UNIVERSITY of OULU

DEPT. OF ELECTRICAL AND INFORMATION ENGINEERING

11.01.2008

Circuit Theory II (Graphical calculator and an A4-sized crib sheet are allowed)

1. For the circuit in Fig. 1, calculate the transfer function $V_{out}(s)/V_{in}(s)$ and draw the corresponding pole-zero map. The opamp is assumed ideal.

2. Draw the Bode diagrams for H(s) using straight-line approximation.

$$H(s) = 10^{-6} \cdot \frac{(s+10^4)\cdot(s+10^3)}{s} \quad .$$

3. For the circuit in Fig. 2, the Laplace-transform of the input voltage $v_{in}(t)$ is 10/s. Calculate voltage $v_R(t)$, when $t \geq 0$ and $v_C(0) = 7V$. You may use the transformation table on the next page.

4. For the two-port circuit in Fig. 3, calculate the y-parameters.

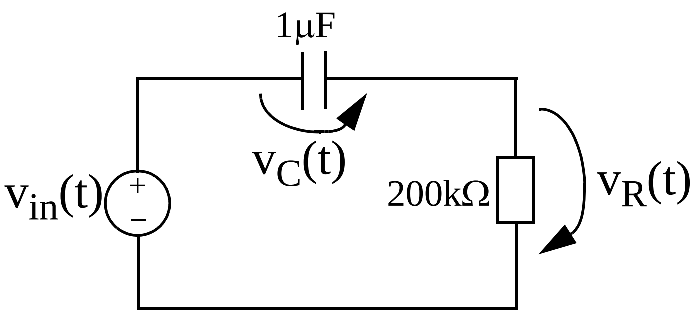

Figure 2

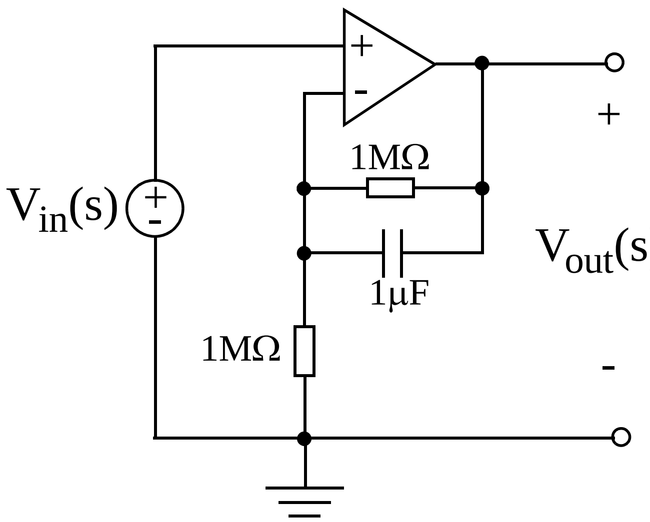

Figure 1

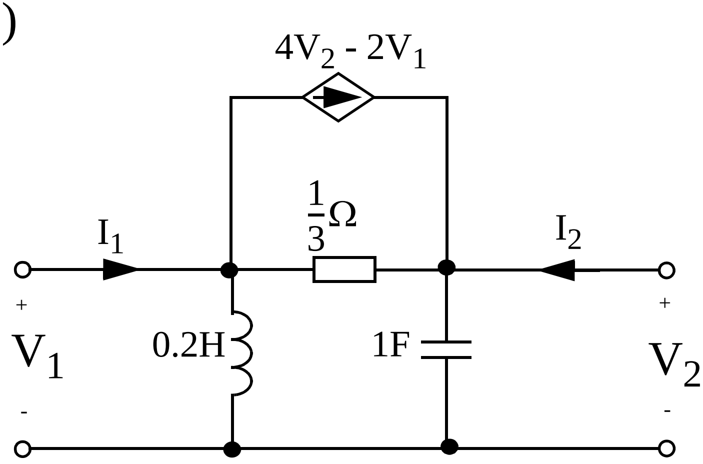

Figure 3

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Table 1: Common Laplace-transform pairs

	x(t)	X(s)
impulse	$\delta(t)$	1
unit step	1	1 / s
ramp	t	$1 / s^2$
n^{th} power	t^n	$n! / s^{n+1}$
a^{th} power (a>0)	$t^{a-1} / \Gamma(a)$	$1 / s^a$
	$1 / \sqrt{(\pi t)}$	$1 / \sqrt{s}$
exp. function	e^{-at}	1 / (s+a)
	$1 - e^{-at}$	a / (s(s+a))
	$t^n e^{-at}$	$n! / (s+a)^{n+1}$
sin	$\sin(\omega t)$	$\omega / (s^2+\omega^2)$
cos	$\cos(\omega t)$	$s / (s^2+\omega^2)$
sinh	sinh(at)	$a / (s^2-a^2)$
cosh	cosh(at)	$s / (s^2-a^2)$
Linearity	ax(t) + by(t)	aX(s) + bY(s)
translation in freq	$e^{-at} x(t)$	X(s+a)
translation in time	x(t-T)	$e^{-sT} X(s)$
first time derivative	dx(t) / dt	sX - x(0)
n^{th} time derivative	$d^n x(t) / dt^n$	$s^n X(s) - s^{n-1} x(0) - s^{n-2} x^{(1)}(0) \ldots - x^{(n-1)}(0)$
Time integral	$\int_o^t x(t)dt$	$\frac{X(s)}{s} + \frac{1}{s} \cdot \int_{-\infty}^{0} x(t)dt$
convolution	$\int_o^t x(\tau)g(t-\tau)d\tau$	G(s)X(s)
n^{th} freq derivative	$(-t)^n x(t)$	$d^n X(s) / ds^n$

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