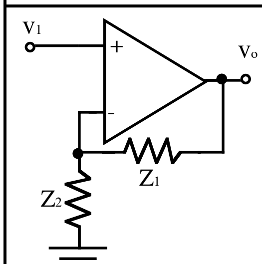
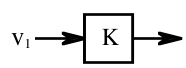
FOURIER COEFFICIENTS: $v(t)=V_A\cos(\omega t+\phi)=a\cos(\omega t)+b\sin(\omega t)$ where

$V_A=\sqrt{a^2+b^2}$ and $\phi=\tan^{-1}\left(\frac{-b}{a}\right)$. Conversely, $a=V_A\cos\phi$ and $b=-V_A\sin\phi$

	INDUCTORS	CAPACITORS
Terminal relationship	$v_L=L\frac{di_L}{dt}$	$i_C=C\frac{dv_C}{dt}$
Impedance	$Z_L=j\omega L$	$Z_C=\frac{1}{j\omega C}$
Energy	$W_L=\frac{1}{2}Li^2$	$W_C=\frac{1}{2}Cv^2$
Time constant	$T_C=\frac{L}{R_T}$	$T_C=R_TC$

INITIAL/FINAL VALUE THEOREM: $f(t)=[IV-FV]e^{-\frac{t}{T_C}}+FV$
where IV=initial value and FV=final value.

OP AMP CIRCUITS:

CIRCUIT	BLOCK DIAGRAM	GAINS
	 Non-inverting amplifier	$K=\frac{Z_1+Z_2}{Z_2}$

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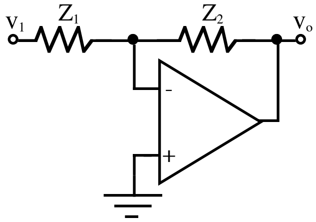
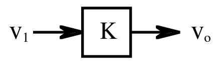
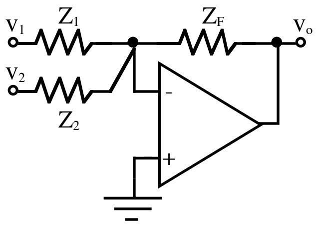
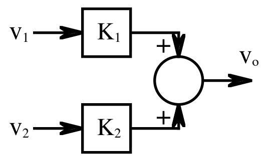
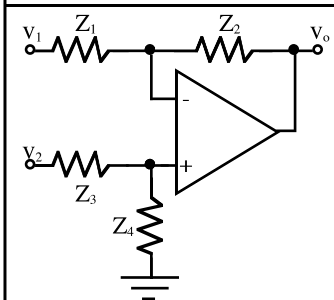
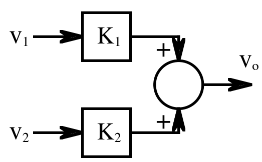
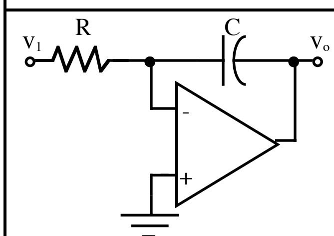
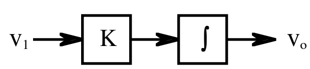
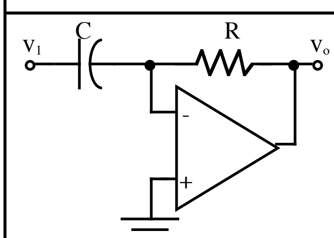
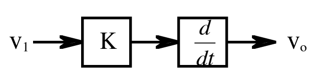
	 Inverting amplifier	$K = -\dfrac{Z_2}{Z_1}$
	 Summer	$K_1 = -\dfrac{Z_F}{Z_1}$, $K_2 = -\dfrac{Z_F}{Z_2}$
	 Subtractor	$K_1 = -\dfrac{Z_2}{Z_1}$, $K_2 = \left(\dfrac{Z_1 + Z_2}{Z_1}\right)\left(\dfrac{Z_4}{Z_3 + Z_4}\right)$
	 Integrator	$K = -\dfrac{1}{RC}$
	 Differentiator	$K = -RC$