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Name..................................

B.TECH. DEGREE EXAMINATION, MAY 2014

Sixth Semester

Branches : Applied Electronics and Instrumentation/Electronics and Communication/ Electronics and Instrumentation Engineering

AI 010 602/EC 010 602/EI 010 602—DIGITAL SIGNAL PROCESSING (AI, EC, EI)

(New Scheme—2010 Admission onwards)

[Regular/Improvement/Supplementary]

Time : Three Hours Maximum : 100 Marks

Part A

Answer **all** *questions briefly.*
Each question carries 3 marks.

1. Determine if the system $y(n) = e^{x(n)}$ is time invariant or not ?

2. Find the transfer function description of the system difference equation

   $y\ (n) = x(n)\ - b_1 y\ (n-1)\ -\ b_2 y\ (n-2)$, where $x\ (n)$ is input and $y\ (n)$ is the output.

3. Draw the frequency response characteristics for the ideal low-pass, band-pass and high-pass filters.

4. Write the equations specifying Barlett and Hamming windows.

5. Obtain the linear convolution of the sequences $x(n) = \{1, 2, 3\}$, $h(n) = \{-1, -2\}$ using circular convolution.

(5 × 3 = 15 marks)

Part B

Answer **all** *questions.*
Each question carries 5 marks.

6. Find the z-transform of $x(n) = n2^n \sin\left(\pi/_2\, n\right) u(n)$.

7. Solve the difference equation, where input sequence is $x(n) = 3^{n-2}$, $n \geq 0$, using z-transform, where

   $2y\,(n-2) - 3y\,(n-1) + y(n) = x(n)$ with the initial conditions : $y(-2) = \frac{-4}{9}$, $y(-1) = -\frac{1}{3}$.

8. Draw the cascade and parallel form realisations of $\frac{(4s+28)}{(s+1)\,(s+5)}$.

Turn over

9. In a band-pass filter, the desired frequency response is :

$$H_d\left(e^{jw}\right) = \begin{cases} e^{-jw\tau} & , \; w_{c_1} \le |w| \le w_{c_2} < \pi \\ 0 & , \; \text{otherwise} \end{cases}$$

Obtain the filter coefficients for a rectangular window for

$$N = 7, w_{c_1} = 1 \text{ rad/s}, \; w_{c_2} = 2 \text{ rad/s}, \; \tau = \frac{(N-1)}{2}.$$

10. Compute the DFT of the sequence whose values for one period is given by $\tilde{x}(n) = \{1, 1, -2, -2\}$.

(5 × 5 = 25 marks)

Part C

Answer **all** *questions.*

Each question carries 12 *marks.*

11. Calculate the frequency response for the LTI system representation below :

(a) $h(n) = \left(\frac{1}{2}\right)^n u(n)$.

(b) $h(n) = \delta(n) - \delta(n-1)$.

(c) $h(n) = (0.9)^n \left(e^{j\pi/2}\right)^n u(n)$.

Or

12. A causal LTI system is described by the difference equation $y(n) - ay(n-1) = bx(n) + x(n-1)$ where 'a' is real and less than 1 in magnitude. Find a value of 'b' $(a \ne b)$ such that the frequency response of the system satisfies $\left|H\left(e^{jw}\right)\right| = 1$ for all w.

13. For the LSIV system $H(s) = \dfrac{z - a^{-1}}{z - a}$, where '$a$' is real.

(a) For what range of values of 'a' is the system stable ?

(b) If $0 < a < 1$, plot the pole-zero diagram and shade the ROC.

(c) Show graphically in the z-plane that this system is an all pass system.

Or

14. Find $H(z)$, and the frequency response of $h(n) = \left(\frac{1}{2}\right)\left[\left(\frac{1}{2}\right)^n + \left(\frac{-1}{4}\right)^n\right]u(n)$ substituting $z = e^{jw}$.

Locate the zeros and poles in the z-plane.

15. (a) Determine the direct form realisation of the system function

$$H(z) = 1 + 2z^{-1} - 3z^{-2} - 4z^{-3} + 5z^{-4}.$$

(b) Obtain the cascade realisation of the system function $H(z) = 1 + \frac{5}{2}z^{-1} + 2z^{-2} + 2z^{-3}$.

Or

16. Design an ideal low-pass filter with frequency response

$$H_d\left(e^{jw}\right) = 1 \quad \text{for } -\frac{\pi}{2} \le w \le \frac{\pi}{2}$$
$$= 0 \quad \text{for } \frac{\pi}{2} \le |w| \le \pi.$$

Find the values of $h(n)$ for N = 11.

17. Design a filter with $H_d\left(e^{-jw}\right) = e^{-j3w}, \quad \frac{-\pi}{4} \le w \le \frac{\pi}{4}$

$$= 0, \quad \frac{\pi}{4} < |w| \le \pi.$$

Use Hanning window with N = 7.

Or

18. Using Bilinear Transformation design a digital band-pass Butterworth filter with the following specifications :

Sampling frequency f = 8 kHz

α_p = 2 dB in the pass-band 800 Hz $\le f \le$ 1000 Hz

α_s = 20 dB in the stopband, $0 \le f \le 400$ Hz and $2000 \le f \le \infty$.

19. Find the output of $y(n)$ of a filter whose impulse response in $h(n) = \{1, 1, 1\}$ and input signal $x(n) = \{3, -1, 0, 1, 3, 2, 0, 1, 2, 1\}$ using (a) overlap-save method ; and (b) overlap-add method.

Or

20. Find the DFT of a sequence $x(n) = \{1, 2, 3, 4, 4, 3, 2, 1\}$ using DIT algorithm.

(5 × 12 = 60 marks)