ELEC 466 : DIGITAL SIGNAL PROCESSING
1995/96 WINTER SESSION TERM 2

MID-TERM EXAMINATION

10:30 am – 11:20 am
February 27, 1996

Answer all five (5) questions, in any order. The marks for each question are as indicated and there are a total of 50 marks. Write your answers in the exam booklet provided and show your work. Books, notes and calculators are allowed.

Question 1 (5 marks)

A sine wave with an amplitude of 3 volts is quantized by an 8-bit ADC. The ADC full-scale input range is from -6 to 6 volts. What is the quantization SNR of the sampled signal?

Question 2 (10 marks)

A 4-th order ($n = 4$) analog Butterworth filter with a 3 dB frequency (f_c) of 2 kHz is used to filter a signal with a flat (constant) spectrum. This filtered signal is then sampled at a rate of 8 kHz. Find the ratio of signal power to aliasing noise power at a frequency of 2 kHz. Express your answer in dB.

Question 3 (20 marks)

A LTI system is defined by the difference equation

$$y(n) - 0.8y(n-2) = x(n) + 2x(n-1) + x(n-2)$$

where $x(n)$ is the input and $y(n)$ is the output.

(a) Find the z-domain transfer function, $H(z)$ of the system.

(b) Draw a signal flow graph for the system using branches with gains of $1z^{-1}$ to indicate delays.

(c) Find the values and sketch the positions of the poles and zeros of the system. Include poles and zeros at the origin, do not include those at infinity.

(d) Based on the locations of the poles and zeros in your diagram, sketch the amplitude response of the system over the range $-F_s/2$ to $F_s/2$. Indicate the frequencies of any peaks and nulls.

(e) Is this system stable? Why or why not?

Question 4 (5 marks)

$X(k)$ is the DFT of the sequence $x(n) = \{1, 0, 2\}$. Find the value of $X(5)$.

Question 5 (10 marks)

The following diagram shows the *real* and *imaginary* components of the N-point DFT, $X(k)$, of a *real* signal for $k = 0 \ldots N/2 - 1$. Sketch the *amplitude* and *phase* spectrum over the range $k = 0 \ldots N - 1$. Show the numerical values of the phase (radians or degrees) and magnitude. You may draw the magnitude and phase as continuous (rather than discrete) functions.