UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2008/2009

SUBJECT NAME	: COMMUNICATION ENGINEERING
SUBJECT CODE	: BEE 3123
COURSE	: 3 BEE
EXAMINATION DATE	: APRIL 2009
DURATION	: 3 HOURS
INSTRUCTION	: ANSWER **ALL** QUESTIONS IN SECTION A AND **THREE (3)** QUESTIONS IN SECTION B

THIS QUESTION PAPER CONSISTS OF TEN (10) PAGES

SECTION A

Q1 Given a periodic sawtooth signal as shown in Figure Q1.

(a) State the symmetrical function of the signal.

(1 mark)

(b) Decribe the signal's expression for one cycle.

(1 mark)

(c) Give the period and angular frequency of the signal.

(1 mark)

(d) Determine the trigonometric Fourier Series of the periodic signal.

(5 marks)

Q2 (a) Explain the difference between correlated and uncorrelated noise.

(3 marks)

(b) A deep-space communication system dish antenna receives a signal from a satellite with -50 dBm of power. The special preamplifier boosts it an additional 20 dB. Further amplifier stages add 30 dB, 25 dB and 15 dB to the signal.

(i) Calculate the overall gain.

(1 mark)

(ii) Determine the power level in watts and dBm in final stage.

(4 marks)

Q3 (a) By using an appropriate diagram, derive the equation for index modulation, m using V_{max} and V_{min}.

(6 marks)

(b) As an RF engineer, you have been given a task to design the best AM receiver. Several factors and parameter should be considered in designing the receiver. List FOUR (4) parameters that you might consider in designing the receiver.

(2 marks)

Q4 Despite the fact that Frequency Modulation (FM) has superior noise rejection qualities, noise still interferes with an FM signal and this is particularly true for the high-frequency components in the modulating signal. From your understanding, state the TWO (2) circuits that help to overcome the problem. Explain briefly the function of each circuit. What would happen if the circuits can not compensate each other?

(8 marks)

Q5 (a) Given the signal $m(t) = 10\cos 2000\pi\, t \cos 8000\pi\, t$. Discover the Nyquist rate and the Nyquist interval from the signal given.

(5 marks)

(b) Consider the binary sequence 010 0101. Illustrate the waveform for the following signaling formats.

(i) Unipolar NRZ -L signaling format
(ii) Bipolar RZ signaling format
(iii) Alternate mark inversion, AMI RZ signaling format

(3 marks)

SECTION B

Q6 (a) Below is a Fourier Series expression for a periodic triangular signal for T = 2 and $\omega_0 = \pi$. Determine the amplitude and phase values up to the 6^{th} harmonics. Then plot the spectra.

$$f(t) = \frac{1}{4} + \sum_{n=1}^{\infty}\left[\frac{\left[(-1)^n - 1\right]}{(n\pi)^2}\cos n\pi t + \frac{(-1)^{n+1}}{n\pi}\sin n\pi t\right]$$

(16 marks)

(b) If the Fourier transform of $f(t)$ is $F(\omega) = \dfrac{10}{(2+j\omega)(5+j\omega)}$, determine the transform of $f(2t-1)$.

(4 marks)

Q7 Telecommunication receiver consists of three cascaded amplifier. The input signal power is 100 μW and each amplifier contributes an additional 80 μW of noise and 1 μW of input noise. The first amplifier has 2 dB of Noise Figure (NF), followed by second amplifier having NF of 1.5 dB and the third amplifier 2.5 dB. Determine the power gain for each amplifier in dB.

(20 marks)

Q8 (a) The total power in amplitude-modulated wave is equal to the sum of the powers of carrier, the upper sideband and lower sideband. Show that the total power, equal to the equation below.

$$P_T = P_c\left(1 + \frac{m^2}{2}\right)$$

(8 marks)

(b) Construct the equation for amplitude modulation signal by referring to Figure Q8(b).

(12 marks)

Q9 An FM signal has a deviation of 10 kHz and is modulated by a sine wave with frequency of 5 kHz. The carrier frequency is 100 MHz and the signal has a total power of 12.5 W operating into an impedance of 50 Ω. Determine,

(a) The modulation index.
(b) Carrier swing.
(c) Bandwidth using Bessel Table.
(d) Bandwidth using Carson's rule.
(e) If the modulated signal is filtered by a 20 kHz bandpass filter centered at f_c, determine the output frequency sidebands.
(f) The power at the carrier frequency and each of the sideband frequencies found in part (e).
(g) The percentage of the total power is unaccounted for by the components described above.
(h) Write the full equation for the FM signal.

(20 marks)

Q10 Consider an audio signal with spectral components limited to the frequency band of 300 to 3300 Hz. A PCM signal is generated with sampling rate of 8000 samples/ s. The required output signal to quantizing noise ratio is 30 dB. Determine,

(i) the minimum number of uniform quantizing levels and minimum number of bits per sample needed,
(ii) the minimum bandwidth required for this system,
(iii) repeats (i) and (ii) when a μ law compander is used with $\mu = 255$, and
(iv) Conclude your findings in (i), (ii) and (iii)

Given that signal to quantization noise ratio is

$$\left(\frac{S}{N_q}\right)_{0dB} = 1.76 + 20\log L \geq 30$$

and signal to quantization noise ratio for $\mu \geq 1$ is

$$\left(\frac{S}{N_q}\right)_{0dB} = 20\log L - 10.1 \geq 30$$

(20 marks)

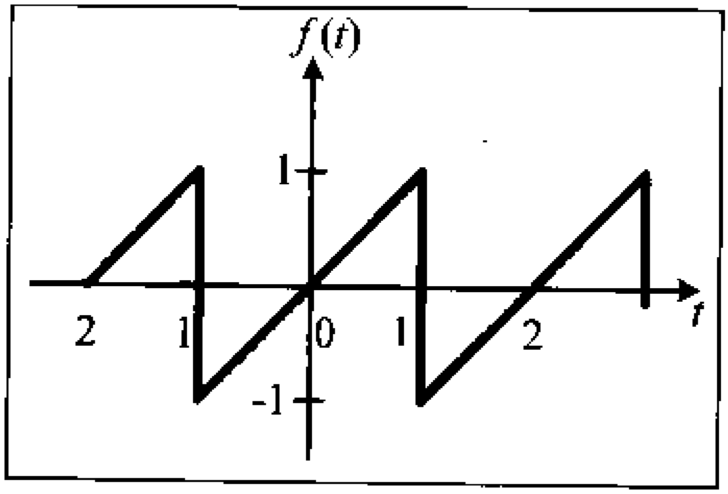

FIGURE Q1: Sawtooth signal.

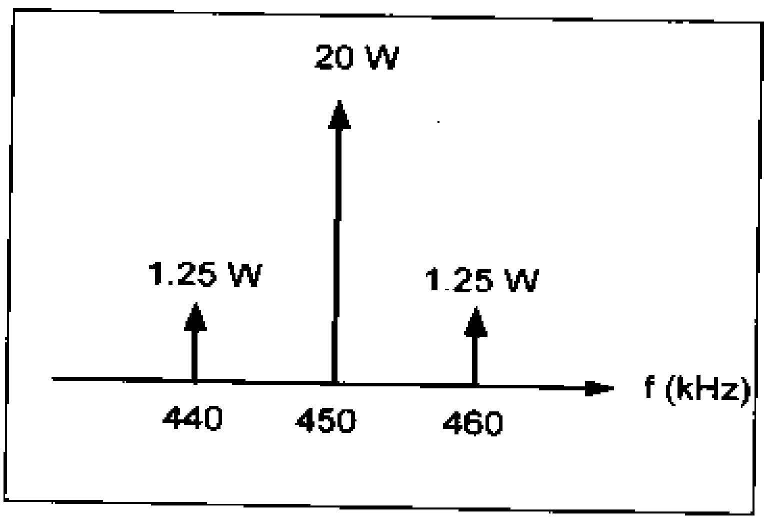

FIGURE Q8(b) : Power Spectrum

Table 1: Fourier Transform Pair

Time Domain	Frequency Domain
$\delta(t)$	1
1	$\delta(f)$
$\delta(t-t_0)$	$e^{-j2\pi f t_0}$
$e^{j2\pi f_0 t}$	$\delta(f-f_0)$
$\cos(2\pi f_0 t)$	$\frac{1}{2}\delta(f-f_0)+\frac{1}{2}\delta(f+f_0)$
$\sin(2\pi f_0 t)$	$-\frac{1}{2j}\delta(f+f_0)+\frac{1}{2j}\delta(f-f_0)$
$\Pi(t)$	$\mathrm{sinc}(f)$
sinc (t)	$\Pi(f)$
$\Lambda(t)$	$\mathrm{sinc}^2(f)$
$e^{-\alpha t}u_{-1}(t), \alpha > 0$	$\frac{1}{\alpha+j2\pi f}$
$te^{-\alpha t}u_{-1}(t), \alpha > 0$	$\frac{1}{(\alpha+j2\pi f)^2}$
$e^{-\alpha\|t\|}$	$\frac{2\alpha}{\alpha^2+(2\pi f)^2}$
$e^{-\pi t^2}$	$e^{-\pi f^2}$
$\mathrm{sgn}(t)$	$\frac{1}{j\pi f}$
$u_{-1}(t)$	$\frac{1}{2}\delta(f)+\frac{1}{j2\pi f}$
$\delta'(t)$	$j2\pi f$
$\delta^{(n)}(t)$	$(j2\pi f)^n$
[illegible]	$-j\pi\,\mathrm{sgn}(f)$
$\sum_{n=-\infty}^{+\infty}\delta(t-nT_0)$	$\frac{1}{T_0}\sum_{n=-\infty}^{+\infty}\delta\left(f-\frac{n}{T_0}\right)$

Table 2: Fourier Transform Properties

Signal	Fourier Transform
$\alpha x_1(t)+\beta x_2(t)$	$\alpha X(f)+\beta X(f)$
$X(t)$	$x(-f)$
$x(at)$	$\frac{1}{\lvert a\rvert}X\left(\frac{f}{a}\right)$
$x(t-t_0)$	$e^{-j2\pi f t_0}X(f)$
$e^{-j2\pi f_0 t}x(t)$	$X(f-f_0)$
$x(t)*y(t)$	$X(f)Y(f)$
$x(t)y(t)$	$X(f)*Y(f)$
$\frac{d}{dt}x(t)$	$j2\pi f X(f)$
$\frac{d^n}{dt^n}x(t)$	$(j2\pi f)^n X(f)$
$tx(t)$	$\left(\frac{j}{2\pi}\right)\frac{d}{df}X(f)$
$t^n x(t)$	$\left(\frac{j}{2\pi}\right)^n \frac{d^n}{df^n}X(f)$
$\int_{-\infty}^{t} x(\tau)d\tau$	$\frac{X(f)}{j2\pi f}+\frac{1}{2}X(0)\delta(f)$

Table 3: Bessel Function

Modulation index	Carrier	Sidebands									
	J_0	J_1	J_2	J_3	J_4	J_5	J_6	J_7	J_8	J_9	J_{10}
0.0	1.00	—	—	—	—	—	—	—	—	—	—
0.25	0.98	0.12	—	—	—	—	—	—	—	—	—
0.5	0.94	0.24	0.03	—	—	—	—	—	—	—	—
1.0	0.77	0.44	0.11	0.02	—	—	—	—	—	—	—
1.5	0.51	0.56	0.23	0.06	0.01	—	—	—	—	—	—
2.0	0.22	0.58	0.35	0.13	0.03	—	—	—	—	—	—
2.5	−0.05	0.50	0.45	0.22	0.07	0.02	—	—	—	—	—
3.0	−0.26	0.34	0.49	0.31	0.13	0.04	0.01	—	—	—	—
4.0	−0.40	−0.07	0.36	0.43	0.28	0.13	0.05	0.02	—	—	—
5.0	−0.18	−0.33	0.05	0.36	0.39	0.26	0.13	0.06	0.02	—	—
6.0	0.15	−0.28	−0.24	0.11	0.36	0.36	0.25	0.13	0.06	0.02	—
7.0	0.30	0.00	−0.30	−0.17	0.16	0.35	0.34	0.23	0.13	0.06	0.02
8.0	0.17	0.23	−0.11	−0.29	0.10	0.19	0.34	0.32	0.22	0.13	0.06

Table 4: Trigonometry Properties

Trigonometric Identity	**Trigonometric Integral**
$e^{\pm jA} = \cos A \pm j\sin A$	$\int_0^T \sin n\omega_0 t \, dt = 0,\ \int_0^T \cos n\omega_0 t \, dt = 0$
$\cos A = \frac{1}{2}\left(e^{jA} + e^{-jA}\right),\ \sin A = \frac{1}{2j}\left(e^{jA} - e^{-jA}\right)$	$\int_0^T \sin n\omega_0 t \cos m\omega_0 t \, dt = 0$
$\sin^2 A + \cos^2 A = 1,\ \cos^2 A - \sin^2 A = \cos 2A$	$\int_0^T \sin n\omega_0 t \sin m\omega_0 t \, dt = 0, (m \neq n)$
$2\sin A\cos A = \sin 2A$	$\int_0^T \cos n\omega_0 t \cos m\omega_0 t \, dt = 0, (m \neq n)$
$\cos^2 A = \frac{1}{2}(1 + \cos 2A),\ \sin^2 A = \frac{1}{2}(1 - \cos 2A)$	$\int_0^T \sin^2 n\omega_0 t \, dt = \frac{T}{2},\ \int_0^T \cos^2 n\omega_0 t \, dt = \frac{T}{2}$
$\sin(A \pm B) = \sin A\cos B \pm \cos A\sin B$	$\int \cos at \, dt = \frac{1}{a}\sin at,\ \int \sin at \, dt = -\frac{1}{a}\cos at$
$\cos(A \pm B) = \cos A\cos B \mp \sin A\sin B$	$\int t\cos at \, dt = \frac{1}{a^2}\cos at + \frac{1}{a}t\sin at$
$\sin A\sin B = \frac{1}{2}\left[\cos(A - B) - \cos(A + B)\right]$	$\int t\sin at \, dt = \frac{1}{a^2}\sin at - \frac{1}{a}t\cos at$
$\cos A\cos B = \frac{1}{2}\left[\cos(A - B) + \cos(A + B)\right]$	
$\sin A\cos B = \frac{1}{2}\left[\sin(A - B) + \sin(A + B)\right]$	

Constant

Boltzmann's Constant, $k = 1.38 \times 10^{-23}$
Ambient Temperature, $T_0 = 290$ K