KATHMANDU UNIVERSITY
End Semester Examination
August/September, 2017

Mark Scored:

Level : B. E.
Year : III
Course : ETEG 305
Semester : II

Exam Roll No. :
Time: 30 min
F. M. : 10

Registration No.:
Date : SEP 10 2017

SECTION "A"
[20 Q × 0.5 = 10 marks]

Choose the most appropriate option. Symbols have their usual meaning.

1. Which of the following discrete time signal represents the energy signal?
   a. $(1/2)^n u(n)$ b. $\sin(\frac{\pi}{3})n$ c. $nu(n)$ d. $e^{[(\pi/3)n + (\pi/2)]}$

2. If Z[x(n)] is X(z) then Z[nx(n)] is given by
   a. $Z\frac{dX(z)}{dz}$ b. $(1/z)\frac{dX(z)}{dz}$ c. $(-1/z)\frac{dX(z)}{dz}$ d. $-Z\frac{dX(z)}{dz}$

3. The number of complex multiplications in computation of N-point DFT by radix –2 DIT-FFT is_____.
   a. $N \log_2 N$ b. $(1/N) \log_2 N$ c. $\frac{N}{2}\log_2 N$ d. $\frac{N}{2}\log_{10} N$

4. For the analog signal $x(t) = 3Cos100\pi t$, what is the corresponding discrete-time signal if the signal is sampled at 75Hz?
   a. $3Cos\pi n$ b. $3Cos(\pi/3)n$ c. $3Cos(3\pi/2)n$ d. $3Cos(2\pi/3)n$

5. The DFT of x (n) is defined as
   a. $X(k) = X(\omega)|_{\omega=2\pi k}$ b. $X(k) = X(\omega)|_{\omega=2\pi n/N}$
   c. $X(k) = X(\omega)|_{\omega=2\pi n}$ d. $X(k) = X(\omega)|_{\omega=2\pi k/N}$

6. If reverse polynomial of $A_m(z)$ is $B_m(z)$, which of the following expression is correct?
   a. $B_m(z) = z^{-m} A_m(z^{-1})$ b. $B_m(z) = z^m A_m(z^{-1})$
   c. $B_m(z) = z^{-m} A_m(z)$ d. $B_m(z) = z^{-1} A_m(z^{-1})$

7. The filter structure which uses less number of delay element is _____
   a. Direct form-I b. Direct form-II c. Cascade form d. Parallel form

8. If Z[x(n)] is X(z) then initial value theorem states that
   a. $x(0) = \lim_{z\to\infty} zX(z)$ b. $x(0) = \lim_{z\to\infty} (z-1)X(z)$
   c. $x(0) = \lim_{z\to 0} zX(z)$ d. $x(0) = \lim_{z\to\infty} X(z)$

9. A system whose output y(n) at time n depends on any number of past output values is called a _____
   a. Recursive system b. Non-recursive system
   c. Causal system d. Non-causal system

10. Inverse Fourier transform of $X(\omega) = e^{-j\omega}(1+Cos\omega)$ is equal to _____
    a. $\sin\frac{\pi n}{\pi n}$ b. $Cos\frac{\pi n}{\pi n}$ c. $\sin\frac{\pi(n-1)}{\pi(n-1)}$ d. $Cos\frac{\pi(n-1)}{\pi(n-1)}$

11. Which of the following represents the expression for causal Hanning window?

a. $\begin{cases} 0.5 + 0.5\text{Cos}\left(\frac{2\pi n}{M-1}\right) & \text{for } 0 \le n \le M-1 \\ 0 \text{ otherwise} \end{cases}$

b. $\begin{cases} 0.54 - 0.46\text{Cos}\left(\frac{2\pi n}{M-1}\right) & \text{for } 0 \le n \le M-1 \\ 0 \text{ otherwise} \end{cases}$

c. $\begin{cases} 0.54 + 0.46\text{Cos}\left(\frac{2\pi n}{M-1}\right) & \text{for } 0 \le n \le M-1 \\ 0 \text{ otherwise} \end{cases}$

d. $\begin{cases} 0.5 - 0.5\text{Cos}\left(\frac{2\pi n}{M-1}\right) & \text{for } 0 \le n \le M-1 \\ 0 \text{ otherwise} \end{cases}$

12. The number of stages in computation of 1024-point DFT by radix – 2 FFT is_____
a. 1024 b. 32 c. 8 d. 10

13. A FIR filter is linear phase if and only if its coefficients are symmetrical around the centre coefficient. For order m, the condition is given by
a. $h(n) = h(m-1+n)$ b. $h(n) = h(m-n)$ c. $h(n) = h(m-1)$ d. $h(n) = h(m-1-n)$

14. For the following specification of a low pass discrete time filter, the cut-off frequency is equal to _____

$0.99 \le |H(e^{j\omega})| \le 1.01 \quad \text{for } |\omega| \le 0.4\pi$

$|H(e^{j\omega})| \le 0.01 \quad \text{for } 0.6\pi \le |\omega| \le \pi$

a. 0.5π b. 0.3π c. 0.4π d. 0.2π

15. Let $x(n) = \{0,1,A,2,3,4\}$. If $X(0) = 10$, A = ?
a. A = 0 b. A = 1 c. A = 2 d. A = 3

16. The DFT$[x_1(n) \oplus x_2(n)]$ is equal to _____
a. $X_1(k) \oplus X_2(k)$ b. $X_1(k) + X_2(k)$
c. $X_1(k) - X_2(k)$ d. $X_1(k)X_2(k)$

17. The twiddle factor is given by
a. $W_N = e^{\frac{-j\pi}{N}}$ b. $W_N = e^{j2\pi/N}$ c. $W_N = e^{j\pi/N}$ d. $W_N = e^{-j\pi N}$

18. In bilinear transformation method, the relationship between analog frequency and digital frequency is given by
a. $\Omega = \frac{T}{2}(\tan(\frac{\omega}{2}))$ b. $\Omega = 2T(\tan(\frac{\omega}{2}))$
c. $\Omega = \frac{1}{T}(\tan(\frac{\omega}{2}))$ d. $\Omega = \frac{2}{T}(\tan(\frac{\omega}{2}))$

19. If Ω is analog frequency, Ω_p is pass band edge frequency and Ω_s is stop band edge frequency then the squared magnitude response of Butterworth filter is given by
a. $|H(\Omega)|^2 = 1/(1+(\Omega_c/\Omega_p)^{2N})$ b. $|H(\Omega)|^2 = 1/(1+(\Omega/\Omega_c)^{2N})$
c. $|H(\Omega)|^2 = 1/(1+(\Omega_s/\Omega_p)^{2N})$ d. $|H(\Omega)|^2 = 1/(1+(\Omega/\Omega_p)^{2N})$

20. The type I Chebyshev filter contains _____
a. Oscillations in the pass band b. Oscillations in the stop band
c. Oscillations in the pass band and stop band d. Oscillations in the transition band

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SECTION "B"
[4Q.× 10 = 40 marks]

Attempt *ANY FOUR* questions. Figure in the margin indicates the full mark. Students are required to answer in their own words as far as practicable.

1. a. Determine the unit sample response, h(n) of the system characterized by the difference equation:
   $y(n) = 2.5\,y(n-1) - y(n-2) + x(n) - 5x(n-1) + 6x(n-2)$ [3]
   b. Check mathematically whether the discrete time ramp signal is energy signal, power signal or neither power nor energy signal. [2]
   c. Perform the circular convolution of the following two sequences. Also write the circular convolution property of DFT.
   $x(n) = \{2,1,2,1\}$ and $x(n) = \{1,2,3,4\}$. [5]

2. a. Find the Z-transform of signal $x(n) = a^n (\cos\omega_o n)\, u(n)$. Also, explain that the Z-transform cannot uniquely specify the signal in time domain. [2+1]
   b. Given a three stage lattice filter with coefficients $K_1 = 1/4$, $K_2 = 1/2$, $K_3 = 1/3$, determine the FIR filter coefficients for the direct form structure. Also draw the direct form-II structure. [5]
   c. Differentiate between FIR filters and IIR filters. [2]

3. a. Convert the Analog filter with the following system function:
   $H_a(s) = (s+0.1)/((s+0.1)^2 + 16)$ into a digital filter by means of bilinear transformation. The digital filter is to have a digital resonant frequency of $\omega = \pi/2$ [3]
   b. Compute the IDFT of the sequence using DIF-FFT algorithm: [5]
   $X(k) = \{7, -0.707 - j0.707, -j, 0.707 - j0.707, 1, 0.707 + j0.707, j, -0.707 + j0.707\}$
   c. Determine the causal signal x(n) having the Z-transform
   $X(z) = \frac{1}{(1+z^{-1})(1-z^{-1})^2}$ [2]

4. a. A low pass digital filter has the desired frequency response as shown: [6]
   $$H_d(e^{j\omega}) = \begin{cases} e^{-j\omega\frac{(M-1)}{2}}, & 0 \le |\omega| \le \pi/2 \\ 0, & \pi/2 \le |\omega| \le \pi \end{cases}$$
   Design a FIR filter using frequency sampling method for order, M = 7
   b. List some advantages of DSP processors over conventional microprocessors. [2]
   c. How phase distortion and delay distortion are introduced in FIR filters? Write the conditions for linear phase digital filters. [2]

5. a. Check whether the corresponding LTI system with system function [2]
   $H(z) = -1 - 0.4z^{-1}/(1 - 2.8\,z^{-1} + 1.6\,z^{-2})$ is stable and causal if ROC is:
   i) $|z|>2$
   ii) $|z|<0.8$
   iii) $0.8<|z|>2$
   b. Design a Butterworth digital filter using bilinear transformation method. The specifications of the desired low pass filter are given by [6]
   $0.9 \le |H(e^{j\omega})| \le 1$ for $\le |\omega| \le \pi/2$
   $|H(e^{j\omega})| \le 0.2$ for $\frac{3\pi}{4} \le |\omega| \le \pi$ (Assume sampling period =1 sec)
   c. What are the factors that influence the choice of structure for realization of an LTI system? [2]