Chittagong University of Engineering and Technology
Department of Computer Science and Engineering
B. Sc. Engineering L-2, Term-II, Exam. 2022

Course No: CSE-223
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 signal, system and signal processing. What are the advantages of digital signal processing over analog signal processing? 09

Q.1(b) Write down the characterizing properties of continuous-time and discrete-time sinusoidal signals. In case of discrete-time sinusoidal signals, what happens for $\pi \leq \omega_0 \leq 2\pi$? 10

Q.1(c) What is sampling frequency? With necessary figure explain how sampling converts an analog signal to a discrete-time continuous-valued signal. 10

Q.1(d) Tabulate the relations among the frequency variables of continuous-time and discrete-time signals. 06

Q.2(a) Consider the analog signal 12

$$x_a(t) = 3\cos 100\pi t$$

i) Determine the minimum sampling rate required to avoid aliasing.
ii) Supposed that the signal is sampled at the rate $F_s = 200Hz$. What is the discrete time signal obtained after sampling?
iii) Repeat part (ii) for $F_s = 75Hz$.
iv) What is the frequency $0 < F < F_s/2$ of a sinusoid that yields samples identical to those obtained in part (iii)?

Q.2(b) State Shannon's sampling theorem. What is Nyquist rate? Consider the analog signal: 13

$$x_a(t) = 3\cos 2000\pi t + 5\sin 6000\pi t + 10\cos 12000\pi t$$

i) What is the Nyquist rate for this signal?
ii) Assume now that we sample this signal using a sampling rate $F_s = 5000$ Samples/S. What is the discrete time signal obtained after sampling?

Q.2(c) The discrete-time signal $x(n) = 6.35\cos(\frac{\pi}{10})n$ is quantized with a resolution (i) $\Delta = 0.1$ or (ii) $\Delta = 0.02$. How many bits are required in the A/D converter in each case? 10

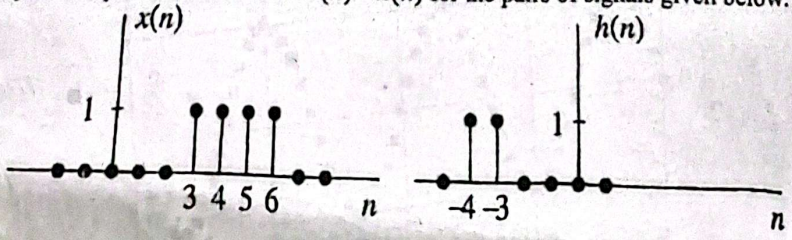
Q.3(a) Consider the system 11

$$y(n) = \Im[x(n)] = x(n^2)$$

Is the system time-invariant? Justify your answer.

Q.3(b) Define symmetric and antisymmetric signals. Prove that – any arbitrary signal can be expressed as the sum of two signal components, one of which is even and the other is odd. 10

Q.3(c) Write down the steps of computing the convolution between two signals $x(k)$ and $h(k)$. Compute and plot the convolution $x(n) * h(n)$ for the pairs of signals given below. 14



Q.4(a) What is region of convergence? Show that properties of ROC depend on the nature of the signal, with necessary diagram. 12

Q.4(b) z-transform is an infinite power series, proof that it is exists only for the series convergence. 09

Q.4(c) Determine the z-transform of the following signals and sketch the corresponding pole-zero patterns. 14

$$x(n) = (4^n + 4^{-n})u(n)$$

Also write some properties of z-transform.

Section-B

Q.5(a) Define natural and forced response of a causal signal. 09

Q.5(b) Find the system function and impulse response from the given difference equation 10

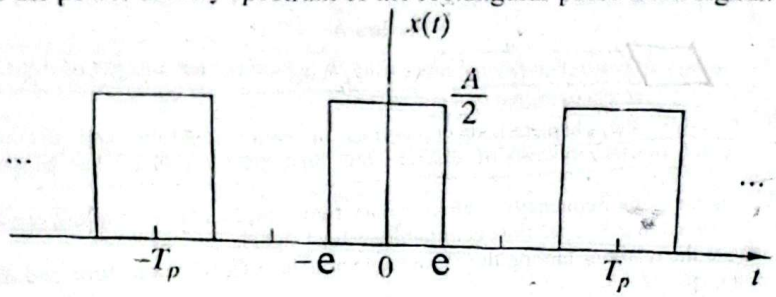
$$y(n) = \frac{1}{2}y(n-1) + 2x(n)$$

Q.5(c) Do you think inverse system and deconvolution is necessary for signal processing? Justify your answer. 06

Q.5(d) Determine the inverse system of the system with impulse response 10

$$h(n) = \left(\frac{1}{3}\right)^n u(n)$$

Q.6(a) Determine the power density spectrum of the rectangular pulse train signal. 12



Q.6(b) Classify ideal filters according to their frequency-domain characteristics. Explain each type with necessary expressions and figures. 13

Q.6(c) Determine the magnitude and phase of H(ω) for the three point moving average (MA) system. 10

$$y(n) = \frac{1}{3}[x(n+1) + x(n) + x(n-1)], \qquad 0 \le \omega \le \pi$$

Q.7(a) What is oversampling? What are the basic elements of an oversampling D/A converter? 07

Q.7(b) With appropriate figures and examples, explain the operation of a Sample and Hold D/A converter. 10

Q.7(c) With necessary figure, briefly explain the three major steps of Fast Fourier Transform. 18

Q.8(a) Distinguish between Real DFT and Complex DFT. Explain – how to transfer real DFT data into and out of the complex DFT format. 08

Q.8(b) What do you know about DFT basis functions? Illustrate all the cosine basis functions for an N = 16 point DFT. 12

Q.8(c) A 64-point signal x1 is shown in Fig. 8(c). It is composed of nothing but a sine wave that makes three cycles between points 0 and 63. Calculate *Re X*[3] for the given signal x1. 15

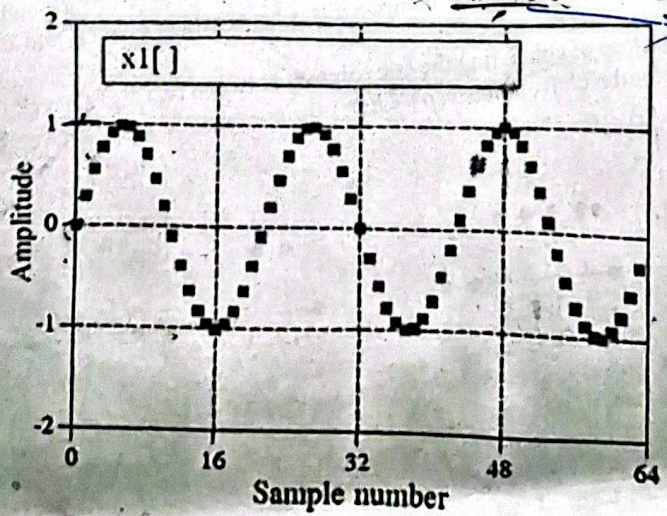


Fig. 8(c)

amplitude of the cos wave that makes 3 comple cycles

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B. Sc. Engineering L-2, Term-II, Exam. 2022

Course No: CSE-243
Course Title: Algorithm Design and Analysis
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 algorithm. Write down the properties of good algorithms. Why choosing appropriate data structure for an algorithm is so important? 10

Q.1(b) Define O (Big Oh), Ω (Big Omega) and Θ (Big Theta) notations. Why do we need them? 10

Q.1(c) The pseudocode for the INSERTION-SORT algorithm is given below. Now, find out the time complexity of the algorithm (show line by line analysis). Show the best case, worst case and average case time complexity by stating the necessary assumptions. 15

```
INSERTION-SORT (A)
1 for j = 2 to A.length
2       key = A[j]
3       //Insert A[j] into the sorted sequence A[1, ..., j – 1]
4       i = j – 1
5       while i > 0 and A[i] > key
6             A[i + 1] = A[i]
7             i = i – 1
8       A[i + 1] = key
```

Q.2(a) Check whether the following questions are correct or not: 10

i) $n^3 + 10^k n^2 = \Theta(n^3)$ where k is a constant
ii) $2n^3 + 5n^2 = O(n^2)$
iii) $2n^2 \log n = \Theta(n^2)$
iv) $2n^3 + 5n^2 = \Omega(n^3)$
v) $2n^2 \log n = O(n^3)$

Q.2(b) Prove that any comparison sort algorithm requires $\Omega(n \log n)$ comparisons in the worst case. 10

Q.2(c) What do you mean by optimal substructure property in divide and conquer approach? Write down the pseudocode for the merge sort algorithm using divide and conquer approach. Calculate the time complexity of merge sort using substitution method. 15

Q.3(a) Explain the master method to find the complexity of a recurrence relation. Calculate the time complexity of the following recurrence relations by applying the master method. 15

i) $T(n) = 3T(n/2) + n^2$
ii) $T(n) = 4T(n/2) + n^2$
iii) $T(n) = T(n/2) + n^2$
iv) $T(n) = 16T(n/4) + n$
v) $T(n) = 2T(n/2) + n \log n$

Q.3(b) Write down the pseudocode of the bucket sort and prove that the time complexity of the bucket sort is linear. 1

Q.3(c) Show the average case time complexity for quick sort algorithm using recursion tree method. 1

Q.4(a) Suppose, you are given a list of activities with their start and finish times. Now, apply a greedy approach to find the maximum set of activities to be finished without any overlap. Table 4(a) shows a set of activities with their corresponding start and finish times.

Table 4(a):

i	1	2	3	4	5	6	7	8	9	10	11
s_i	1	3	0	5	3	5	6	8	8	2	12
f_i	4	5	6	7	9	9	9	11	12	14	16

Q.4(b) A thief entered into a shop with his backpack having a capacity of 6kg. Table 4(b) shows all products (with weight and profit) found in the shop. Suppose, the amateur thief applied the greedy approach to select products based on profit-per-kg to have the maximum profit within the limited capacity of his backpack. 20

Table 4(b):

Product	Weight	Profit ($)
A	3	15
B	2	20
C	10	30
D	2	14

i) Calculate the maximum profit gained by the thief by selecting product by applying the greedy approach.

ii) Suppose, each product of the shop cannot be partially taken (like electronic products). Can we still solve the problem using greedy approach? Apply an appropriate algorithm again to calculate the maximum profit.

Q.4(c) What are the main properties of a problem that suggest that the given problem can be solved using Dynamic Programming? 05

Section-B

Q.5(a) What is topological sorting? Write down the intuition to find the topological sorting of a directed acyclic graph using DFS algorithm. 10

Q.5(b) What is spanning tree of a graph? Write Kruskal's algorithm for finding a minimum spanning tree of an edge-weighted graph. Analyze the time complexity of the algorithm by suggesting data structures for efficient implementation of the algorithm. 15

Q.5(c) Find a minimum spanning tree of a graph in Figure 5(c) using prime's algorithm. 10

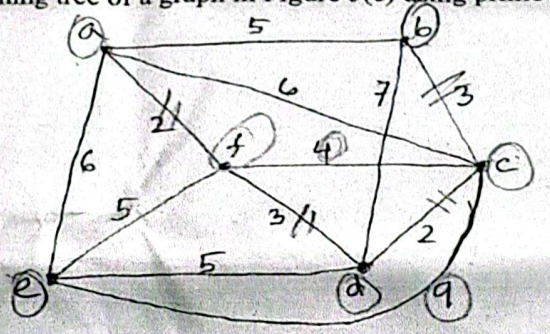

Figure 5(c)

Q.5(d) Suppose you need to store a sparse graph into the memory. Which data structure will be the best choice? Explain with associated advantages. 08

Q.6(b) What are the difference between the BFS and DFS algorithm? Write the pseudocode for the DFS algorithm and find the complexity. 12

Q.6(c) Define the following terms in graph with necessary details. 15

i) Bipartite graph
ii) Pseudograph
iii) Handshaking theorem
iv) Multigraph
v) Complete graph.

Q.7(a) What do you mean by relation? 05

Q.7(b) Explain the intuitive idea behind Bellman-Ford algorithm. How will you detect a negative cycle using Bellman-Ford algorithm? 10

Q.7(c) Write the pseudocode of Dijkstra's algorithm for single source shortest path problem. Prove its correctness. Analyze the time complexity of the algorithm. What would be the running time of Dijkstra's algorithm if a Fibonacci heap is used instead of a binary heap. 20

Q.8(a) Why $P \neq NP$? Justify: what would have been if $N = NP$. 09

Q.8(b) Briefly discuss the relationship among N, NP, NP-complete and NP-hard problems. 08

Q.8(c) What is a parallel algorithm? What are reasons behind the evolution of the parallel algorithm concept. Write down parallel version of merge sort algorithm. 10

Q.8(d) "DAGs inherently have a topological sort order". Justify this statement with appropriate example. 08

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Course No: EE-283
Course Title: Electronic Drives and Instrumentation
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)	Explain the importance of studying the operating principle of various electrical machines, drives, and measuring instruments for a computer engineer.	10
Q.1(b)	A long-shunt compound generator delivers a load current of 50A at 500V and has armature, series field, and shunt field resistances of 0.05Ω, 0.03Ω, and 250Ω respectively. Calculate the generated voltage and armature current. Allow 1V per brush for contact drop.	12
Q.1(c)	Explain the principle of a variable reluctance stepper motor for 1-phase-ON, 2-phase-ON, and half-step operation.	13
Q.2(a)	Describe the principle of a single loop generator. How AC can be converted to unidirectional current in this generator?	20
Q.2(b)	Classify DC generators.	05
Q.2(c)	A short-shunt compound generator delivers a load current of 30A at 220V, and has armature, series-field and shunt-field resistances of 0.05Ω, 0.03Ω and 200Ω respectively. Calculate the induced e.m.f. and armature current. Allow 1.0V per brush for contact drop.	10
Q.3(a)	Write a short note on Universal machine.	10
Q.3(b)	Derive the condition for maximum power developed in DC motor.	~~10~~ 12
Q.3(c)	A 250V DC shunt motor has armature resistance of 0.25Ω, on load it takes an armature current of 50A and runs at 750 r.p.m. If the flux of motor is reduced by 10% without changing the load torque, find the new speed of the motor.	~~10~~ 13
Q.4(a)	Draw and explain the OCC curve of a self-excited DC shunt generator and from the curve, define critical resistance.	10
Q.4(b)	Define starting torque. Derive the equation of the starting torque of an induction motor and show the condition that achieves the maximum starting torque.	12
Q.4(c)	How is back emf produced in the DC motor? Show that it is dangerous to start DC series motor without mechanical load.	13

Section-B

Q.5(a)	What are the conditions of synchronization of an alternator to connect in parallel with infinite bus-bar.	08
Q.5(b)	What do you mean by transducer? What are the criteria of selecting a good transducer?	07
Q.5(c)	How does a fixed resultant magnetic flux is created and runs at constant speed when three phase supply is fed to the stator of a three phase induction motor?	20

Q.6(a)	What is the piezo-electric effect? Prove that the voltage sensitivity of a crystal, $g = \frac{\varepsilon}{P}$, where ε = Electric field and P = Pressure.	10
Q.6(b)	What is LVDT? How does linear motion can be converted into electrical signal in LVDT?	12
Q.6(c)	Draw and explain the architecture of a solar-panel. Also explain its operation.	13
Q.7(a)	What is controlled rectifier? Explain the principle of on-off control of a single-phase full wave AC voltage controller.	07
Q.7(b)	A 3-phase, 50Hz, 4-pole induction motor has a slip of 0.04 per unit when the output is 20KW. The friction loss is 400W. What is the relative speed between the rotating emf and the rotor? What is the rotor circuit copper loss?	10
Q.7(c)	Prove that the maximum power developed by a synchronous motor is $Pm(\max) = E_b V / X_s$, where symbols have their usual meaning.	10
Q.7(d)	Draw the vector diagram of a loaded transformer with i) Resistive load ii) Inductive load.	08
Q.8(a)	Describe digital data acquisition system.	10
Q.8(b)	Describe the components of photo-electric transducer (e.g. photo diode and photo transducer).	08
Q.8(c)	A stepper motor has a step-angle of 2.5°, Determine: (i) resolution (ii) number of steps required for the shaft to make 25 revolutions and (iii) shaft speed, if the stepping frequency is 3600 rps.	07
Q.8(d)	Derive the electrical equivalent circuit of a single phase transformer.	10

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Term (Question)
20 Batch