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Q 2241

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2007.

Sixth Semester

Mechatronics Engineering

EE 351 — DIGITAL SIGNAL PROCESSING

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What are linear time invariant systems?
2. List any four applications of digital signal processing.
3. Does the discrete time Fourier transform have a better chance of converging than the Z transform? Justify your answer.
4. Is the system described by the following difference equation causal? Justify your answer.

   $y[n] - 2y[n-2] = x[n]$.
5. State Parseval's theorem.
6. What is the discrete time sequence $x[n]$ for a DFT sequence $X[k] = \{8,0,0,0\}$?
7. Develop a digital transfer function $G[z]$ for the analog transfer function $H(s) = 2/(s+3)$ using impulse-invariance method.
8. What is the impulse response $h[n]$ of an ideal high pass linear phase filter?
9. What is prewarping in filter design? Why is it needed?
10. Distinguish between IIR and FIR filter.

PART B — (5 × 16 = 80 marks)

11. (a) (i) List the advantages of digital signal processing as compared to analog signal processing. (8)

    (ii) Given $x1[n] = \{1,2,0,1\}$ and $x2[n] = \{2,2,1,1\}$ determine the circular convolution of $x1[n]$ and $x2[n]$. (8)

Or

(b) (i) Determine the common time period and the fundamental frequency of the signal $x(t) = 2\sin(2/3\,t) + 4\cos(1/2\,t) + 4\cos(1/3t - 1/5\,\pi)$. (6)

(ii) If $x[n] = [2,4,6,8]$, determine the linear convolution of $x[n] * x[n]$ and $x[2n] * x[2n]$ using graphical method. (10)

12. (a) (i) Given a linear shift invariant system represented by

$y[n] = \frac{1}{2}y[n-1] = x[n] - \frac{1}{2}x[n-1], n \geq 0$, determine the frequency response, magnitude and phase response for the system. (10)

(ii) If $h[n] = \{5,-4,3,-2\}$. Identify the filter type and establish whether the impulse response is a linear phase sequence? (6)

Or

(b) (i) The system is represented by

$y[n] = 3y^2[n-1] - nx[n] + 4x[n-1] - 2x[n+1], n > 0$

(1) Is the system linear? Explain.

(2) Is the system shift invariant? Explain.

(3) Is the system causal? Explain.

(4) Is the system static? Explain. (8)

(ii) Solve the following difference equation for $y[n]$ using Z transform $y[n] + y[n-2] = \delta[n], n \geq 0$, where $y[-2] = 0$ and $y[-1] = 1$. (8)

13. (a) (i) Construct and explain the flowgraph for a 4 point radix 2 decimation in time FFT and hence obtain the DFT of $X[n] = [1,-1,2,1]$. (10)

(ii) State and prove any two properties of Fourier series. (6)

Or

(b) (i) State and prove the convolution and time shift properties of Fourier transform. (6)

(ii) Explain Gibbs effect with suitable example. (5)

(iii) An LTI system is described by $H(\omega) = 4/(2 + j\omega)$. Find its response $y(t)$ if the input is $x(t) = 3e^{-2t}u(t)$. (5)

14. (a) (i) Compare the features of Butterworth and Chebyshev filter. (6)

(ii) Explain the approximation of derivatives method for digitizing the analog filter into a digital filter with example. (10)

Or

(b) (i) Discuss the various finite word length effects in filter design. (6)

(ii) Draw the circuit diagram of a sample and hold circuit and explain its operation. (10)

15. (a) Design a digital filter $H[z]$ which satisfy the following equivalent analog specifications :

(i) Low pass filter with a $-2\,dB$ cutoff at 10π rad/sec.

(ii) Stop band attenuation of 20 dB or greater at and past 60π rad/sec

(iii) Sampling rate of 300 samples/sec

(iv) Monotonic passband. (16)

Or

(b) Design a band pass FIR filter of length seven, having lower and upper cutoff frequencies of 2 kHz and 5 kHz respectively. The sampling frequency is 20 kHz. Find the filter coefficients using Hamming window and draw the structure of the filter. (16)
