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SET B

UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION
JULY 2010 SESSION

SUBJECT CODE	:	FLB 30402
SUBJECT TITLE	:	SIGNALS AND SYSTEMS
LEVEL	:	BACHELOR
TIME / DURATION	:	3.00pm – 5.00pm (2 HOURS)
DATE	:	12 NOVEMBER 2010

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. Please write your answers on the answer booklet provided.
4. Answer should be written in blue or black ink except for sketching, graphic and illustration.
5. This question paper consists of TWO (2) sections. Section A and B. Answer all questions in Section A. For Section B, answer THREE (3) questions only.
6. Answer all questions in English.

THERE ARE 6 PAGES OF QUESTIONS AND 2 PAGES OF APPENDIX, EXCLUDING THIS PAGE.

SECTION A (Total: 40 marks)

INSTRUCTION: Answer ALL questions.
Please use the answer booklet provided.

Question 1

Briefly describe the following terms.

a) Time variant and Time Invariant systems.
b) Causal and Anti-causal signals.
c) Periodic and Aperiodic signals.

(6 marks)

Question 2

Sketch the following signals in its Continuous Time form.

a) Impulse signal.
b) Unit Step signal.
c) Ramp signal.
d) Real Exponential signal.

(4 marks)

Question 3

Given the discrete time unit step and impulse function as shown in **Figure 1 and Figure 2** respectively. Sketch each of the following special digital sequence.

(a) u(-n)

(2 marks)

(b) u(n-5)

(2 marks)

(c) -u(n)

(2 marks)

(d) 2δ(n-2) -2δ(n-1)

(2 marks)

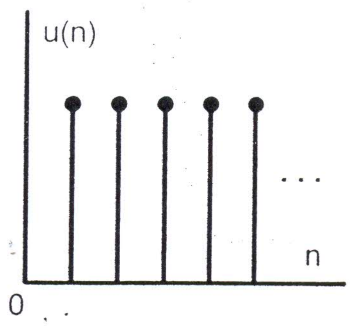

Figure 1

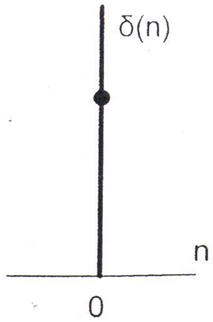

Figure 2

Question 4

Sketch and label carefully each of the following discrete time signals.

a) $5h(n-1)$ where $h(n) = \delta(n)+ \delta(n-1)+\delta(n-2)$

b) $h(2-n)$ where $h(n) = \delta(n) + \delta(n-1) + \delta(n-2)+2\delta(n-3)$.

(6 marks)

Question 5

Graph the even and odd parts of the functions in **Figure 3.**

(6 marks)

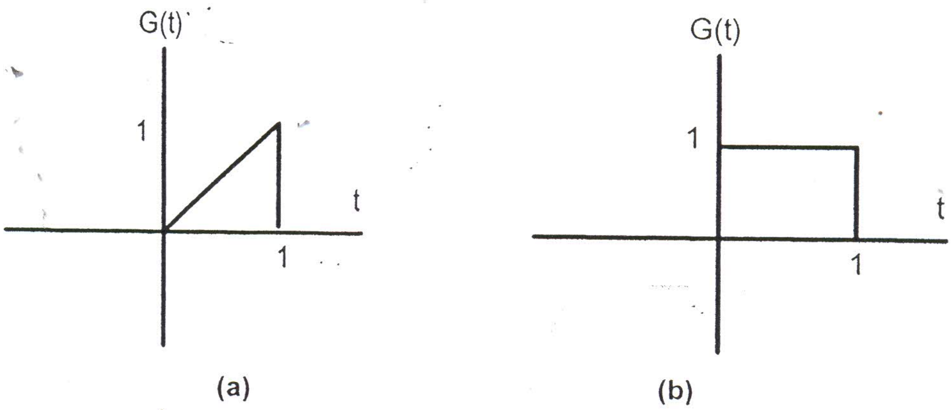

Figure 3

Question 6

Determine the Fourier series of the signal shown in **Figure 4**.

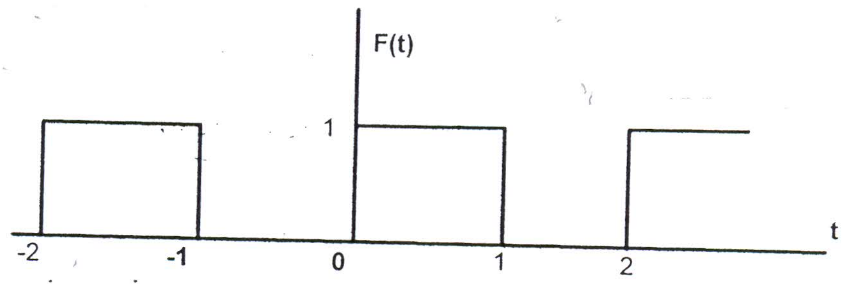

Figure 4

(10 marks)

SECTION B (Total: 60 marks)

INSTRUCTION: Answer THREE (3) questions only.
Please use the answer booklet provided.

Question 7

Given the piecewise continuous time function;

$$f(t)=\begin{cases}-1 & , \quad -2<t<-1 \\ t & , \quad -1<t<1 \\ 1 & , \quad 1<t<2\end{cases}$$

Where $f(t+4)=f(t)$

(a) Sketch the graph of f(*t*) such that $-6 \le t \le 6$.

(4 marks)

(b) Find an expression for the Continuous Time Fourier Series (CTFS) of *f(t)*.

(16 marks)

Question 8

(a) **Figure 5** shows the signal x(t), sketch 4x(-0.5t+1) by using analytical method.

(12 marks)

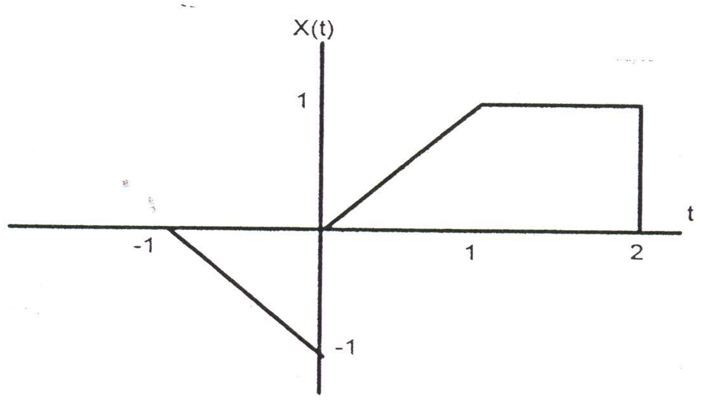

Figure 5

(b) **Figure 6** shows the signal f(t), sketch the following functions by using graphical method.

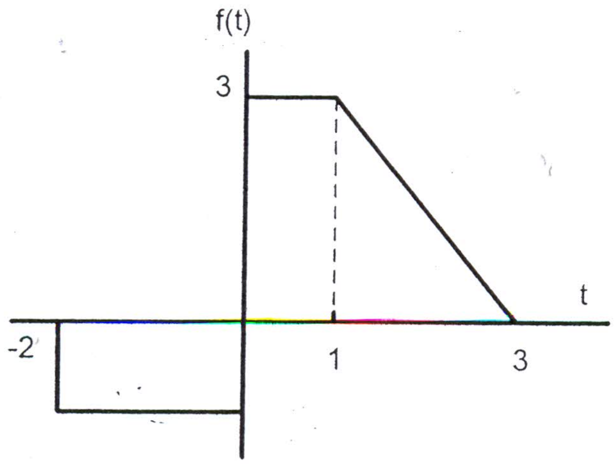

Figure 6

i. x(-t)
ii. x(2t)
iii. x (-0.1t)
iv. x(t-3)

(8 marks)

Question 9

Use the continuous-time periodic signal shown in **Figure 7**; determine:

(a) The fundamental period of x(t).

(2 marks)

(b) The fundamental frequency of x(t).

(2 marks)

(c) The angular frequency of x(t).

(2 marks)

(d) The average (DC) value of the signal x(t).

(2 marks)

(e) The expression for the Continuous-Time Fourier series (CTFS) coefficients. Simplify your expression as much as possible

(12 marks)

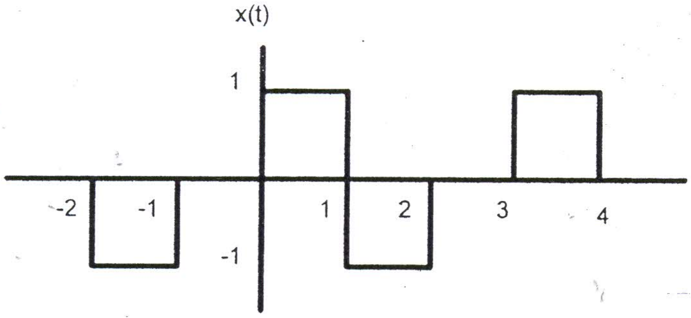

Figure 7

Question 10

Assuming a digital signal processing system with a sampling interval of 125 microseconds,

(a) Convert the following analog signals x(t) to the digital signal x(n).

$$X(t) = 10 \sin(2000\pi t)$$

(4 marks)

(b) Determine and plot the sample values from each obtained digital function for n=0 to n=7.

(8 marks)

(c) If the expression of $X(t) = 10 \sin(2000\pi t)$ is a periodic signal, prove that $x(t) = x(t + T_o)$.

(8 marks)

END OF QUESTION PAPER

APPENDIX – Table of Formulas

MATHEMATICAL FORMULAS

Trigonometric identities

$\sin(-x) = -\sin x$

$\cos(-x) = \cos x$

$\sin x = \cos(x - 90°)$

$-\sin x = \cos(x + 90°)$

$-\cos x = \cos(x \pm 180°)$

$e^{\pm jx} = \cos x \pm j \sin x$

$\cos x = \dfrac{e^{jx} + e^{-jx}}{2}$

$\sin x = \dfrac{e^{jx} - e^{-jx}}{j2}$

$\sin n\pi = 0$

$\cos n\pi = (-1)^n$, $\cos 2n\pi = 1$

Complex numbers

$z = x + jy = r\angle\phi = re^{j\phi}$

where $r\angle\phi = \sqrt{x^2 + y^2}\angle \tan^{-1}\dfrac{y}{x}$

Integrals

$\int te^{at}dt = \dfrac{e^{at}}{a^2}(at - 1) + C$

$\int t \sin at dt = \dfrac{1}{a^2}\sin at - \dfrac{t}{a}\cos at + C$

$\int t \cos at dt = \dfrac{1}{a^2}\cos at + \dfrac{t}{a}\sin at + C$

$\int e^{at} \sin bt\, dt = \dfrac{e^{at}}{a^2 + b^2}(a \sin bt - b \cos bt) + C$

$\int e^{at} \cos bt\, dt = \dfrac{e^{at}}{a^2 + b^2}(a \cos bt + b \sin bt) + C$

$\int \dfrac{dx}{a^2 + x^2} = \dfrac{1}{a}\tan^{-1}\dfrac{x}{a} + C$

$\int \dfrac{dx}{(a^2 + x^2)^2} = \dfrac{1}{2a^2}\left(\dfrac{x}{x^2 + a^2} + \dfrac{1}{a}\tan^{-1}\dfrac{x}{a}\right) + C$

FOURIER SERIES

Sine-cosine form

$$f(t) = a_0 + \sum_{n=1}^{\infty}(B_K \cos k\omega_0 t + C_K \sin k\omega_0 t), \qquad \omega_0 = \frac{2\pi}{T}$$

where

$$a_0 = \frac{1}{T}\int_0^T f(t)dt \qquad B_K = \frac{2}{T}\int_0^T f(t)\cos k\omega_0 t dt \qquad C_K = \frac{2}{T}\int_0^T f(t)\sin k\omega_0 t dt$$

Amplitude-phase form

$$f(t) = a_0 + \sum_{n=1}^{\infty} A_n \cos(n\omega_0 t + \phi_n)$$

where

$$A_n\angle\phi_n = a_n - jb_n$$

Exponential form

$$f(t) = c_O + \sum_{n=-\infty}^{\infty} c_n e^{jn\omega_0 t}$$

where

$$c_n = \frac{1}{T}\int_0^T f(t)e^{-jn\omega_0 t}dt$$

$$c_0 = a_0,$$

Parseval's theorem

$$P_{1\Omega} = a_0^2 + \frac{1}{2}\sum_{n=1}^{\infty}(a_n^2 + b_n^2) = a_0^2 + \frac{1}{2}\sum_{n=1}^{\infty}A_n^2 = \sum_{n=-\infty}^{\infty}|c_n|^2$$

FOURIER TRANSFORM

Definition of Fourier transform

$$F(\omega) = \mathcal{F}\{f(t)\} = \int_{-\infty}^{\infty} f(t)e^{-j\omega t}\,dt$$

Inverse Fourier transform

$$f(t) = \mathcal{F}^{-1}\{F(\omega)\} = \frac{1}{2\pi}\int_{-\infty}^{\infty} F(\omega)e^{j\omega t}\,d\omega$$

Properties of the Fourier transform

Property	$f(t)$	$F(\omega)$
Linearity	$a_1 f_1(t) + a_2 f_2(t)$	$a_1 F_1(\omega) + a_2 F_2(\omega)$
Scaling	$f(at)$	$\frac{1}{\|a\|}F\left(\frac{\omega}{a}\right)$
Time shift	$f(t-a)$	$e^{-j\omega a}F(\omega)$
Frequency shift	$e^{j\omega_0 t}f(t)$	$F(\omega-\omega_0)$
Modulation	$\cos(\omega_0 t)f(t)$	$\frac{1}{2}[F(\omega+\omega_0)+F(\omega-\omega_0)]$
Time differentiation	$\frac{df}{dt}$ $\frac{d^n f}{dt^n}$	$j\omega F(\omega)$ $(j\omega)^n F(\omega)$
Time integration	$\int_{-\infty}^{t} f(t)dt$	$\frac{F(\omega)}{j\omega} + \pi F(0)\delta(\omega)$
Frequency differentiation	$t^n f(t)$	$(j)^n \frac{d^n F(\omega)}{d\omega^n}$
Reversal	$f(-t)$	$F(-\omega)$ or $F^*(\omega)$
Duality	$F(t)$	$2\pi f(-\omega)$
Convolution in t	$f_1(t) * f_2(t)$	$F_1(\omega)F_2(\omega)$
Convolution in ω	$f_1(t)f_2(t)$	$\frac{1}{2\pi}F_1(\omega) * F_2(\omega)$

Fourier transform pairs

$f(t)$	$F(\omega)$
$\delta(t)$	1
1	$2\pi\delta(\omega)$
$u(t)$	$\pi\delta(\omega) + \frac{1}{j\omega}$
$u(t+\tau) - u(t-\tau)$	$2\frac{\sin\omega\tau}{\omega}$
$\|t\|$	$-\frac{2}{\omega^2}$
$\text{sgn}(t)$	$\frac{2}{j\omega}$