DIGITAL SIGNAL PROCESSING
(ECE2204)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

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

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) For the system with input x(n) = δ(n-1) and the impulse response h(n) = δ(n+1) , the z transform of the output is
(a) 0 (b) 1 (c) z (d) z^{-1}

(ii) The z transform of the signal
x(n) = $\sum_{k=-\infty}^{0} \delta(n-k)$ has the following ROC:
(a) |z| > 1 (b) |z| < 1 (c) |z| = 1 (d) 0 <|z| < 1

(iii) The z transform of e^{-t} signalsampled at 10 Hz will be
(a) z/(z-10) (b) z/(z-0.1) (c) z/(z- 0.9) (d) z/(z-1.1)

(iv) Which of the following is true regarding the number of computations required to compute an N-point DFT?
(a) N^2 complex multiplications and N(N-1) complex additions
(b) N^2 complex additions and N(N-1) complex multiplications
(c) N^2 complex multiplications and N(N+1) complex additions
(d) N^2 complex additions and N(N+1) complex multiplications

(v) If x(n) and X(k) are an N-point DFT pair, then X(k+N)=?
(a) X(-k) (b) -X(k) (c) X(k) (d) None of the mentioned

(vi) The main lobe width of length M rectangular window is
(a) $\frac{4\pi}{M}$ (b) $\frac{8\pi}{M}$ (c) $\frac{12\pi}{M}$ (d) variable

(vii) Compared to Butterworth filter, the transition band of Chebyshev filters is
(a) more (b) less (c) equal (d) none of the above

(viii) The mapping in the bilinear transformation is
(a) one-to-one (b) one-to-many (c) many-to-one (d) many-to-many

(ix) Downsampler is usually preceeded by a LPF to avoid
(a) images (b) noise (c) aliasing (d) none of those

(x) The TMS320 C6713 is a _____ processor.
(a) fixed-point (b) floating-point
(c) multiprocessor (d) none of the above.

Fill in the blanks with the correct word

(xi) In the mapping $z=e^{st}$, the _____ of s plane are mapped into _____ of unit circle in z plane.

(xii) For a sequence x(n) of length M, h(n) of length N , the length of the sequence resulting from circular convolution of x(n) and h(n) is _____ (given M>N)

(xiii) The FIR filters have _____ phase response.

(xiv) The length of the filter having transfer function, $H(z) = 2 + 1.z^{-1} + 3.z^{-3} + 2.z^{-10}$ is _____.

(xv) In sampling rate conversion by rational factor, _____ is performed first.

Group - B

2. (a) Find z transform and ROC of the following sequence
$x(n) = ½\ \delta(n+1) + 5(1/2)^{-n}\ u(-n) + u(-n-1)$ *[(CO2)(Apply/IOCQ)]*

(b) Find the causal signal x(n)which is having the z transform as under
$X(z)= \frac{z^3}{(z+1)(z-1)^2}$ $|z|> 1$ *[(CO2)(Apply/IOCQ)]*

6 + 6 = 12

3. (a) Find the output response of the discrete time system described by the following difference equation:
$y[n]-0.75y[n-1]+0.166y[n-2]=x[n]$ where $x(n) = (1/5)^n\ u(n)$ subjected to the initial conditions y[-1] = 0 and y[-2] = 1. Also find out the step response.
[(CO2)(Analyse/HOCQ)]

(b) Express the relationship between s-plane and z-plane. *[(CO2)(Remember/LOCQ)]*

(c) Determine the z-transform and ROC for the signal $x(n) = \delta(n-k) +\delta(n+k)$.
[(CO2)(Apply/IOCQ)]

6 + 3 + 3 = 12

Group - C

4. (a) Explain the role of zero padding. Give few examples where we use zero padding.
[(CO3)(Remember/LOCQ)]

(b) Explain how do we find out DFT of a sequence in matrix method? *[(CO3)(Analyse/HOCQ)]*

(c) Calculate 4 point DFT of $x(n)=cos(\pi/3)n$ *[(CO3)(Evaluate/HOCQ)]*

4 + 3 + 5 = 12

5. (a) Perform the circular convolution of the following two sequences using graphical method

$x1(n)=\{1,2,2,3,4,\}$, $x2(n)=\{2,3,1,1,2\}$
$\uparrow$ $\uparrow$

[(CO3)(Apply/IOCQ)]

(b) DFT of sequence x(n) is given by X(K)= {4 , 1+2j , j ,1-3j}.using DFT property only, determine DFT of $x^*(n)$ if $x^*(n)$ is complex conjugate of x(n). *[(CO3)(Apply/IOCQ)]*

6 + 6 = 12

Group - D

6. (a) Explain warping effect and also explain the way to mitigate warping effect. *[(CO4)(Understand/LOCQ)]*

(b) Transform the analog filter transfer function

$H_a(s) = \frac{4s+7}{s^2+5s+4}$

into a digital filer H(z) using the impulse-invariant method. *[(CO4)(Analyze/IOCQ)]*

(c) Explain the disadvantages of impulse invariant method. Explain how bilinear transformation method can overcome the disadvantages. *[(CO4)(Apply/IOCQ)]*

5 + 4 + 3 = 12

7. (a) Explain the necessity of windowing method in FIR filters. *[(CO4)(Understand/LOCQ)]*

(b) "FIR filters are always stable" Justify the statement. *[(CO4)(Analyze/IOCQ)]*

(c) A digital Butterworth filter has to be designed using bilinear transformation. The filter specifications are as follows:

$0.9 \le |H(e^{jw})| \le 1$ $\quad 0 \le w \le 0.5\pi$

$|H(e^{jw})| \le 0.2$ $\quad 0.75\pi \le w \le \pi$

Find the filter order N and cut-off frequency. Assume T=1 sec. *[(CO4)(Apply/IOCQ)]*

4 + 2 + 6 = 12

Group - E

8. (a) Determine a cascade realization of the system characterized by the transfer function which is expressed as under:

$$H(z) = \frac{2(z+2)}{(z-0.1)(z+0.5)}$$

[(CO6)(Apply/IOCQ)]

(b) Explain briefly about Up sampling and Down sampling with example. *[(CO5)(Remember/LOCQ)]*

6 + 6 = 12

9. (a) Explain the architecture of the TMS320C67XX DSP processor in detail. Discuss the main components such as the CPU, memory, buses, and peripherals. *[(CO5)(Remember/LOCQ)]*

(b) Describe the memory organization in the TMS320C67XX DSP processors. *[(CO5)(Remember/LOCQ)]*

8 + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	35.42	50	14.58