ADVANCED DSP AND APPLICATIONS
(ECEN 5202)

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

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and
<u>any 4 (four)</u> from Group B to E, taking <u>one</u> 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) The step response of LTI system when the impulse response $h(n)$ is unit step $u(n)$ is
(a) $n+1$ (b) $n-1$ (c) n (d) n^2

(ii) If R_1 is the ROC of $x_1(n)$ and R2 is the ROC of $x_2(n)$, then the ROC of $x_1(n)$ convoluted $x_2(n)$ is
(a) $R_1 + R_2$ (b) $R_1 \cap R_2$ (c) $R_1 - R_2$ (d) $R_1 \cup R_2$

(iii) The N-point DFT of a finite length signal $x(n)=\delta(n)$ is
(a) 0   (b) 1   (c) z^{-1} (d) W_N

(iv) If $x(n)=\{1,4,5,3,2,7\}$ is a periodic sequence starting at $n=0$, with periodicity $N=8$, what should be the value of $x(25)$?
(a) 5   (b) 2   (c) 4   (d) 7

(v) The order of a finite length filter having transfer function $3+2z^{-2}+5z^{-4}+4z^{-8}$
(a) 9   (b) 8   (c) 10   (d) 4

(vi) Which of the following is the formula of symmetric impulse response of FIR filter?
(a) $h(n)= h(N-1-n)$ (b) $h(n)= -h(N-1-n)$
(c) $h(n)= h(N-1+n)$ (d) $h(n)= h(N-1/n)$

(vii) The effect of windowing on a signal spectrum can be
(a) reduced resolution   (b) leakage
(c) both (a) and (b)   (d) none of the above

(viii) Wavelet Transform of time domain signal $x(t)$ results in
(a) Frequency domain signal   (b) Time domain Signal
(c) Time and Frequency domain signal   (d) None of the choices are correct.

(ix) If $y(n) = x(n/2)$, system is using
(a) Quantization   (b) Interpolation
(c) Decimation   (d) None of the mentioned

(x)   A signal x(n) is downsampled by a factor M. The output y(n) of the downsampler is given as
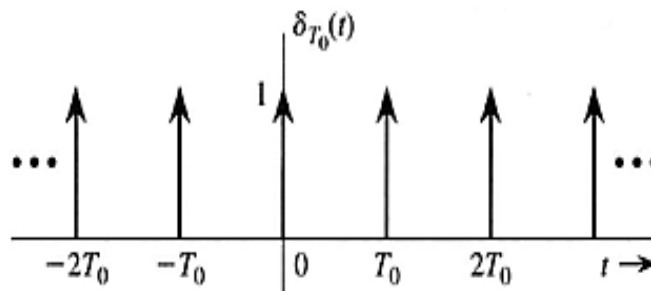(a) Mx(n)   (b) x(n/M)   (c) (1/M)x(n)   (d) x(nM)

Fill in the blanks with the correct word

(xi)   The ratio of z transformation of output to z-transform of input is called _____ of the system.

(xii)   The number of complex multiplications required for computation of a 32-point DFT is _____.

(xiii) The processing of signal at different sampling rates is called _____.

(xiv)   If $W_8^{50}=W_x^{100}$, then what is the value of x is _____.

(xv)   The main lobe width of length M Hamming window is _____.

Group - B

2. (a)   Two discrete time signal x(n) and h(n) are both nonzero only for n = 0,1,2 and are zero otherwise. It is given that x(0)=1 , x(1) = 2 , x(2) = 1 and h(0) =1. If y(n) be the linear convolution of x(n) and h(n), then find the value of expression 10 y(3) + y(4) where y(1) =3 and y(2)= 4.   *[(CO1)(Analyse/IOCQ)]*
    (b)   Evaluate the convolution of two sequences
    $h(n)=(0.5)^n u(n)$, $x(n)=3^n u(n)$ *[(CO1)(Evaluate/HOCQ]*
    (c)   Establish the relationship between fourier transform $X(e^{j\omega})$ and z-transform X(z).
                    [(CO1)Understand/LOCQ)]
                    6 + 4 + 2 = 12

3. (a)   Find Inverse z-transformation of $X(z) = log(1-az^{-1})$ using differentiation property.
                    [(CO1)(Apply/IOCQ)]
    (b)   Find the exponential Fourier series for the wave form shown below

                    [(CO1)(Apply/IOCQ)]
    (c)   Prove the power of the energy signal is zero over infinite time.   *[(CO1)(Analyse/IOCQ)]*
                    4 + 4 + 4 = 12

Group - C

4. (a)   Explain the role of zero padding. Give few examples where we use zero padding.
                    [(CO4)(Remember/LOCQ)]
    (b)   Explain how do we find out DFT of a sequence in matrix method.
                    [(CO4)(Understand/LOCQ)]

(c)   Calculate 4 point DFT of x(n)=cos(π/3)n   *[(CO4)(Apply/IOCQ)]*

4 + 3 + 5 = 12

5. (a)   Consider the length-8 sequence defined for 0≤n≤7 ,x(n)={1,-1,-3,0,1,-1}

                                                   ↑

    with an 8-point DFT. Evaluate the following functions of X(k) without computing DFT.

    (a) $X(0)$ (b) $\sum_{k=0}^{7} X(k)$ (c) $\sum_{k=0}^{7} |X(k)|^2$ *[(CO4)(Analyse/IOCQ)]*

(b)   Explain the computational complexity of N-point DFT. Also explain how FFT can help reduce the same.   *[(CO4)(Remember/LOCQ)]*

8 + 4 = 12

Group - D

6. (a)   Compare between IIR Digital filter and FIR Digital filter.   *[(CO5)(Analyse/IOCQ)]*
   (b)   Explain linear phase response characteristics of FIR filter.   *[(CO5)(Remember/LOCQ)]*
   (c)   Given a system with impulse response

$$h(n) = \{2,1,1,2\}$$
          ↑

    Prove that the system has linear phase response.   *[(CO5)(Apply/IOCQ)]*

4 + 4 + 4 = 12

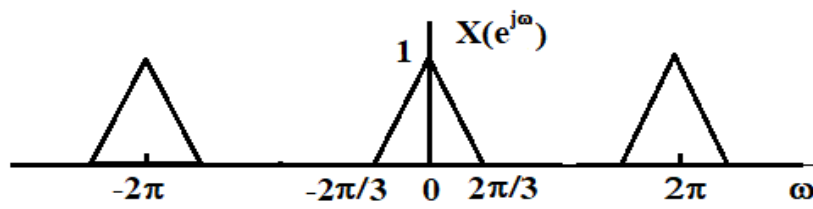7. (a)   Determine the frequency response of the non-causal Hamming window, which is given as

$$w_{han}(n) = \begin{cases} 0.54 + 0.46cos\left(\frac{2\pi n}{M-1}\right) & -\frac{M-1}{2} \leq n \leq \frac{M-1}{2} \\ 0 & otherwise \end{cases}$$

                                             [(CO5)(Apply/IOCQ)]

(b)   Explain briefly about spectrum estimation methods.   *[(CO4)(Remember/LOCQ)]*

6 + 6 = 12

Group - E

8. (a)   Explain briefly about wavelet transformation.   *[(CO6)(Remember/LOCQ)]*
   (b)   Obtain the polyphase decompositions of the IIR digital system having the following transfer function: *[(CO3)(Analyse/HOCQ)]*

$$H(z) = \frac{1-4z^{-1}}{1+5z^{-1}}$$

6 + 6 = 12

9. (a)   Consider the sequence x(n) with X(e^{jω}) as shown in fig. below. Let x(n) be obtained at the sampling rate of F$_s$. Convert the sampling rate of x(n) to F$_s'$ =(⅔)F$_s$ using multirate building blocks and plot the spectrum of the output signal.

$X(e^{j\omega})$

$-2\pi \quad\quad -2\pi/3 \quad 0 \quad 2\pi/3 \quad\quad 2\pi \quad\quad \omega$

[(CO3)(Analyse/IOCQ)]

(b)   Explain briefly about downsampling.   *[(CO3)(Remember/LOCQ)]*

8 + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	34.37	55.21	10.42