Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/M.Tech(EIE)/SEM-2/EIEM-204C/2012

2012

DIGITAL SIGNAL AND IMAGE PROCESSING

Time Allotted : 3 Hours *Full Marks* : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A

Answer any *five* questions. 5 × 2 = 10

1. a) If $X(n)$ has the Z-transform as $X(Z)$, prove that $x(n-1)$ has the Z-transform of $Z^{-1} X(Z)$.

   b) Prove that $Y(Z) = X(Z) H(Z)$ when

   $$y(n) = x(n) * h(n).$$

   c) If $x(n)$ is real and even, then what is the characteristic of its DFT ?

   d) For the signal sequence $x(n) = a^n$ for $n \geq 0$ and $x(n) = b^n$ for $n < 0$ $[\,|a| < |b|\,]$, where is the region of convergence ?

   e) If $X(Z) = (Z^2 - 3) / (2Z^2 - 5Z + 1)$, find $x(0)$.

   f) Define a recursive process.

GROUP – B

Answer any *five* questions. 5 × 12 = 60

2. a) A system is defined by the difference equation $y(n) - 2k\,y(n) + k^2\,y(n-2) = x(n)$. Determine the range of the parameter k for which system is stable. 4

   b) Determine the transfer function $h(n)$ of the system. 4

   c) Using initial value theorem, find $h(0)$. 2

   d) Draw the region of convergence. 2

3. a) Determine the inverse Z-transform of

   $$H(Z) = (Z + 2) / (2Z^2 - 7Z + 3).$$ 6

   b) Realise a system network to implement the function

   $y(n) - 2y(n-1) + 3y(n-2) = 3x(n) + 2x(n-1) + x(n-2)$

   using direct form II. 6

4. a) What is radix-2 FFT algorithm ? What are the decimation in frequency and decimation in time in FFT ? How many complex multiplication and complex addition operations are required for 1024 points radix-2 butterfly structure of FFT ? 2 + 2 + 2

   b) Find $y(n) = x_1(n) * x_2(n)$ by DFT and IDFT method, where $x_1(n) = [1, 2, 2, 1]$ and $x_2(n) = [1, 1, 1, 1]$. 6

5. a) Find the expression for a first order low-pass butterworth filter with 3dB cut-off frequency of $0{\cdot}2\pi$ using bilinear transformation. 6

   b) Realise above filtre with direct form-II. 6

6. What are the applications of morphological operations ? Define morphological dilation and erotion operation in image processing. What are the properties of dialation ? 4 + 4 + 4

7. Define segmentation. Suppose there are two types of regions R_1 and R_2 in a gray level image. Gray level pixels of R_1 follow the Gaussian distribution with mean μ_1 and variance σ and those of R_2 follow mean μ_2 and same variance. If the probabities are P_1 and P_2 for the regions R_1 and R_2 respectively, find the optimum threshold for image segmentation. 2 + 10

8. a) What is image compression ? Briefly mention the types of image compression. 2 + 3

   b) Find out the code words and average code length using Huffman coding scheme for the set of events *Si* and probabilities as given below :

Input	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8
Probabilities	0·30	0·20	0·15	0·15	0·10	0·05	0·03	0·02

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9. The frequency domain characteristics of a low-pass filtre is $H_d(\omega) = e^{-3j\omega}$ for $0 \leq \omega \leq \frac{\pi}{2}$ and $H_d(\omega) = 0$ for $\frac{\pi}{2} < \omega \leq \pi$. Determine the transfer function $h_d(n)$ by frequency sampling method with $N = 7$. 12