BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: BE | **SEMESTER : V**
BRANCH: ECE | **SESSION : MO/19**

SUBJECT: EE4207 DIGITAL SIGNAL PROCESSING

TIME: 3 HOURS | **FULL MARKS: 60**

INSTRUCTIONS:
1. The question paper contains 7 questions each of 12 marks and total 84 marks.
2. Candidates may attempt any 5 questions maximum of 60 marks.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

Q.1(a) Determine whether unit ramp sequence is power or energy signal. [2]

Q.1(b) Find the zero-state response of the system described by the difference equation: [4]
$y(n) - 3y(n-1) - 4y(n-2) = x(n) + 2x(n-1)$, with input, $x(n) = 4^n u(n)$.

Q.1(c) i) Check whether the system: $y(n) = x(2n)$, is static or dynamic and linear or non-linear. [2+4]
ii) Find the inverse z-transform of the following system using contour integration:

$$X(z) = \frac{2}{z(z-0.5)} \text{ ; ROC: } |z| > 1$$

Q.2(a) Prove the formula for IDTFT, given by: $x(n) = \frac{1}{2\pi}\int_{-\pi}^{\pi} X(\omega)\, e^{j\omega n} d\omega$. [2]

Q.2(b) What are the drawbacks of DFT? Compute the DFT of the four-point sequence x(n)= (0 1 2 3). [4]

Q.2(c) Find FFT of $x(n) = \cos\left(\frac{\pi}{4}n\right)$, 0 ≤n≤7, using radix-2 Decimation in Time algorithm. [6]

Q.3(a) If M and N are the orders of numerator and denominator of rational system function respectively, then how many multiplications and additions are required in direct form-I realization of that IIR filter? [2]

Q.3(b) Obtain the cascade structure for the following systems: [4]
y(n) = -0.1y(n-1) + 0.72y(n-2) + 0.7x(n) – 0.252x(n-2)

Q.3(c) Sketch the ladder structure for the system: [6]

$$H(z) = \frac{1 - 0.8z^{-1} + 0.5z^{-2}}{1 + 0.1z^{-1} - 0.72z^{-2}}$$

Q.4(a) Draw the magnitude characteristics of a practical low pass filter with its different specifications. [2]

Q.4(b) Distinguish between Type-I and Type-II Chebyshev filter. With the help of transfer function of Type-I Chebyshev filter, find an expression of the order of filter. [4]

Q.4(c) Design an analog Butterworth filter that has a -2 dB passband attenuation at a frequency of 20 rad/sec and atleast -10 dB stopband attenuation at 30 rad/sec. [6]

Q.5(a) What are the formulae used in converting an analog prototype lowpass filter to an arbitrary lowpass and high pass analog filters? [2]

Q.5(b) Convert the single-pole lowpass Butterworth filter with system function, $H(z) = \frac{0.245(1+z^{-1})}{1-0.509z^{-1}}$ into a bandpass filter with upper and lower cutoff frequencies $\frac{3\pi}{5}$ and $\frac{2\pi}{5}$ respectively with passband frequency $\frac{\pi}{5}$. [4]

Q.5(c) Design an analog Band Pass filter which passes the frequencies in the interval 5 kHz ≤ F ≤ 6 kHz. Let the filter be Butterworth with order N = 3. Determine the transfer function of the desired Band Pass filter. [6]

Q.6(a) What is Matched-z transform? Explain it briefly. [2]

Q.6(b) Explain the method of Impulse invariance method by taking the example of analog system function as: $H_a(s) = \sum_{k=1}^{N} \frac{C_k}{s-p_k}$, where $\{C_k\}$ represent coefficients of distinct poles $\{p_k\}$. [4]

Q.6(c) Design a digital Butterworth filter satisfying the constraints: [6]

$$0.707 \le |H(z)| \le 1, \text{for } 0 \le \omega \le \frac{\pi}{2} \;\;\&\;\; |H(z)| \le 0.2, \text{for } \frac{3\pi}{4} \le \omega \le \pi$$

with T=2 sec using Bilinear Transformation. Design the filter in Direct form-II.

Q.7(a) Explain the term linear phase and state its importance in digital filter. [2]

Q.7(b) Determine the expression of transfer function, H(z) for symmetric and antisymmetric FIR filters for odd value of sample length (i.e. M=odd). [4]

Q.7(c) The desired response of low pass filter is [6]

$$H_d(e^{j\omega}) = e^{-3j\omega} \quad , \quad -\frac{3\pi}{4} \le \omega \le +\frac{3\pi}{4}$$

$$= 0 \quad , \quad \frac{3\pi}{4} \le \omega \le \pi$$

Determine $H(e^{j\omega})$ for M=7 using Hamming window.

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