MERU UNIVERSITY OF SCIENCE AND TECHNOLOGY

P.O. Box 972-60200 – Meru-Kenya

Tel: +254(0) 799 529 958, +254(0) 799 529 959, + 254 (0) 712 524 293,

Website: info@must.ac.ke Email: info@must.ac.ke

University Examinations 2019/2020

SECOND THIRD SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF TECHNOLOGY IN ELECTRICAL AND ELECTRONIC ENGINEERING

EET 3370: DIGITAL SIGNAL PROCESSING

DATE: APRIL 2020 **TIME: 2 HOURS**

INSTRUCTIONS: *Answer question **one** and any other **two** questions*

QUESTION ONE (30 MARKS)

a). Define the following terms:
   i). Aliasing (2 marks)
   ii). Nyquist sampling frequency (2 marks)

b). Explain in the summary the process of analogue to digital conversion (6 marks)

c). Draw a basic digital filter that can be used as a three-sample averager, naming all its components (5 marks)

d). Find the unit-sample response of a digital filter whose output is given as
$y(n) = 1/3(x(n+1) + x(n) + x(n-1))$ (6 marks)

e). A first order recursive filter whose input is $x(n)$ has an output given as $y(n) = ay(n-1) + x(n)$ where a is a constant. Determine whether the filter is stable or not. (4 marks)

f). Find the Discrete Fourier Transform (DFT) of a digital system whose unit impulse response is defined by $h(n) = \begin{cases} \frac{1}{3} & \text{for } 0 \le n \le 2 \\ 0 & \text{otherwise} \end{cases}$ (5 marks)

g). Find the z – transform of a filter whose impulse response is given as $h(n) = \begin{cases} a^n & \text{for } n \le 0 \\ 0 & \text{otherwise} \end{cases}$

(4 marks)

QUESTION TWO (15 MARKS)

a). Explain any two properties of the DFT. (4 marks)

b). Find the circular convolution for $x(n) = \begin{cases} 1 & \text{for } n = 0 \\ 0.5 & \text{for } n = 1 \\ 0 & \text{otherwise} \end{cases}$ and $h(n) = \begin{cases} 0.5 & \text{for } n = 0 \\ 1 & \text{for } n = 1 \\ 0 & \text{otherwise} \end{cases}$ (5 marks) c). Derive analytically, the decimation in time FFT algorithm. (6 marks)

QUESTION THREE (15 MARKS)

a). Find the z – transform of the second order recursive filter given by

$$h(n) = \begin{cases} r^n \cos(\omega_0 n) & \text{for } n \geq 0 \\ 0 & \text{otherwise} \end{cases}$$ (6 marks)

b). Determine the system function for a system whose output is given as

$$y(n) = a_1 y(n-1) + a_2 y(n-2) + b_0 x(n) + b_1 x(n-1)$$ (4 marks)

c). State the four types of singularities generated by elementary filters with respect to the complex z – plane. (4 marks)

QUESTION FOUR (15 MARKS)

a). Perform Direct Form II implementation for a filter given by

$$y(n) = 2r\cos(\omega_0) y(n-1) - r^n y(n-2) + x(n) - r\cos(\omega_0) x(n-1)$$ (9 marks)

b). Explain the difference between recursive and causal filters (4 marks)

c). What is meant by FIR and IIR (2 marks)

QUESTION FIVE (15 MARKS)

a). Explain the performance differences between FIR and IIR filters. (6 marks)

b). Design an FIR filter using the DFT / windowing procedure. The filter is specified as:

passband: $-1 \leq |H(e^{j\omega})|_{\text{dB}} \leq 0$ for $0.42\pi \leq \omega \leq 0.61\pi$

stopband: $|H(e^{j\omega})|_{\text{dB}} < -60$ for $0 \leq \omega \leq 0.16\pi$ and $0.87\pi \leq \omega \leq \pi$

(9 marks)