PE/PE/H/T/422B/2023

B.E.(Power Engg.) 4th Year 2nd Semester 2023
Digital Signal Processing

Full Marks 100 Answer all Questions Time 3 hours

1. If $x[n] = u[n]$ and $h[n] = a^n u[n], |a| < 1$ deduce $y[n] = x[n] * h[n]$ deduce $y[n]$ from first principles. CO(1) 10
   Consider 2 discrete LTI signals $x[n] = 1, 0 \leq n \leq 4$ and $h[n] = 1, -2 \leq n \leq 2$. Obtain $y[n] = x[n] * h[n]$using tabular method. CO(1) 10

   Or

   Express the application

   $$y[n] = a_0x[n] + a_1x[n-1] + a_2x[n-2] + a_3x[n-3] + a_4x[n-4] + a_5x[n-5]$$

   using branch, delay and summation operations. CO(1) 10

   Consider a causal sequence $x[n] = 0.3(-1)^n, n \geq 0$. Calculate its energy and power. CO(1) 10

2. Obtain the Z-transform of a Unit Ramp function at $t = 0$ with a sample time T .Hence deduce the Region of Convergence. Deduce the Z-transform for the same Unit Ramp commencing at $= mT, m > 0$. CO(2) 8+4+8

   Or

   Prove that a continuous time signal $x(t)$ may be expressed as
   $$x(t) = c_0 + \sum_{k=-N}^{N} c_k\, e^{j\omega_k t}, k \neq 0$$ CO(2) 20

3. Deduce the Fourier Transform of a single rectangular pulse of height H and duration D. How does it differ from the Fourier Transform of a train of the same pulse with time period T. Deduce the results CO(2) 10+10

   Or

   Assume that $p(t) = \sum_{n=-\infty}^{\infty} \delta(t - nT)$ and a continuous time signal $x(t)$ is sampled using $p(t)$ to produce $x_s(t)$. Deduce an expression for $X_s(e^{j\omega})$, where the symbols have usual significance. CO(2) 20

4. State and prove Nyquist's sampling theorem for a band limited signal. CO(3) 20

   Or

   Enumerate the different re-construction techniques for discrete signals. Explain mathematically why an ideal sampler defined by $h(t) = \frac{sin(\frac{\pi t}{T})}{\frac{\pi t}{T}}$ is so named. CO(3) 20

5. Consider a discrete sequence given by $x[n] = [2, -1, 1, 2]$. Compute its Discrete Fourier Transform terms. CO(4) 5
   Define Twiddle Factor and write the Matlab code to compute the FFT of a sine wave of 25Hz. CO(4)15

   Or

   For an IIR discrete filter with two complex Z-pane poles, compute the Z transfer function and deduce the Bandwidth with suitable assumptions CO(4) 20