Dr Rishbendra Singh 5/12/2022 (120)

(E)

National Institute of Technology Hamirpur
Digital Signal Processing (EC-313)

Note: Questions 1–6 are of 7 marks and question 7 is of 8 marks. Write answers of sub-parts of each question in continuation only.

Maximum time: 3 Hours

- Q1. Derive expressions for decimation-in-time FFT algorithm and draw flow graph of an 8-point DFT computation.
- Q2. If $x[n] = \sum_{k=0}^{N-1} X[k]e^{j2\pi kn/N}$, then show that $X[k] = \frac{1}{N}\sum_{n=0}^{N-1} x[n]e^{-j2\pi kn/N}$. Also show that the set of vectors $\{e^{j2\pi kn/N}\}$ form an orthogonal set.
- Q3. Compute the discrete time Fourier transform of the signals (i) $e^{j\omega_0 n}$, and (ii) $x[n] = 1$ for $0 \leq n \leq M$ and $x[n] = 0$ otherwise.
- Q4. Obtain the z-transform and region of convergence (ROC) of the signals (a) $a^n \cos(bn)\mathrm{u}[n]$, and (b) $na^n\mathrm{u}[n]$.
- Q5. Consider the linear time-invariant (LTI) system described by the difference equation $y[n] + 3y[n-1] = x[n]$, suppose that input to the system is $x[n] = 8\mathrm{u}[n]$ and the initial condition $y[-1] = 1$, then find the $y[n]$?
- Q6. Consider the second order system function $H(z) = \frac{1+2z^{-1}+z^{-2}}{1-0.75z^{-1}+0.125z^{-2}}$, and obtain the corresponding difference equation, and draw the block diagram representations in direct form I and II.
- Q7. Derive the impulse response of an ideal lowpass filter with a cutoff frequency ω_c. Use the window method to design a linear-phase and causal FIR system with 7 coefficients to approximate and ideal lowpass filter whose cutoff frequency is $\omega_c = 0.1\pi$.
