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CONFIDENTIAL

UNIVERSITI KUALA LUMPUR

MALAYSIAN INSTITUTE OF INFORMATION TECHNOLOGY

FINAL EXAMINATION
JANUARY 2016 SEMESTER

SUBJECT CODE	:	IBB21103
SUBJECT TITLE	:	SIGNALS AND SYSTEM
LEVEL	:	BACHELOR
TIME / DURATION	:	02:00 pm – 04:30 pm (2 ½ HOURS)
DATE	:	26 MAY 2016

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper.
2. This question paper is printed on both sides.
3. It consists of ONE (1) section ONLY.
4. Please write your answers with correct working on the answer booklet provided.
5. Answer all questions in English. Use PEN ONLY.
6. Required formula is appended. Calculator can be used.

THERE ARE 7 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.

SECTION A (100 Marks)

INSTRUCTION: Answer FOUR questions ONLY.

Please use the answer booklet provided.

Question 1 [25 marks]

(a) The RL circuit is shown in Figure 1, as a system with the input, applied voltage $x(t)$ and the current output, $y(t)$.

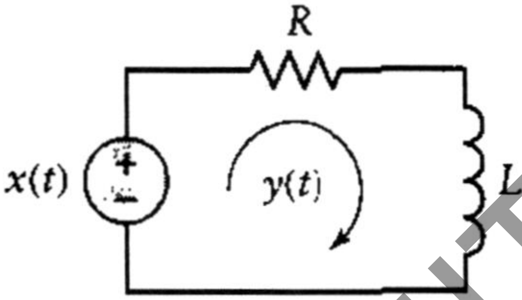

Figure 1

i. Find the differential equation that describes the system

(1 mark)

ii. Determine the natural response of the system for $t > 0$.

(9 marks)

iii. What is the particular solution, if the system is given an input $x(t) = \cos(\omega_0 t)$, in Voltage ?

(10 marks)

(b) Determine the inverse Z-transform for $\frac{8z-19}{(z-2)(z-3)}$?

(5 marks)

Question 2 [25 marks]

(a) What is signal? Explain using at least two examples and clear drawings of signal.

(15 marks)

(b) With the aid of definitions of Equation 1.1 and Equation 1.2, can you develop, mathematically, the even and odd decomposition of a general signal, $x(t)$.

$$x(-t) = x(t) \quad \text{for all t} \quad (1.1)$$

$$x(-t) = -x(t) \quad \text{for all t} \quad (1.2)$$

(10 marks)

Question 3 [25 marks]

(a) Based on your understanding, describe systems in your own words. Make use of a simple diagram for a *specific system* with appropriate *labels*.

(20 marks)

(b) Why sampling is important in signals and systems? Your answer MUST BE JUSTIFIED by providing three examples of real-world application.

(5 marks)

Question 4 [25 marks]

(a) Write MATLAB commands and functions to plot a square wave signal as in Figure 2. Comment the functions of each MATLAB command appropriately.

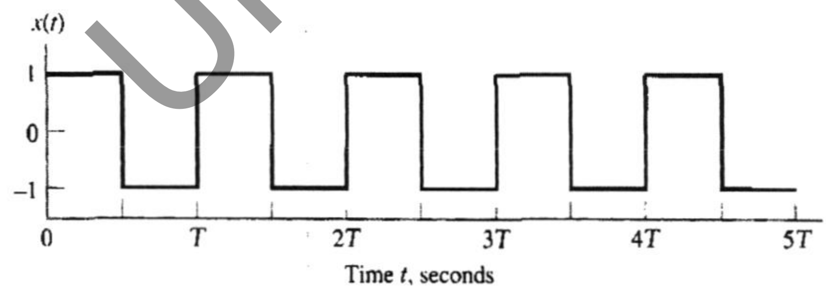

Figure 2

(10 marks)

(b) Two exponential signals are shown in Figure 3 and Figure 4. Can you generate the signals using MATLAB commands? Comment the functions of each MATLAB command appropriately.

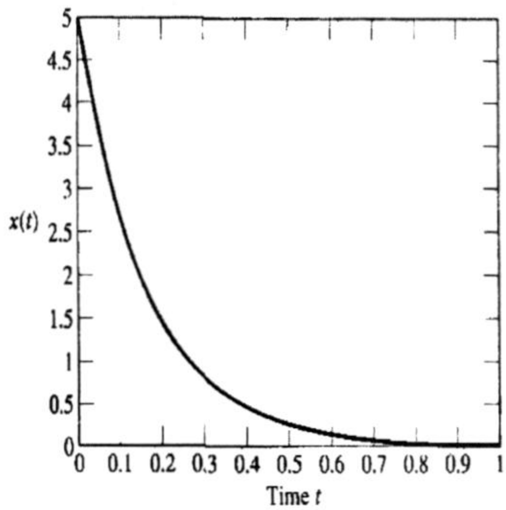

Figure 3 Decaying Signal

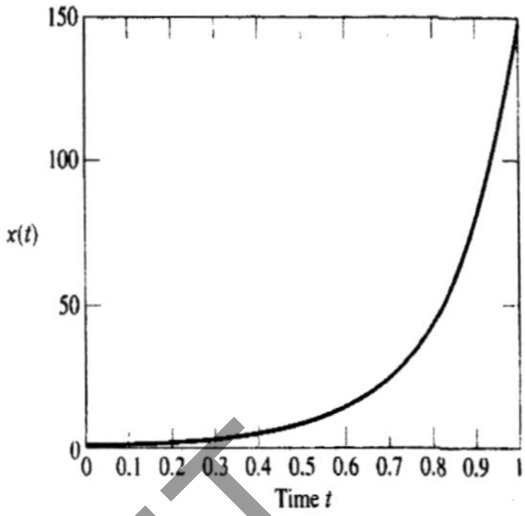

Figure 4 Growing Signal

(15 marks)

Question 5 [25 marks]

(a) In Fourier series representation of a periodic continuous-time signal, the Fourier series approximation of a discontinuous signal will in general show high-frequency ripples and overshoot near the discontinuities. This is known as **Gibbs phenomenon**. Please explain why this phenomenon does not exist in the Fourier series representation of a periodic discrete-time signal.

(10 marks)

(b) An RC circuit is shown in Figure 5. Assume the circuit's time is constant with RC = 1s and the circuit is linear and time invariant. The input is given as $x(t) = e^{-3t}u(t)$. Can you sketch the output which is the *convolution* of, $y(t) = h(t) * x(t)$, where the impulse response for this circuit is $h(t) = e^{-t}u(t)$. Label the axis correctly.

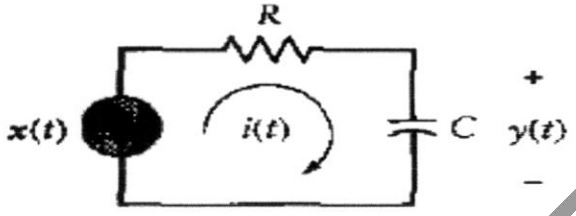

Figure 5

(15 marks)

END OF QUESTION

APPENDIX : FORMULA SHEET

TABLE OF FOURIER TRANSFORM

x(t)	X(ω)	
$e^{-at}u(t)$	$\frac{1}{a+j\omega}$	$a>0$
$e^{at}u(-t)$	$\frac{1}{a-j\omega}$	$a>0$
$e^{-a\|t\|}$	$\frac{2a}{a^2+\omega^2}$	$a>0$
$te^{-at}u(t)$	$\frac{1}{(a+j\omega)^2}$	$a>0$
$t^n e^{-at}u(t)$	$\frac{n!}{(a+j\omega)^{n+1}}$	$a>0$
$\delta(t)$	1	
1	$2\pi\delta(\omega)$	
$e^{j\omega_0 t}$	$2\pi\delta(\omega-\omega_0)$	
$\cos\omega_0 t$	$\pi[\delta(\omega-\omega_0)+\delta(\omega+\omega_0)]$	
$\sin\omega_0 t$	$j\pi[\delta(\omega+\omega_0)-\delta(\omega-\omega_0)]$	
$u(t)$	$\pi\delta(\omega)+\frac{1}{j\omega}$	
$\text{sgn}\ t$	$\frac{2}{j\omega}$	
$\cos\omega_0 t\ u(t)$	$\frac{\pi}{2}[\delta(\omega-\omega_0)+\delta(\omega+\omega_0)]+\frac{j\omega}{\omega_0^2-\omega^2}$	
$\sin\omega_0 t\ u(t)$	$\frac{\pi}{2j}[\delta(\omega-\omega_0)-\delta(\omega+\omega_0)]+\frac{\omega_0}{\omega_0^2-\omega^2}$	
$e^{-at}\sin\omega_0 t\ u(t)$	$\frac{\omega_0}{(a+j\omega)^2+\omega_0^2}$	$a>0$
$e^{-at}\cos\omega_0 t\ u(t)$	$\frac{a+j\omega}{(a+j\omega)^2+\omega_0^2}$	$a>0$
$\text{rect}\left(\frac{t}{\tau}\right)$	$\tau\ \text{sinc}\left(\frac{\omega\tau}{2}\right)$	
$\frac{W}{\pi}\text{sinc}(Wt)$	$\text{rect}\left(\frac{\omega}{2W}\right)$	
$\Delta\left(\frac{t}{\tau}\right)$	$\frac{\tau}{2}\text{sinc}^2\left(\frac{\omega\tau}{4}\right)$	
$\frac{W}{2\pi}\text{sinc}^2\left(\frac{Wt}{2}\right)$	$\Delta\left(\frac{\omega}{2W}\right)$	
$\sum_{n=-\infty}^{\infty}\delta(t-nT)$	$\omega_0\sum_{n=-\infty}^{\infty}\delta(\omega-n\omega_0)$	$\omega_0=\frac{2\pi}{T}$
$e^{-t^2/2\sigma^2}$	$\sigma\sqrt{2\pi}e^{-\sigma^2\omega^2/2}$	

TABLE OF Z-Transfom

$X[n]$	$X[z]$
$delta[n-n]$	z^{-k}
$u[n]$	$\frac{z}{z-1}$
$nu[n]$	$\frac{z}{(z-1)^2}$
$n^2u[n]$	$\frac{z(z+1)}{(z-1)^3}$
$n^3u[n]$	$\frac{z(z^2+4z+1)}{(z-1)^4}$
$\gamma^n u[n]$	$\frac{z}{z-\gamma}$
$\gamma^{n-1}u[n-1]$	$\frac{1}{z-\gamma}$
$n\gamma^n u[n]$	$\frac{\gamma z}{(z-\gamma)^2}$
$n^2\gamma^n u[n]$	$\frac{\gamma z(z+\gamma)}{(z-\gamma)^3}$
$\frac{n(n-1)(n-2)\cdots(n-m+1)}{\gamma^m m!}\gamma^n u[n]$	$\frac{z}{(z-\gamma)^{m+1}}$
$\lvert\gamma^n\rvert \cos\beta n\ u[n]$	$\frac{z(z-\lvert\gamma\rvert\cos\beta)}{z^2-(2\lvert\gamma\rvert\cos\beta)z+\lvert\gamma\rvert^2}$
$\lvert\gamma\rvert^n \sin\beta n\ u[n]$	$\frac{z\lvert\gamma\rvert\sin\beta}{z^2-(2\lvert\gamma\rvert\cos\beta)z+\lvert\gamma\rvert^2}$
$r\lvert\gamma\rvert^n \cos(\beta n+\theta)u[n]$	$\frac{rz[z\cos\theta-\lvert\gamma\rvert\cos(\beta-\theta)]}{z^2-(2\lvert\gamma\rvert\cos\beta)z+\lvert\gamma\rvert^2}$
$r\lvert\gamma\rvert^n \cos(\gamma n+\theta)u[n]$ $\gamma=\lvert\gamma\rvert e^{j\gamma}$	$\frac{(0.5re^{j\theta})z}{z-\gamma}+\frac{(0.5re^{-j\theta})z}{z-\gamma^*}$
$r\lvert\gamma\rvert^n\cos(\gamma n+\theta)u[n]$ $r=\sqrt{\frac{A^2\lvert\gamma\rvert^2+B^2-2AaB}{\lvert\gamma\rvert^2-a^2}}$ $\beta=\cos^{-1}\frac{-a}{\lvert\gamma\rvert}$ $\theta=\tan^{-1}\frac{Aa-B}{A\sqrt{\lvert\gamma\rvert^2-a^2}}$	$\frac{z(Az+B)}{z^2+2az+\lvert\gamma\rvert^2}$

LAPLACE AND Z TRANSFORM TABLE

Laplace Transform	Time Function	z-Transform
1	Unit impulse $\delta(t)$	1
$\frac{1}{s}$	Unit step $u_s(t)$	$\frac{z}{z-1}$
$\frac{1}{1-e^{-Ts}}$	$\delta_T(t) = \sum_{n=0}^{\infty} \delta(t-nT)$	$\frac{z}{z-1}$
$\frac{1}{s^2}$	t	$\frac{Tz}{(z-1)^2}$
$\frac{1}{s^3}$	$\frac{t^2}{2}$	$\frac{T^2z(z+1)}{2(z-1)^3}$
$\frac{1}{s^{n+1}}$	$\frac{t^n}{n!}$	$\lim_{\alpha \to 0} \frac{(-1)^n}{n!} \frac{\partial^n}{\partial \alpha^n} \left[\frac{z}{z-e^{-\alpha T}} \right]$
$\frac{1}{s+\alpha}$	$e^{-\alpha t}$	$\frac{z}{z-e^{-\alpha T}}$
$\frac{1}{(s+\alpha)^2}$	$te^{-\alpha t}$	$\frac{Tze^{-\alpha T}}{(z-e^{-\alpha T})^2}$
$\frac{\alpha}{s(s+\alpha)}$	$1-e^{-\alpha t}$	$\frac{(1-e^{-\alpha T})z}{(z-1)(z-e^{-\alpha T})}$
$\frac{\omega}{s^2+\omega^2}$	$\sin \omega t$	$\frac{z \sin \omega T}{z^2 - 2z \cos \omega T + 1}$
$\frac{\omega}{(s+\alpha)^2+\omega^2}$	$e^{-\alpha t} \sin \omega t$	$\frac{ze^{-\alpha T} \sin \omega T}{z^2 - 2ze^{-\alpha T} \cos \omega T + e^{-2\alpha T}}$
$\frac{s}{s^2+\omega^2}$	$\cos \omega t$	$\frac{z(z - \cos \omega T)}{z^2 - 2z \cos \omega T + 1}$
$\frac{s+\alpha}{(s+\alpha)^2+\omega^2}$	$e^{-\alpha t} \cos \omega t$	$\frac{z^2 - ze^{-\alpha T} \cos \omega T}{z^2 - 2ze^{-\alpha T} \cos \omega T + e^{-2\alpha T}}$

TABLE OF PARTICULAR SOLUTION FOR COMMON INPUT

Continuous Time		*Discrete Time*	
Input	*Particular Solution*	*Input*	*Particular Solution*
1	c	1	c
e^{-at}	ce^{-at}	α^n	$c\alpha^n$
$\cos(\omega t + \phi)$	$c_1 \cos(\omega t) + c_2 \sin(\omega t)$	$\cos(\Omega n + \phi)$	$c_1 \cos(\Omega n) + c_2 \sin(\Omega n)$