KENYATTA UNIVERSITY

UNIVERSITY EXAMINATIONS 2011/2012

FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE (TELECOMMUNICATION AND INFORMATION TECHNOLOGY)

SPH 310: SIGNAL PROCESSING

DATE: Thursday, 24th November, 2011 TIME: 11.00 a.m. – 1.00 p.m.

INSTRUCTIONS: Answer question **ONE** and any other **TWO** questions.

You may use:

Q1. (a) (i) What is meant by recursive discrete time processor? (1 mark)

(ii) Sketch the block diagram of a processor described by
$y[n] = x[n] + x[n-1] + x[n-2] + \ldots\ldots$ (3 marks)

(b) (i) What is meant by convolution sum in discrete time systems? (1 mark)

(ii) The input sequence x[n] = 4,1,3,5,0,0,0,... is applied o a discrete-time processor with the unit impulse response h[n] = 2,5,1,1,0,... What is the output sequence? (3 marks)

(c) (i) What is the importance of Fourier Transform. (1 mark)

(ii) An exponential decaying pulse is given
$h(t) = e^{-\alpha t}$ for $t > 0$
$= 0$ for $t < 0$. Find the frequency response. (3 marks)

(d) (i) What is meant by amplitude modulation? (1 mark)

(ii) A multi-tone message signal has amplitudes 3, 5 and 8 V. If it modulates a carrier of amplitude 10 V find the overall modulation.

(3 marks)

(e) (i) What is meant by frequency modulation? (1 mark)

(ii) What is the band width required for an FM wave signal in which the modulating frequency signal is 2 kHz and the maximum frequency deviation is 12 kHz? (3 marks)

(f) (i) What is the advantage of SSB modulation over DSB-OAM? (1 mark)

(ii) Sketch the circuit for generating an SSB signal. (3 marks)

(g) (i) What is the main advantage of digital over analogue signals. (1 mark)

(ii) An AM transmitter is coupled to an antenna. With no modulation the input current is 10.8 A. With modulation, the current rises to 12.15 A. Find the modulation depth. (3 marks)

(h) Show that an ordinary AM signal with a large carrier can be demodulated by squaring it and then passing the resulting signal through a low-pass filter. (2 marks)

Q2. (a) Show that the NBFM is equivalent to DSB-AM with a phase shift of π in the lower sideband. Assume cosinusoidal message and carrier signals. (7 marks)

(b) Draw a circuit diagram for FM modulation, explaining the function of the major sections. (7 marks)

(c) In an aerial current before modulation is 10 A. After modulation it rises to 11.6 A. Determine the

(i) modulation index (3 marks)

(ii) power after modulation if the carrier power is 10 kW. (3 marks)

Q3. (a) An FM wave is represented by the voltage equation $x(t) = 10sn(8x10^6t + 6sin3x10^4t)$ calculate the

(i) modulating frequency. (2 marks)

(ii) carrier frequency (2 marks)

(iii) modulation index (2 marks)

(iv) frequency deviation (2 marks)

(v) power dissipated in an 8 Ω load (2 marks)

(b) The output voltage of a transmitter is given by

$v(t) = 500(1+0.4\sin 3140t)\sin 6.28\times10^{7}t$.

This voltage is fed to a load of 600 Ω resistance. Determine the

(i) carrier frequency (2 marks)

(ii) modulating frequency (2 marks)

(iii) carrier power (2 marks)

(iv) mean power output (2 marks)

(v) peak power output (2 marks)

Q4. (a) For a compressor with $\mu = 255$ determine the

(i) voltage gain for the relative values $V_{in} : V_{max}$ where $0.75V_{max}$, $0.5\ V_{max}$, $0.25\ V_{max}$ (3 marks)

(ii) compressed output voltage for a maximum input voltage of 4 V. (3 marks)

(iii) input-output dynamic range (3 marks)

(iv) input-output compression (2 marks)

(b) Show that the Fourier transform of

(i) $x(t-\tau)$ is $X(i\omega)e^{-i\omega\tau}$. (3 marks)

(ii) $\delta(t-\tau)$ is $e^{-i\omega\tau}$. (3 marks)

(iii) $\delta(t) + 2\delta(t-\tau) + \delta(t-2\tau)$ is $2(1 + \cos\omega\tau)$ (3 marks)

Q5. (a) An A-law expander has $A = 87.6$. If $m_p = 20$ V and 256 quantizing levels are employed, what is the

(i) smallest effective separation between levels (5 marks)

(ii) largest effective separation between levels (5 marks)

(b) A system has 128 characters which are binary-coded. If it generates 100000 characters per second, determine the

(i) number of bits per character (3 marks)

(ii) bit rate (3 marks)

(c) A pulse modeled as the weighted sample response $2\delta(t)$, is applied to a system and produces an output $y(t)= 6e^{-2t} - 4e^{-3t}$. What is the frequency response of the system. (4 marks)

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