Chittagong University of Engineering and Technology
Department of Computer Science and Engineering
B. Sc. Engineering Level-4, Self Study, Exam. 2020

Course No.: CSE-465
Course Title: Digital Signal Processing
Marks: 210
Time: 3 Hours

The figure in the right margin indicates full marks. The questions are of equal value. Answer any three questions from each section. Use separate script for each section.

Section-A

Q.1(a) Define signals, systems and signal processing. Distinguish between Digital and Analog signal processing. 08

Q.1(b) With appropriate examples and figures, briefly explain: Multidimensional signal, Continuous-time continuous-valued signal, Discrete-time continuous-valued signal, Continuous-time discrete-valued signal, Discrete-time discrete-valued signal. 12

Q.1(c) Write down the properties that characterize Continuous-time and Discrete-time Sinusoidal Signals. Prove that a discrete-time sinusoid is periodic only if its frequency f is a rational number. 15

Q.2(a) While sampling analog signals, what happens for the signals having frequencies above $\frac{F_S}{2}$ (where F_S is the sampling frequency)? Explain with appropriate example. 12

Q.2(b) What are the three different ways of representing the discrete-time signals? Represent the signal of Fig. 2(b) using those three techniques. 11

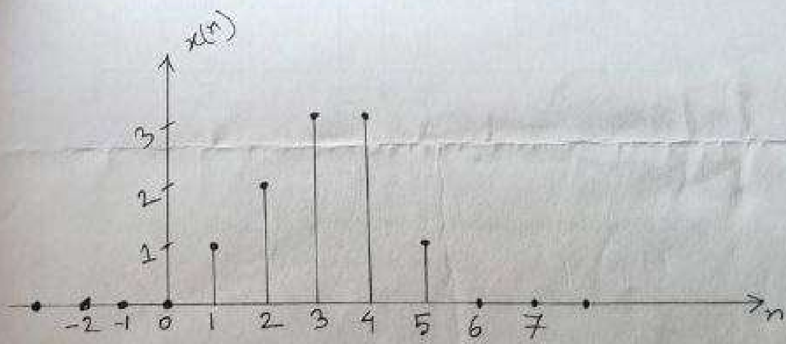

Fig. 2(b)

Q.2(c) Determine the response of the following systems to the input signal, 12

$$x(n) = \begin{cases} |n|, & -3 \leq n \leq 3 \\ 0, & otherwise \end{cases}$$

i. $y(n) = x(n-1)$
ii. $y(n) = x(n+2)$
iii. $y(n) = \frac{1}{3}[x(n+1) + x(n) + x(n-1)]$
iv. $y(n) = max[x(n+1), x(n), x(n-1)]$
v. $y(n) = x(n) + x(n-1) + x(n-2) + \cdots\cdots$

Q.3(a) Consider a finite duration sequence $x(n) = \{2, \underset{\uparrow}{4}, 0, 3\}$. Resolve the sequence $x(n)$ into sum of weighted impulse sequences. 10

Q.3(b) Determine the frequency response, magnitude and phase response of the system given by 10

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

Q.3(c) Compute and draw the 8 point FFT butterfly structure. 15

Q.4(a) Determine the Z-transform of the signal $x(n) = \left(\frac{1}{2}\right)^n u(n)$. 10

Q.4(b) What is inverse Z-transform? Derive an expression for inverse Z-transform. 12

Q.4(c) What do you know about the linearity property of Z-transform? Determine the Z-transform and the ROC of the signal, 13

$$x(n) = [3(2^n) - 4(3^n)]u(n)$$

Section-B

Q.5(a) Write down the set of conditions that guarantee the existence of the Fourier transform of a signal. Derive the Parseval's relation for power signal. 11

Q.5(b) Determine the power density spectrum of the rectangular pulse train signal given in Fig. 5(b). 12

$P_x = \sum |c_k|^2$

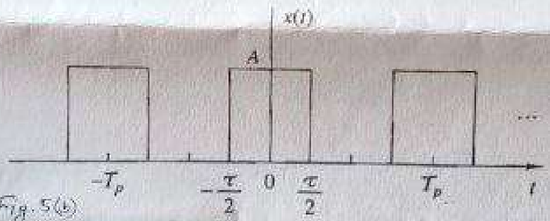

Fig. 5(b)

Q.5(c) Determine the output sequence of the system with impulse response 12

$$h(n) = \left(\frac{1}{2}\right)^n u(n).$$

When the input signal is $x(n) = Ae^{j\pi n/2}, -\infty < n < \infty$.

Q.6(a) Briefly explain each of the five classes of ideal filters, with necessary diagram. 15

Q.6(b) Distinguish between symmetric and antisymmetric FIR filters. 10

Q.6(c) Summarize the window functions for FIR filter design. 10

Q.7(a) Determine the cross correlation sequence $r_{xy}(l)$ of the sequences 15

$$x(n) = \{\cdots, 0, 0, 2, -1, 3, \underset{\uparrow}{7}, 1, 2, -3, 0, 0, \cdots\}$$

$$y(n) = \{\cdots, 0, 0, 1, -1, 2, -2, \underset{\uparrow}{4}, 1, -2, 5, 0, 0, \cdots\}$$

Q.7(b) Explain the sound quality and data rate in digital audio processing technique. 10

Q.7(c) What does it mean by aliasing? How can it be avoided? 10

Q.8(a) The frequency domain representation of a signal (after DFT) is shown below: 15

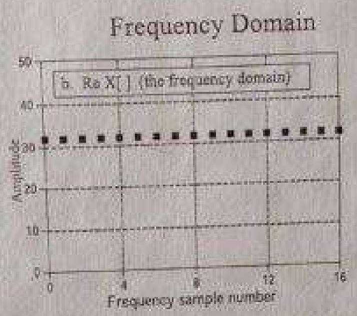

figure 8(a)

It shows the real part of the frequency domain where all the samples hold the constant value of 32. The imaginary part (not shown) is composed of all zeros. Find the time domain signal by using the concept of inverse DFT. Show necessary calculations and figures.

Q.8(b) With necessary figures, explain each of the three steps of FFT operation. Also show the flow diagram of FFT operation that converts time domain data to frequency domain data. 20

-The End-

$F_s \geq 2F$

$2F_{max} \leq F_s$

$F_{max} \leq \frac{F_s}{2}$