ECSE 2010
Electric Circuits
Exam 3
Spring 2004

Name _____

Section Number (please circle one)

1	2	3
MTR	MWR	MTR
10-12	4-6	2-4

Problem No.	Pts.	Score
1	20pts	
2	20pts	
3	20pts	
4	20pts	
5	20pts	
Total	100pts	

Please Note:

* Place all your answers in the spaces provided.
* You MUST show your work to receive any credit.

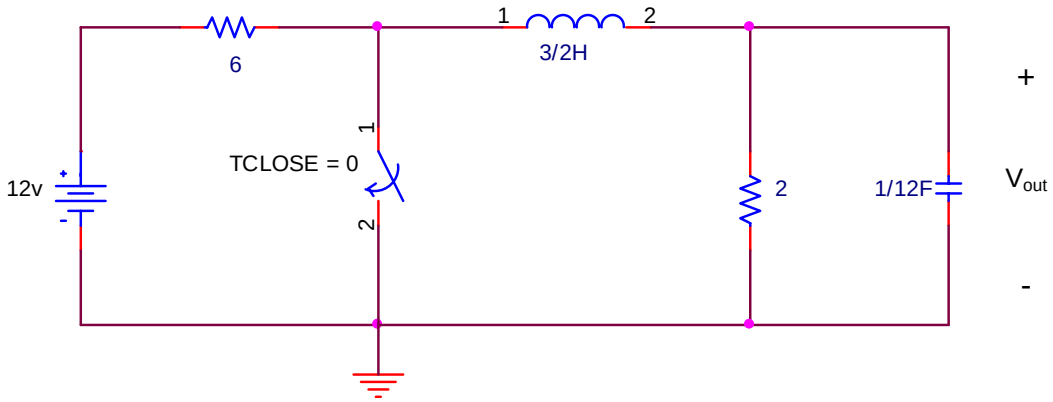
Problem 1 (20pts)

Name _____

Section Number (please circle one)

1	2	3
MTR	MWR	MTR
10-12	4-6	2-4

a.) Find $I_L(0^-)$ and $V_c(0^-)$ in the circuit shown. (4pts)



$I_L(0^-)$	
$V_c(0^-)$	

Problem 1 (cont)

Name _____

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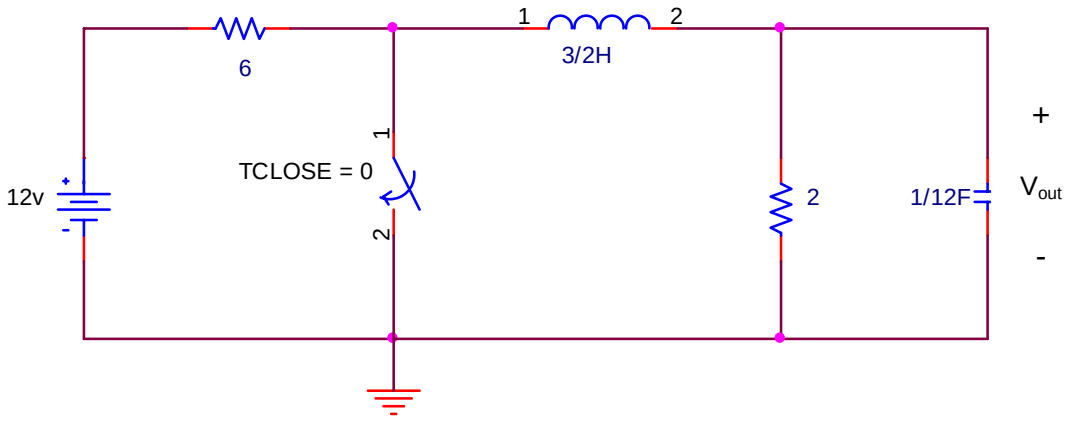
b.) Find $V_{out}(s)$ for t>0 (same circuit as in part a). (10pts)



$V_{out}(s)$	

Problem 1 (cont)

Name _____

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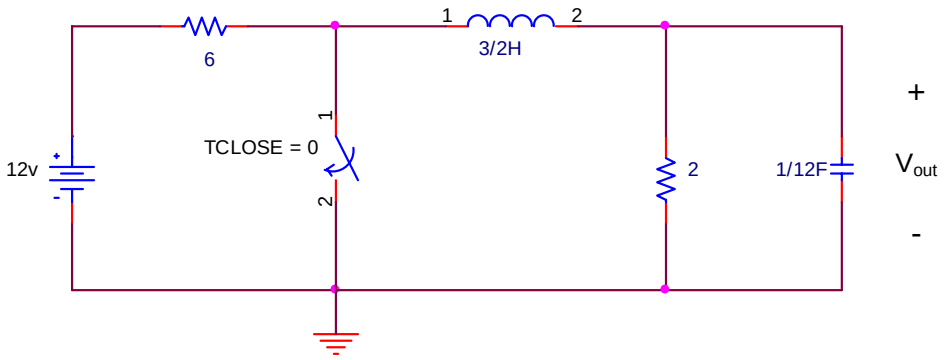
c.) Find $V_{out}(t)$ for $t \geq 0$ (same circuit as in parts a & b). (6pts)



$V_{out}(t)$	

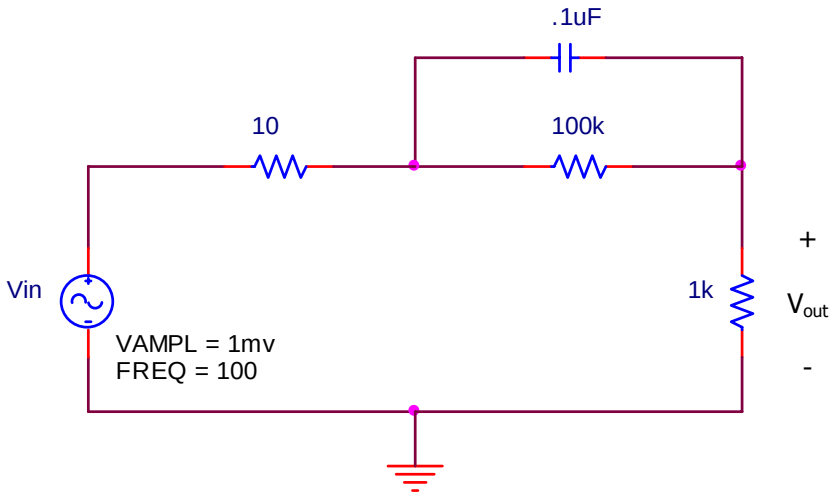
Problem 2 (cont)

Name _____

Section Number (please circle one)

1	2	3
MTR	MWR	MTR
10-12	4-6	2-4

a.) Find V_{out} (t) in the circuit shown if V_{in} (t) = 1mV cos(**200**πt). (10pts)



$V_{out}(t)$	

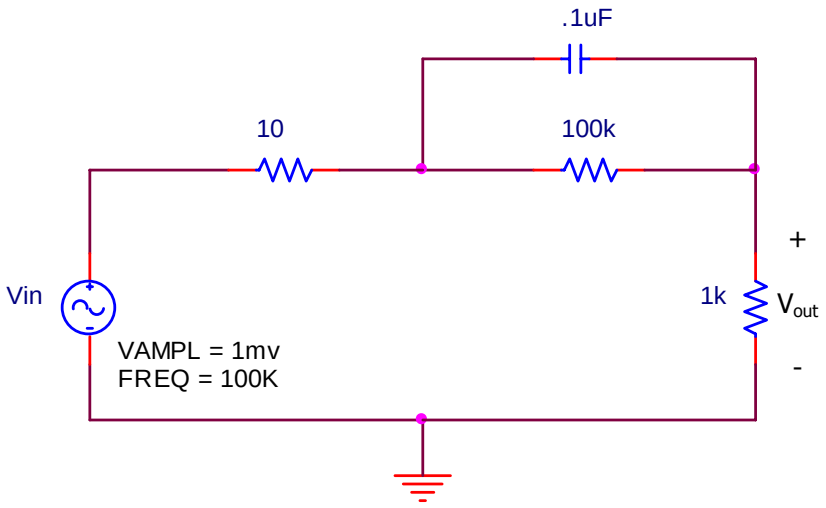
Problem 2 (cont)

Name _____

Section Number (please circle one)

1	2	3
MTR	MWR	MTR
10-12	4-6	2-4

b.) Find V_{out} (t) in the circuit shown if V_{in} (t) = 1mV cos(**200,000**πt). (10pts)



$V_{out}(t)$	

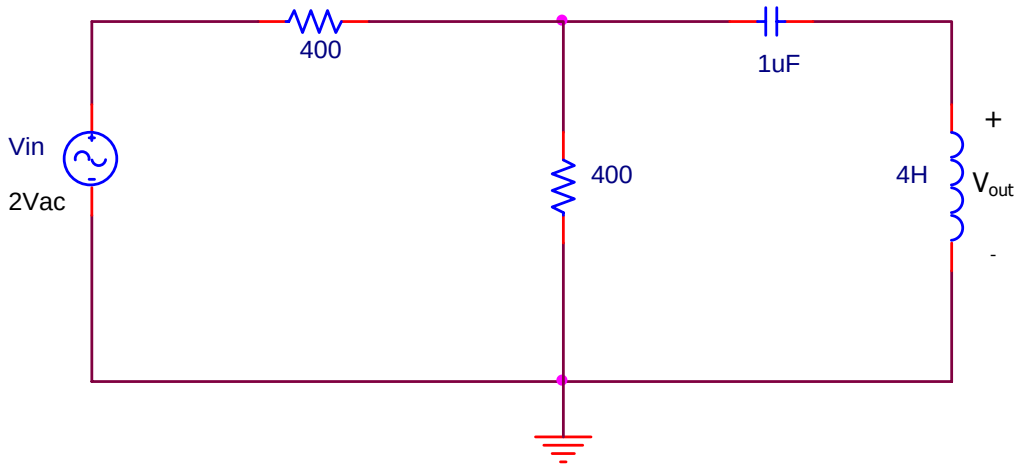
Problem 3 (20pts)

Name _____

Section Number (please circle one)

1	2	3
MTR	MWR	MTR
10-12	4-6	2-4

a.) Find H(s) = V_{out}/V_{in} for the circuit shown below. (10pts)



H(s)	

Problem 3 (cont)

Name _____

Section Number (please circle one)

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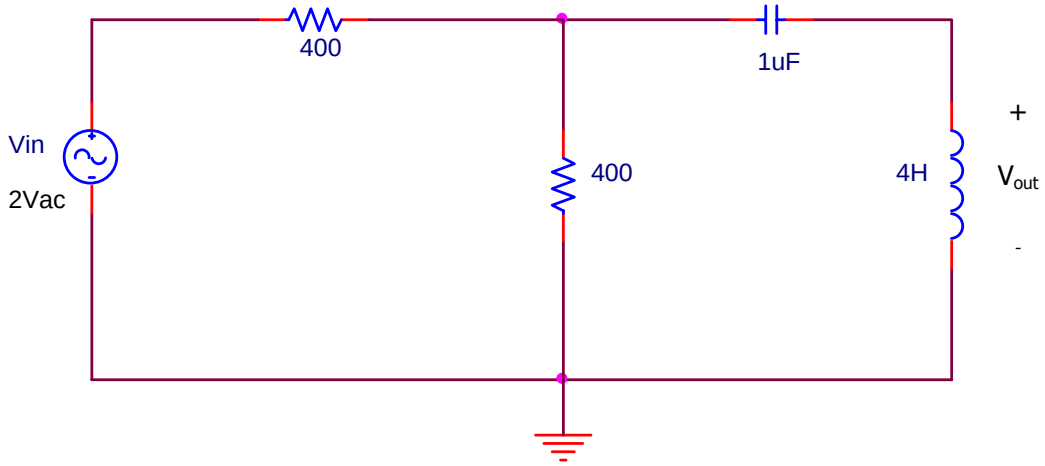
b.) Sketch the asymptotic graphs of $|H(j\omega)|$ and $\Phi(j\omega)$ for the circuit shown. (10pts) (Please be sure to label and mark your axes as appropriate)



$|H(j\omega)|$

log ω

$\Phi(j\omega)$

log ω

Problem 4 (20pts)

Name _____

Section Number (please circle one)

1	2	3
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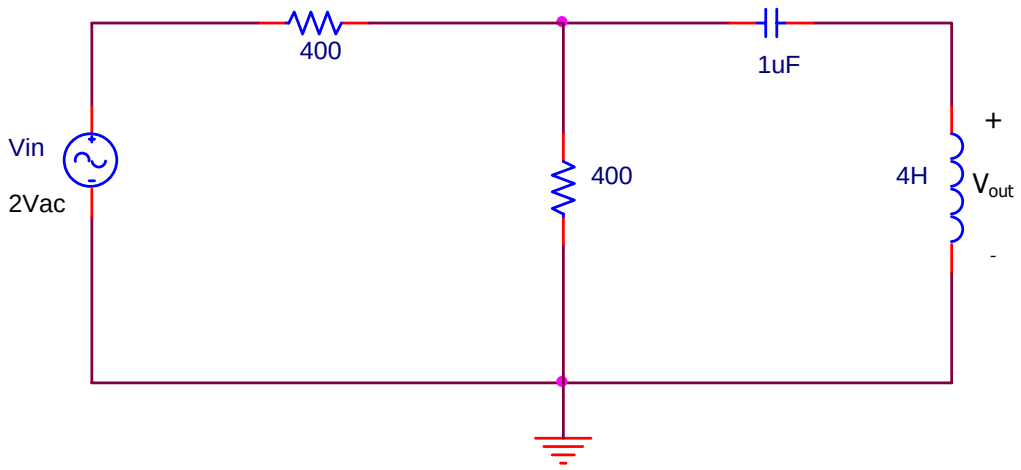
a.) What frequency (ω_o) of V_{in} would cause the circuit shown below to resonate? (10pts) (Please justify your response)



ω_o	

b.) What is the Q of the circuit shown above? (5pts)

Q	

c.) What is the magnitude $|Vout|$ of the circuit shown above at ω_o? (5pts)

$\|Vout\|$	

Problem 5 (20pts)

Name _____

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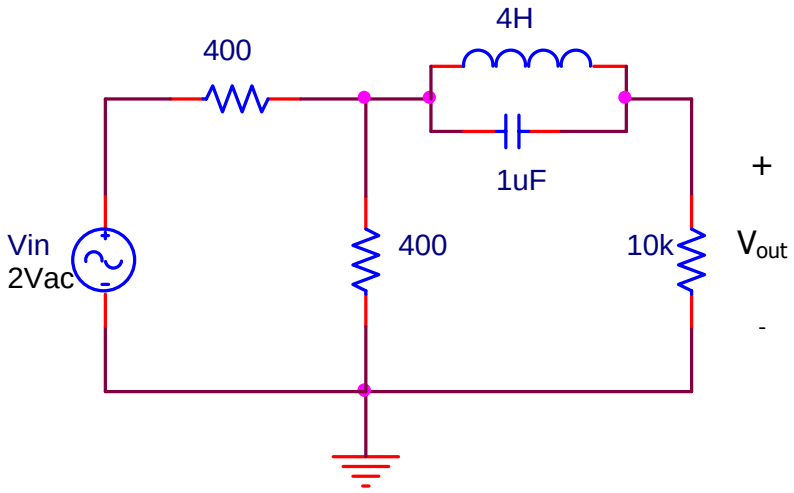
a.) What kind of frequency response would the circuit shown have? (10pts)



(Please circle one and justify your response in the space provided below)

Bandpass filter	Lowpass filter	Highpass filter	Notch filter

Problem 5 (cont)

Name _____

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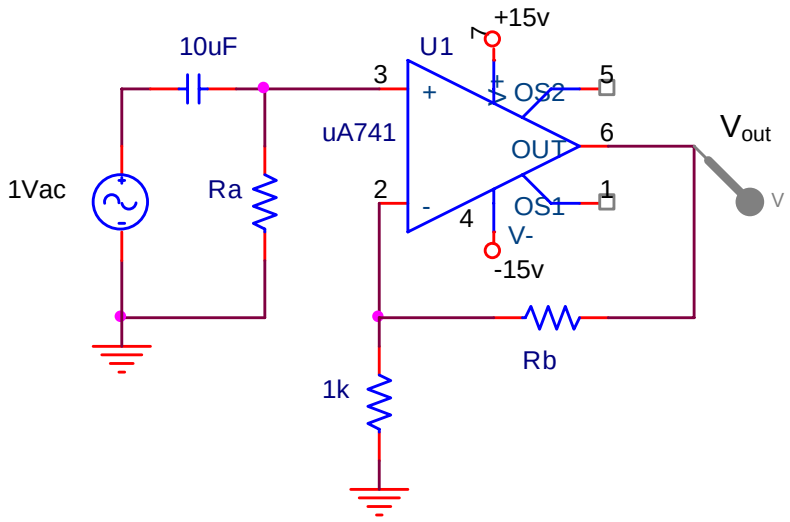
b.) What values of **Ra** and **Rb** in the following circuit could produce the frequency plots shown on the following page? (10pts)



Ra	
Rb	

Problem 5 (cont)

Name _____

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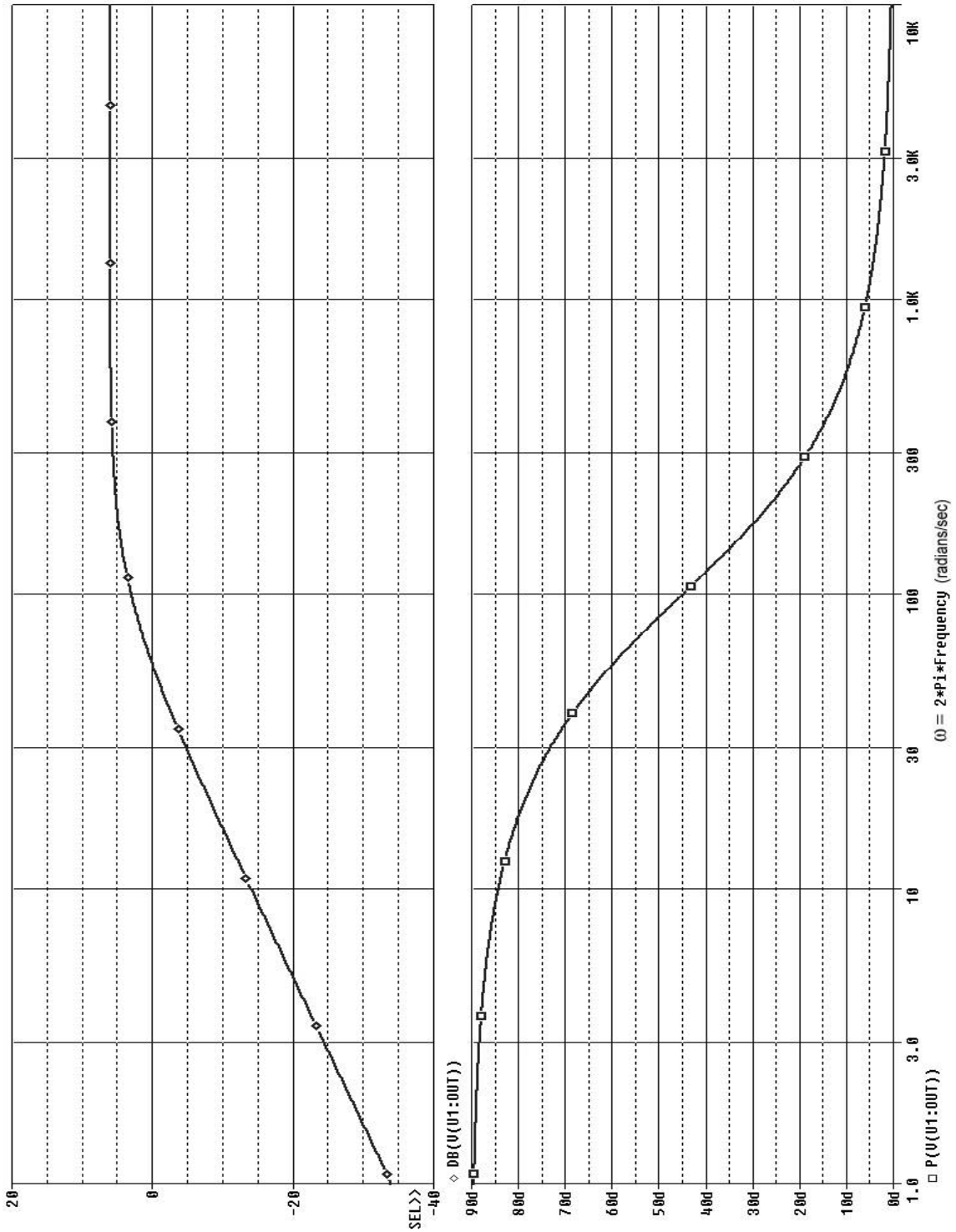

Extra space (if needed)

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Extra space (if needed)

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Laplace Transform Theorems

1.	Definition	$L\left[f(t)\right] = F(s) = \int_{0-}^{\infty} f(t)e^{-st}dt$
2.	Linearity	$L\left[k_1 f(t_1) + k_2 f(t_2)\right] = k_1 F_1(s) + k_2 F_2(s)$
3.	Time shift	$L\left[f(t-\tau)\right] = e^{-\tau s}F(s)$
4.	Frequency Shift	$L\left[e^{-at} f(t)\right] = F(s+a)$
5.	Scaling Theorem	$L\left[f(at)\right] = \frac{1}{a}F\left(\frac{s}{a}\right)$
6.	Differentiation Theorem	$L\left[\frac{df}{dt}\right] = sF(s) - f(0)$
7.	Differentiation Theorem	$L\left[\frac{d^2 f}{dt^2}\right] = s^2 F(s) - sf(0) - \dot{f}(0)$
8.	Differentiation Theorem	$L\left[\frac{d^n f}{dt^n}\right] = s^n F(s) - \sum_{k=1}^{n} s^{n-k} f^{k-1}(0)$
9.	Integration Theorem	$L\left[\int f(\tau)d\tau\right] = \frac{F(s)}{s} + \frac{\int^{0+} f(\tau)d\tau}{s}$
10.	Final value theorem*	$f(\infty) = \lim_{s\to 0} sF(s)$
11.	Initial value theorem**	$f(0^+) = \lim_{s\to\infty} sF(s)$

* Provided all poles of $F(s)$ have negative real parts with the exception of possibly one pole at the origin.

** Provided $f(t)$ is continuous or has a step discontinuity at $t = 0$.

Laplace Transform of Time Functions

1.	$\delta(t)$	1
2.	$u(t)$	$1/s$
3.	$tu(t)$	$1/s^2$
4.	$\frac{1}{2!}t^2u(t)$	$1/s^3$
5.	$\frac{1}{(m-1)!}t^{m-1}u(t)$	$1/(s^m)$
6.	$e^{-at}u(t)$	$1/(s+a)$
7.	$te^{-at}u(t)$	$1/(s+a)^2$
8.	$\frac{1}{(m\text{-}1)!}t^{m-1}e^{-at}u(t)$	$1/(s+a)^m$
9.	$(1-e^{-at})u(t)$	$a/[s(s+a)]$
10.	$\frac{1}{a}(at-1+e^{-at})u(t)$	$a/[s^2(s+a)]$
11.	$(1-at)e^{-at}u(t)$	$s/(s+a)^2$
12.	$\sin(\omega t)u(t)$	$\omega/(s^2+\omega^2)$
13.	$\cos(\omega t)u(t)$	$s/(s^2+\omega^2)$
14.	$e^{-at}\cos(\omega t)u(t)$	$(s+a)/[(s+a)^2+\omega^2]$
15.	$e^{-at}\sin(\omega t)u(t)$	$\omega/[(s+a)^2+\omega^2]$
16.	$\left\{1-\frac{1}{\sqrt{1-\zeta^2}}e^{-\zeta\omega_n t}\left[\sin(\omega_d t+\theta)\right]\right\}u(t)$	
	$\omega_d=\omega_n\sqrt{1-\zeta^2}\;;\quad\theta=\cos^{-1}(\zeta)$	
OR	$\left\{1-e^{-\zeta\omega_n t}\left[\cos(\omega_d t)+\frac{\zeta}{\sqrt{1-\zeta^2}}\sin(\omega_d t)\right]\right\}$	$\frac{\omega_n^2}{s(s^2+2\zeta\omega_n s+\omega_n^2)}$

Laplace Transform of Time Functions (cont)

$$F(s) = \frac{Bs + C}{s^2 + 2\alpha s + \omega_0^2}$$

$$L^{-1}\left[F(s)\right] = f(t)$$

17. $f(t) = Ae^{-\alpha t}\cos(\omega_d t + \phi)$, where

$$\omega_d = \sqrt{\omega_o^2 - \alpha^2}\ , \quad \phi = \tan^{-1}\left(\frac{\alpha B - C}{\omega_d B}\right) \text{ and}$$

$$A = \sqrt{B^2 + \left(\frac{(\alpha B - C)}{\omega_d}\right)^2} = \frac{\sqrt{B^2\omega_o^2 - 2\alpha BC + C^2}}{\omega_d}$$