JSS MAHAVIDYAPEETHA
JSS SCIENCE AND TECHNOLOGY UNIVERSITY, MYSURU

Department of Electronics and Communication Engineering

Bachelor of Engineering Degree

5th Semester: Test 3

Digital Signal Processing

Date: 19.12.23 **Max. Marks: 20**

Q. NO	Scheme of Evaluation	Marks
1.	≥ 50 dB attenuation in the stopband $\longrightarrow$ Hamming window $h_d(n) = \frac{1}{2\pi}\int_{-3\pi/4}^{3\pi/4} e^{j\omega(n-\tau)}\, d\omega$ $= \begin{cases} \frac{\sin\frac{3\pi}{4}(n-3)}{\pi(n-3)} & n \neq 3 \\ \frac{3}{4} & n = 3 \end{cases}$	02M
	$W_{ham}(n) = 0.54 - 0.46\cos\left(\frac{2\pi n}{N-1}\right)$ $0 \leq n \leq 6$	01M
	$N = 2\tau + 1 = 2\times 3 + 1 = 7.$	
	$h_d(n) = \{0.075, -0.159, 0.225, 0.75, 0.225, -0.159, 0.075\}$	02M
	$W_{ham}(n) = \{0.08, 0.31, 0.77, 1, 0.77, 0.31, 0.08\}$	02M
	$h(n) = h_d(n) \cdot W_{ham}(n)$ $= \{0.006, -0.049, 0.173, 0.75, 0.173, -0.049, 0.006\}$	01M

Q. NO	Scheme of Evaluation	Marks
	$H(z) = \sum_{n=0}^{6} h(n) z^{-n}$	
	$= 0.006(1 + z^{-6}) - 0.049(z^{-1} + z^{-5}) + 0.175(z^{-2} + z^{-4}) + 0.751 z^{-3}$	01 M
	$H(\omega) = e^{-j3\omega}(0.75 + 0.012\cos 3\omega - 0.098\cos 2\omega + 0.346\cos 3\omega)$	01 M
2.	$A_p = -1.9328$ dB $\quad \Omega_p = \frac{\omega_p}{T} = 0.2\pi$ r/s	
	$A_s = -13.9794$ dB $\quad \Omega_s = \frac{\omega_s}{T} = 0.6\pi$ r/s	
	$T = 1$ sec (IIT)	
	$N = 1.7 \approx 2$	01 M
	$\Omega_c = 0.7255$ r/s.	01 M
	$H_1(s) = \frac{1}{s^2 + 1.414s + 1}$	02 M
	$H(s) = H_1(s)\Big\vert_{s \to \frac{s}{\Omega_c}}$	
	$= \frac{0.5263}{s^2 + 1.025s + 0.5263}$	02 M

Q. NO	Scheme of Evaluation	Marks

$$H(s) = \frac{1.0259 \times 0.513082}{(s+0.512298)^2 + (0.513082)^2}$$

$$\frac{\text{IIT}}{\frac{b}{(s+a)^2+b^2}} \rightarrow \frac{e^{-aT}\sin bT\, z^{-1}}{1-2e^{-aT}\cos bT\, z^{-1} + e^{-2aT} z^{-2}}$$

$$= \frac{0.3015\, z^{-1}}{1-1.043\, z^{-1} + 0.3588\, z^{-2}} \quad 02M$$

Verification

$$|H(w)| = \frac{0.3015\sqrt{\cos^2 w + \sin^2 w}}{\sqrt{(1-1.043\cos w + 0.3588\cos 2w)^2 + (1.043\sin w - 0.3588\sin 2w)^2}}$$

$$20\log_{10}|H(w)|_{w=0.2\pi} = -2\ dB$$

$$20\log_{10}|H(w)|_{w=0.6\pi} = -14.4\ dB \quad 02M$$

Specifications are slightly different ∴ go IIT approximation

3. $A_p = -3\ dB \quad \Omega_p = \frac{2}{T}\tan\frac{\omega_p}{2} = 0.5095\ rad/s$

$A_s = -20\ dB \quad \Omega_s = \frac{2}{T}\tan\frac{\omega_s}{2} = 1.3752\ rad/s$

BLT $\rightarrow$ $T = 2$ sec

Q. NO	Scheme of Evaluation	Marks

$\epsilon = 0.997$ 01M

$N = 1.8 \simeq 2$ 01M

$$H_1(s) = \frac{0.501}{s^2 + 0.644s + 0.707}$$ 02M

$$H(s) = H_1(s)\Big|_{s = \frac{s}{0.509}} = \frac{0.52}{s^2 + 0.657s + 0.335}$$ 02M

$$H(z) = H(s)\Big|_{s = \frac{2}{T}\left(\frac{1-z^{-1}}{1+z^{-1}}\right)}$$

$$= \frac{0.086\,(1+z^{-1})^2}{1 - 1.08z^{-1} + 0.566z^{-2}}$$ 02M

Verification

$$H(\omega) = \frac{0.086\,(1+e^{-j\omega})^2}{1 - 1.08e^{-j\omega} + 0.566e^{-j2\omega}}$$

$$|H(\omega)| = \frac{0.086\left[(1+\cos\omega)^2 + \sin^2\omega\right]}{\sqrt{(1 - 1.08\cos\omega + 0.566\cos 2\omega)^2 + (1.08\sin\omega + 0.566\sin 2\omega)^2}}$$

$20\log_{10}|H(\omega)|\Big|_{0.3\pi} = -3\ dB$

$20\log_{10}|H(\omega)|\Big|_{0.6\pi} = -22.7\ dB$ 02M

Name & Signature of the Paper Setter:

Sujatha Kumari

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