B.E.(Power Engg.) 4th Year 2nd Semester 2025 Examination
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 $y[n] = x[n] * h[n]$ from first principles. **CO(1) 10**

   Consider 2 discrete LTI signals $h[n] = [1. -1, 2]$ and $x[n] = [1,2,-1,3,4,-1,0,3]$.

   Obtain $y[n] = x[n] * h[n]$ using add and overlap method. **CO(1) 10**

   Or

   Express the application

   $$y[n] = a_0x[n] + a_1x[n-1] + a_2x[n-2] + a_3x[n-3] + a_4x[n-4] + a_6x[n-6]$$

   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**

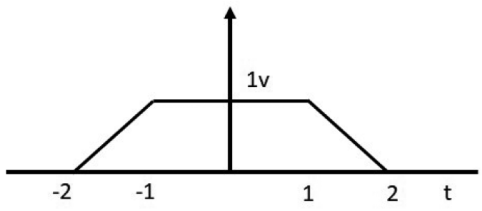
2. For a signal $x(t) = 2\sin(wt) + 0.5\cos\left(3wt + \frac{\pi}{3}\right) + 2\sin(6wt + \frac{\pi}{6})$ derive the amplitude and phase spectra. What should be the minimum sampling frequency if $w = 6.28rad/s$ **CO(2) 20**

   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. Compute the Fourier Transform of the signal shown below and sketch the same. **CO(2) 20**



   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

Starting from Continuous Fourier Transform X(ω) for a signal x(t) derive the Discrete Time Fourier Transform when x(t) is discretized to produce a sequence x[n] of length N with regular sampling. 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

Design an IIR Band-pass Filter with $w_{c=}0.4\pi$ and the $3dB$ Bandwidth $B = 0.1\pi$ CO(4) 20