Ollscoil na hÉireann, Gaillimh GX_____
National University of Ireland, Galway

Semester I Examinations, 2003/2004

Exam Code(s)	3BN121
	3BP121
Exam(s)	Third Year Electronic Engineering
	Third Year Electronic and Computer Engineering
Module Code(s)	EE308
Module(s)	Signals and Communications
Paper No.	1
Repeat Paper	Special Paper
External Examiner(s)	Professor S. McLaughlin
Internal Examiner(s)	Professor D.J. Wilcox
	Dr. J. Breslin

Instructions: Answer 3 questions.
All questions carry equal marks.

Duration	2hrs
No. of Answer books	1
Requirements:	
Handout	
MCQ	
Statistical Tables	
Graph Paper	
Log Graph Paper	
Other Material	Yes Standard Mathematics Tables
No. of Pages	3
Department(s)	Electronic Engineering

1.

(a) Define the following:

(i) LTI system

[3 marks]

(ii) Orthogonal basis function for signals

[3 marks]

(iii) Parseval's theorem for periodic functions

[3 marks]

(iv) Gibbs' effect

[3 marks]

(b) Obtain the *exponential* Fourier series representation of f(t), the periodic sawtooth waveform as shown in Figure 1.

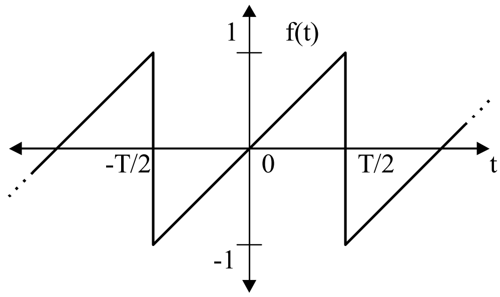

Figure 1

[8 marks]

2.

(a) Define the following, explaining how the *trigonometric* Fourier series can be simplified for each case:

(i) Odd signals

[3 marks]

(ii) Even signals

[3 marks]

(iii) Have-wave symmetrical signals

[3 marks]

(iv) Quarter-wave symmetrical signals

[3 marks]

(b) Obtain the *trigonometric* Fourier series representation of the signal $g(t) = t^2$ over the interval (0, 2), which repeats with a frequency of 0.5 Hz, as shown in Figure 2. Does it display any of the signal properties defined in part (a)?

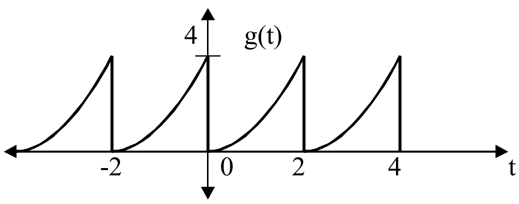

Figure 2

[8 marks]

[cont'd]

3.

(a) Name and prove the following properties of the Fourier transform:

(i) $\Im\{f^*(t)\} = F^*(-\omega)$

[3 marks]

(ii) If $\Im\{g(t)\} = G(\omega)$, then $\Im\{G(t)\} = 2\pi g(-\omega)$

[4 marks]

(iii) $\Im\{f(t - t_0)\} = F(\omega)e^{-j\omega t_0}$

[3 marks]

(b) Find the Fourier transform of the function $g(t) = e^{-a|t|}$, where a > 0. Sketch the resulting spectrum for a = 0.8.

[8 marks]

(c) What is the difference between the spectra of periodic and aperiodic signals?

[2 marks]

4.

(a) Consider the system shown in Figure 3, where the input signal x(t) is the unit step function:

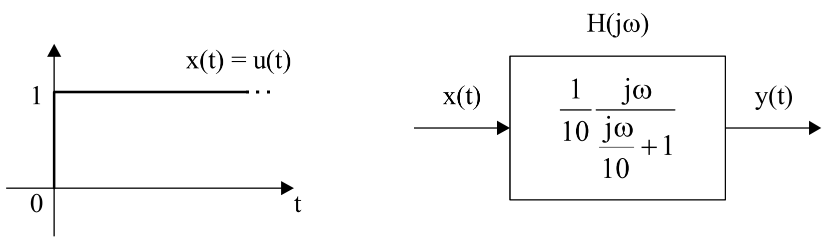

Figure 3

(i) Calculate and sketch the magnitude of H(jω).

[5 marks]

(ii) If this system is a filter, what type is it?

[2 marks]

(iii) Find the output signal y(t) and sketch it. Note the Fourier transform pairs: $\frac{1}{j\omega + a} \Leftrightarrow e^{-at}u(t)$ and $\pi\delta(\omega) + \frac{1}{j\omega} \Leftrightarrow u(t)$.

[5 marks]

(b) Sketch the circuit diagram for a Sallen-Key second-order low-pass active filter. Such a filter is designed to give a Butterworth-type response with f_0 = 7 kHz. If the value of R = 1 kΩ, calculate suitable values for C and k.

[8 marks]

5.

(a) Describe the following physical sources of noise: (i) thermal noise, and (ii) shot noise. In both cases, give an approximate expression for the power spectral density.

[6 marks]

(b) Sketch the PSD and autocorrelation functions for both ideal and bandwidth-limited white noise.

[4 marks]

(c) Define four average quantities used to describe random signals.

[10 marks]