

**University of Dhaka**  
**Department of Computer Science and Engineering**  
**2<sup>nd</sup> Year 2<sup>nd</sup> Semester Final Examination, 2019**  
**CSE-2204: Computer Architecture and Organization**

Full Marks: 70

**Duration: 3 Hours**

**Answer any 5 (Five) of the following questions**

$$3+3=6$$

- ✓ a) Generate the machine code for the following MIPS instructions:

- ii) `beg $s1, $s2, 100` [Opcode=4]

Let PC= 10010010 01010111 10101101 00111010. Generate the destination address for each the above-mentioned instructions.

- b) Consider a number format for representing the floating point number. The total number of bits is 15, where 1 bit is used to represent the sign  $S$ , 5 bits are used to represent the exponent  $E$  and remaining 9 bits are used to represent the fractional part  $M$  of the number. The significand is of form  $1.M$  and 1 is a hidden bit. This number format uses excess  $k$ -bit code and  $k$  is the number of bits in  $E$ . Now determine the following:

1. Bias needed to calculate the exponent.
  2. The number range of E.
  3. The most positive exponent and the most negative exponent.
  4. What is the normalized binary representation of the number  $-17.75_{10}$  using the above mentioned number system?

- c) Store the following 32-bit number using both big-endian and little-endian storage method.

10001110 11001111 10101010 01011010

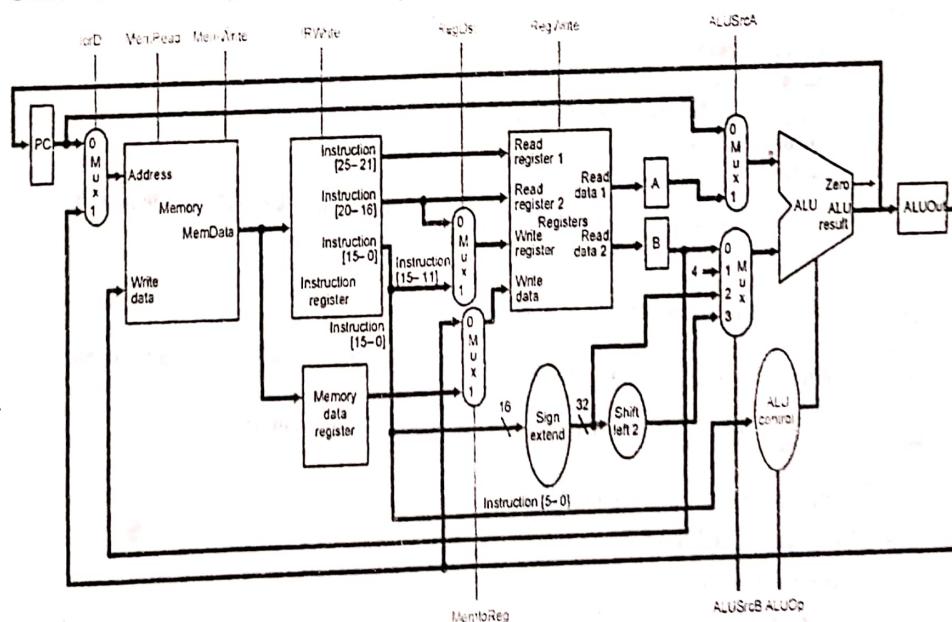
2. a) Describe the working principle of a carry look-ahead adder. What are the disadvantages of a carry look-ahead adder?

b) What is the equivalent one-address machine code of  $(A+B+C)/(A-B*C)$ .

c) Draw the diagram of a Full Adder Array for 4 X 4-bit unsigned multiplication.

3. a) Consider the following datapath of a multi-cycle processor:

$$\begin{array}{r} 3+3+4+2 \\ =12 \end{array}$$



Now consider the following instruction is executed using this processor:

**addi \$s2, \$s1, 100**

- (i) Write down the actions carried out in each cycle of the processor.
- (ii) Write down the control signals activated in each cycle.
- (iii) Draw the FSM Control for executing this instruction.
- (iv) Write down the advantages of micro-program based control unit design over FSM-based control unit design.

2

- b) Draw a 1-bit ALU that can perform AND, OR, Addition, Subtraction and NOR operation.

Discuss the logic behind each of the operation.

3+3+3=9

- ✓ 4. a) Suppose you need to store 64KB data in a cache memory where block size is 8 words. The length of the memory address is 32 bits. Calculate the total number of bits required for (i) direct-mapped cache (ii) 4 way set associative cache and (iii) fully associative cache. In each case, explicitly specify the size of index and tag.

2.5

- b) Discuss the pros and cons of selecting large block for a cache.

2.5

- c) How does non-restoring division improve the performance of restoring division?

2.5+2.5=5

5. a) Consider the following parameters:

- (i) CPI=2 and clock rate = 600 GHz
  - (ii) main memory access time = 150 ns and miss rate at primary cache = 10%
  - (iii) secondary cache access time = 10 ns and miss rate at secondary cache = 2%
- Determine
- (i) CPI with one level caching.
  - (ii) CPI with two level caching.

2+4=6

- b) Discuss the advantages of implementing the next state function of a control unit using a sequencer. Explain how the next state is determined with a circuit diagram showing the design of underlying logic.

3

- c) Write the MIPS instructions for the following code segment:

for ( i=0; i<3;i++)

a[i] = a[i]+i;

where, i → \$s3, 3 → \$s5 and base address of a → \$s6.

3+1+3=7

- ✓ 6. a) Show the execution of the following code segment on a pipelined processor using suitable representation.

```
lw $t2, 0($t3)
lw $t3, 4($t3)
beq $t4, $t5, Label #assume not equal
add $t5, $t2, $t3
Label: ...
```

How many cycles will be taken to execute this code? Write down the action performed at each stage at 5<sup>th</sup> clock cycle.

4

- b) What is load use data hazard and how it can be handled?

- c) What is a delayed branching? Discuss the strategies of implementing a delayed branching.

3

- ✓ 7. a) What is locality of reference? Explain its importance in cache memory?

4

- b) Consider the following code segment:

```
beq $1, $2, TARGET
```

```
sub $6, $4, $3
```

```
add $2, $3, $6
```

```
TARGET: or $1, $1, $2
```

5+5=10

Identify hazards (Consider both cases-1.branch is taken and 2. branch is not taken). Describe how they can be solved.

University of Dhaka  
 Department of Computer Science and Engineering  
 2<sup>nd</sup> Year 2<sup>nd</sup> Semester B.Sc. Final Examination, 2019  
 CSE-2205: Introduction to Mechatronics Engineering

Time: 3 hours

Full Marks: 70

Answer any five (5) of the following questions:

1. a) "Mechatronics is the synergistic integration of different technologies", place your argument in favor of this statement. With the help of a diagram show the Mechatronics design process. 4
- b) What are super node and super mesh? How do they contribute to an electrical circuit analysis? Explain with suitable diagram. 4
- c) What is MOSFET? Write down its types and functions. 2
- d) Write down the properties of an Op Amp and show the pin configuration with the help of a diagram. 2
- e) Determine the voltage across a  $2 \mu\text{F}$  capacitor if the current through it is 2

$$i(t) = 6e^{-3000t} \text{ mA}$$

Assume that the initial capacitor voltage is zero.

2. a) What do you mean by Mechanics, Kinematics and Kinetics? 3
- b) What are the advantages and disadvantages of closed loop control versus open loop control? What are their differences? 4
- c) The three-bar link OA shown in Fig. 1 has a counterclockwise angular velocity of 12 rad/s during a short interval of motion. When link CB is vertical, point A has coordinates (-50 mm, 75 mm). Determine the angular velocity of links AB and BC. 7

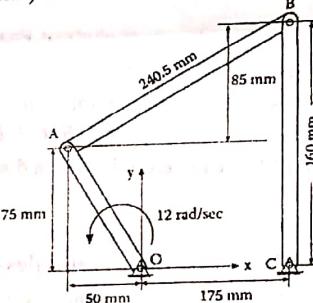


Fig. 1

3. a) Describe the functional stages of a measurement system. 3
- b) Write in short four methodologies by which error and uncertainties in a measurement system could be reduced. 4
- c) What is transfer function? Explain it using an equation. 2
- d) What is the function of a summing point in a block diagram of a control system? Explain it with a suitable diagram. 3
- e) Consider the system shown in Fig. 2 Simplify this diagram. 2

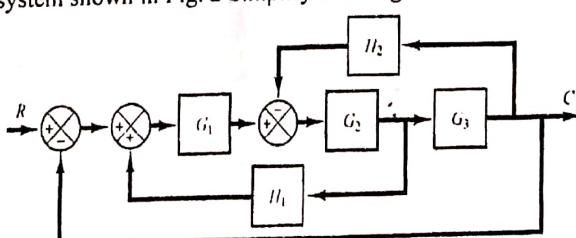


Fig. 2

4. a) Enlist three variables that are needed for a control system and show the components of a sensor by which any one variable could be measured. 3
- b) How does a Hot Wire Anemometer work? Explain it with a suitable diagram. 5
- c) Consider a tachometer with a gain of  $2V/1000 \text{ rpm} = 2V/\text{krpm}$ . It is interfaced to a data acquisition system through an analog to digital converter (ADC) which has 12-bit resolution and  $\pm 10V$  input range. The sensor specifications state that the ripple voltage due to commutators on the tachometer is 0.25% of the maximum voltage output. 6

- i. Determine the maximum speed that the sensor and data acquisition system can measure.  
ii. What are the measurement errors due to the ripple voltage and due to ADC resolution?  
iii. If the ADC was 8-bit, which one of the error sources is more significant: ripple voltage or ADC resolution? 2

5. a) What does Fig. 3 indicate? Explain how it works.

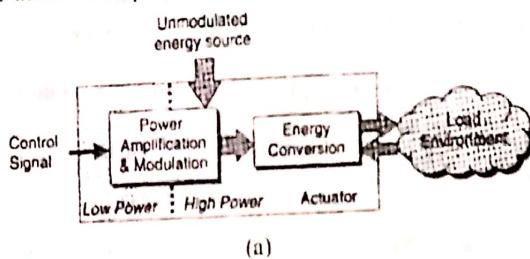


Fig. 3

- b) Explain the components of an actuation system. 5
- c) Describe the electrical actuation system with examples. 2
- d) What do you mean by servo mechanism? 2
6. a) Define PLC. Draw and explain the components of Programmable Logic Controller. 5
- b) What are the different types of PLC timers? 3
- c) Draw the equivalent ladder diagram for the following Boolean expression:  

$$Y = \bar{A}B(C + D)$$
 2
- d) What does Latching in PLC mean? Explain with a diagram. 4

7. a) Enlist three factors which are needed to design a flexible manipulator efficiently. 3
- b) How does safety factor contribute in a manipulator design? 2
- c) What does gear ratio mean? Explain it with a suitable diagram. 3
- d) Motor inertia,  $J_m$ , for a typical 27 W motor is given as  $J_m = 20 \times 10^{-7} \text{ kg m}^2$  if the gear ratio is 10, then the reflected motor inertia on the load side  $J_{mL}$  is  $0.0002 \text{ kg m}^2$ . If someone is driving a load of 2 kg on wheels of 0.03 m radius mounted on an axis to which the output side of the gear system is attached, compute the moment of inertia of the load at the drive wheel. 6

University of Dhaka  
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 2<sup>nd</sup> Year 2<sup>nd</sup> Semester Final Examination, 2019  
 CSE-2202: Design and Analysis of Algorithms-I

Total Marks: 70

Time: 3 Hours

Answer any 5 (five) of the following questions

- (a) Find the adjacency list for an undirected graph,  $G$ . Simulate Depth First Search Algorithm to find the Articulation points and Bridges. [4]

$$\begin{aligned} A &\rightarrow B, C, D \\ B &\rightarrow A \\ C &\rightarrow A, E \\ D &\rightarrow A, E, F \\ E &\rightarrow C, D \\ F &\rightarrow D, G \\ G &\rightarrow F \end{aligned}$$

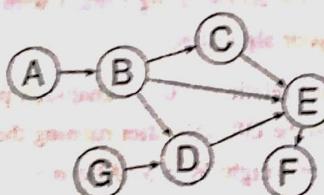
- (b) Design an algorithm to find whether an undirected graph,  $G = (V, E)$  is bipartite or not. Analyze the time and memory complexity of your algorithm. [4]

- (c) Pseudo-bridge of a graph is a edge which is not a bridge, but after deleting that edge, the graph gets extra bridge edge. Write an algorithm to find all the pseudo-bridge from an undirected graph,  $G = (V, E)$ . Analyze the time and memory complexity of your algorithm. [6]

2. (a) Consider the adjacency matrix of the directed graph,  $G$ . Run Bellman Ford algorithm in the graph to find the shortest path from node, A. Consider the edge sequence as: AD, BC, AB, DF, CD, EF, BE, CE [4]

	A	B	C	D	E	F
A	-	3	-	10	-	-
B	-	-	3	-	4	-
C	-	-	-	1	1	-
D	-	-	-	-	-	2
E	-	-	-	-	-	1
F	-	-	-	-	-	-

- (b) Run BPS in the following graph, using A as the source node. Show each intermediate step. [5]



- (c) Give an  $O(V+E)$  algorithm to find the shortest path in a weighted graph where all the edge weights are either 0 or 1. Justify the running time. [5]

- (a) Consider the adjacency matrix of the weighted undirected graph,  $G$ . Run Prim algorithm to find the Minimum Spanning Tree. [4]

	A	B	C	D	E	F
A	-	10	5	-	-	-
B	10	-	15	-	13	-
C	5	15	-	19	-	-
D	-	-	19	-	11	3
E	-	13	-	11	-	27
F	-	-	-	3	27	-

(b) Design an algorithm to detect cycle from an unweighted graph in  $O(V)$  runtime. Proof the efficiency of your algorithm. [4]

(c) Consider the undirected graph,  $G = (V, E)$ . Give an algorithm to find the minimum cost to ensure alternate paths between each pair of nodes. You are allowed to add as much edges as you wish, but the cost should be minimum. Analyze the time and memory complexity of the algorithm. [6]

4. (a) Consider the activities given below. Simulate and find maximum number of non-overlapping activities. Two activities are considered non-overlapping if they share no common time. [4]

Activity	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
Start Time	8	12	12	8	19	5	3	6	1	30
Finish Time	15	16	17	10	30	10	7	14	5	40

(b) Give an divide and conquer based algorithm to find the closest pair from N number of 2D points. Analyze the time complexity of the algorithm. [4]

(c) Activities are identified by four values: start time (st), finish time (ft), weight (wt) and group (gr). You are given N number of activities. Design an algorithm to select some non-overlapping activities such that the total weight of the selected activities is maximized. Two activities are considered non-overlapping if they share no common time. Note that there is a special condition when two overlapping activities can also be selected. The condition is very simple as both the activities must be in same group. Analyze the time and memory complexity of your algorithm. [6]

5. (a) Consider the two string  $A = \text{arabian}$  and  $B = \text{rabits}$ . Find the longest common subsequence of  $A$  and  $B$ . [4]

(b) You are given two string  $x$  and  $y$ , where the length of  $x$  is greater than the length of  $y$ . You have to convert the string  $x$  into the string  $y$  with two allowed operation, insert and change, described below:

Insert Operation: Insert a character. It will cost  $p$ .

Change Operation: Replace a character with any other character. It will cost  $q$ .

Now, design an algorithm to convert the string  $x$  into  $y$  with minimum cost. Analyze the time and memory complexity of your algorithm. [5]

(c) Write down the DP recurrence relation of 0 – 1 knapsack problem. Given 4 items with their weight and value, write down the DP table after running the DP algorithm of 0 – 1 knapsack algorithm to fill a knapsack of weight  $W = 5$ . Also mention the maximum profit and items taken in the process. [5]

Item	Weight	Value
1	2	10
2	1	12
3	3	15
4	2	20

6. (a) Consider the adjacency matrix of the directed weighted graph,  $G$ . Simulate Edmond Karp algorithm to find the maximum flow. [4]

	A	B	C	D	E	F
A	-	-	-	6	-	7
B	-	-	-	11	-	13
C	10	-	-	-	-	9
D	-	-	-	-	-	-
E	-	17	-	-	-	21
F	-	-	-	5	-	-

[4]

- (b) State and Proof Max-Flow Min-Cut theorem.
- (c) Consider that you have been given information of  $N$  airlines. The information consists of start airport, end airport, no of crew on the flight. Design an algorithm to determine the maximum number of crew needed at a particular time for the airlines. Analyze the time and memory complexity of your algorithm. [6]
7. (a) Arrange the following functions of  $n$  in increasing order of complexity. Explain your answer. [5]
- $n \lg n$
  - $\sqrt{n}$
  - $n!$
  - $n^3$
  - $\lg n$
  - $2^n$
- (b) Define big-O, big- $\Theta$  and big- $\Omega$  in terms of algorithm complexity analysis. [5]
- (c) Define Master Method. Give two examples of complexity analysis using Master Method. [4]

University of Dhaka  
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 2<sup>nd</sup> Year 2<sup>nd</sup> Semester Final Examination, 2019  
 CSE-2201: Database Management Systems-I

Time: 3 Hours

Total Marks: 70

Answer any 5 (five) of the following questions

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- 1✓ (a) Consider the relation instance as shown below.

M	N	O
$m_1$	$n_1$	$o_1$
$m_1$	$n_1$	$o_2$
$m_2$	$n_1$	$o_1$
$m_2$	$n_1$	$o_3$

$o_1$

- i. Find the set of functional dependencies that the relation instance satisfies. (3)
- ii. Suppose, the last tuple in the relation instance is  $(m_2, n_1, o_2)$  instead of  $(m_2, n_1, o_3)$ . (2)  
What are the expected changes in the set of functional dependencies in this case?
- (b) Suppose, there is a relation  $R$  having four attributes  $A, B, C$  and  $D$ ; and  $F$  is the set of function dependencies that hold on  $R$ . Find (i) the candidate keys and (ii) the best normal form (1NF, 2NF, 3NF or, BCNF) that  $R$  satisfies when  $F = \{A \rightarrow B, BC \rightarrow D, A \rightarrow C\}$ . (3)
- (c) Let, after a thorough study, the system analyst reported that the  $F$  in the question 1(b) should be changed to  $F = \{AB \rightarrow C, AB \rightarrow D, C \rightarrow A, D \rightarrow B\}$ . Find (i) the candidate key(s) and (ii) the best normal form that  $R$  satisfies for the changed functional dependencies  $F$ . (6)

- 2✓ An airline company keeps track of its flight information using following relations:

$Flights \equiv (\underline{flightno} : varchar(10), \underline{from} : varchar(30), \underline{to} : varchar(30), distance : number(6, 2),$   
 $\underline{departs} : number(4, 0), arrives : number(4, 0), price : number(6, 2))$   
 $Carrier \equiv (\underline{carrid} : varchar(10), \underline{carname} : varchar(30), \underline{maxrange} : number(6, 2))$   
 $Employees \equiv (\underline{empid} : integer, \underline{empname} : varchar(30), \underline{empsalary} : number(6, 2))$   
 $Pilots \equiv (\underline{pltid} : integer, \underline{carrid} : varchar(10))$

Here the Employees schema stores all employees in the airline including the pilots. A pilot can operate a carrier if there exists a pilot-carrier tuple in the pilot schema and a carrier can be used for a flight only when the carrier maxrange is within the flight distance. The departure and arrival time of a flight are always stored in local time and in 24-hour format.

- (a) For the given relations, list the keys (candidate, primary and foreign) for each relation. (4)
- (b) For each primary and foreign keys for the relations, write DDL constraint clause (that is used in CREATE [or ALTER] TABLE statement). You do not need to write the entire SQL DDL statement. (6)
- (c) Do you think that the mentioned relations and their attributes are sufficient to link between them? Justify your answer. (4)

3. Based on the given relations for the airline company in question 2 (including your justification of the question 2(c)), answer the followings:

- (a) Write the following queries in both relational algebra (RA) and SQL:
- Find the pilots who can operate a carrier having maxrange between 500 to 1500 KM. (2)
  - Find the longest flight(s) that the airline operates. (2)
  - Find the flights arrives at the destination between 8:00AM to 11:00AM. (2)
- (b) Write SQL DML statements for the following queries:
- Find the list of pilots that cannot operate a plane longer than 800KM. (3)
  - A customer wants to travel from Dhaka to Johannesburg (South Africa) with no more than two changes of flight. List the choice of departure times from Dhaka if the customer wants to arrive in Johannesburg by 3PM. (5)
4. (a) Explain Data Model and its components. (4)
- (b) Explain the reasons behind introducing the 'NULL' value in DBMS. Compare the NULL value in DBMS and that in structured programming language like 'C' or 'Pascal' (nil). (4)
- (c) When we use any semi-structured database like *xml*, how do we handle the NULL values? (2)
- (d) With a proper example describe the FLWR expression in XQuery. (4)

5. (a) The Bangladesh Pharmaceutical Association (BPA) opened a database design contest for CSE students in Bangladesh. The database will maintain detail information about (a) Doctors, (b) Patient, (c) Medicines and (d) Pharmacies. They will provide lifetime free medicine to the top 3 designers. The database design should consider the followings: (8)

- Doctors, Patients, Medicines and Pharmacies must be identified uniquely as shown in Table 1.

Table 1: Identifications

Doctor	BMA Registration Number (Reg Year and Number)
Patient	Voter ID
Medicine	Manufacturer given name
Pharmacy	Phone Number

- BPA is interested to have an updated list of doctors with their specialities and year of experience.
- BPA is also interested to identify the age and gender groups of the patients that are (or, were) seeking treatment in a time period.
- BPA also want to know the locations (pharmacies) that will increase their sales by changing medicine supply policy (i.e., the most sold medicines in a pharmacy).

As a CSE student, you have to design the database based on the requirements mentioned. You are free to choose the attributes and their types, additional information (that is not mentioned above) to link each other (patients, doctors, medicines and pharmacies).

Draw the E-R diagram of your design for the BPA database. For each relation in the diagram, mention why do you need attributes (if any) in the relations.

- (b) In the BPA application mentioned above, is there any scope of using any *weak entity set*? Explain. (3)
- (c) If anyone converts an ER Model into relational tables, then how they handle many-to-many cardinality and multivalued attributes? (3)
6. (a) What is the difference between 'r satisfies F' and 'F holds on R', where R is a relation schema, r is a relation on R and F is a set of functional dependencies? Which one is more important in case of database design? (3)
- (b) Why Armstrong's axioms are called *sound* and *complete*? Consider the following proposed rule for functional dependencies: If  $\alpha \rightarrow \beta$  and  $\delta \rightarrow \beta$ , then  $\alpha \rightarrow \delta$ . Prove that this rule is not sound by showing a relation r that satisfies  $\alpha \rightarrow \beta$  and  $\delta \rightarrow \beta$ , does not satisfy  $\alpha \rightarrow \delta$ . (1+2)
- (c) Consider  $R = (A, B, C, D, E)$  with functional dependencies  $F = \{ A \rightarrow BC, CD \rightarrow E, B \rightarrow D, E \rightarrow A \}$ . (4+1)  
i. Find the candidate keys mentioning reason.  
ii. Is  $BC \rightarrow DE$  in  $F^+$ ? Prove your answer.
- (d) In case of decomposing schema R to  $R_1, R_2, \dots, R_n$ , how dependency preservation can be ensured using restriction of F given on R? (3)
7. (a) Explain the concept of physical data independence, and its importance in database systems. (3)
- (b) Discuss the relative merits of procedural and nonprocedural languages. (3)
- (c) Show that, in SQL,  $<>$  all is identical to *not in*. (3)
- (d) The SQL like operator is case sensitive, but the lower() function on strings can be used to perform case insensitive matching. To show how, write a query construct (*where* part only) that finds departments whose names contain the string "sci" as a substring, regardless of the case. (1)
- (e) What is trigger? What are the requirements to design a trigger? Mention why trigger is important in database management system? (4)

**University of Dhaka**  
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**2<sup>nd</sup> Year 2<sup>nd</sup> Semester Final Examination, 2019**  
**CSE 2203: Data and Telecommunications**

Time: 3 hours

**Full Marks: 70**

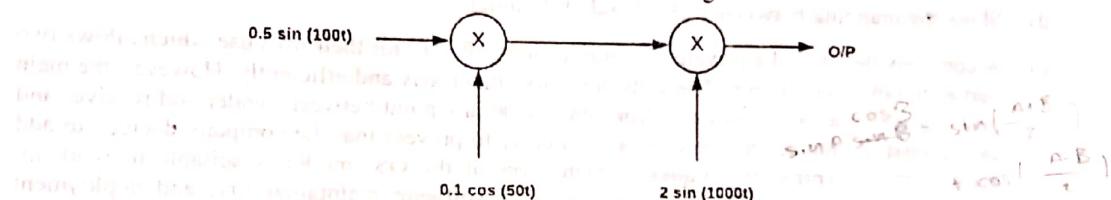
*Answer any five of the following questions*

- ✓ a) Two blue armies are each poised on opposite hills preparing to attack a single red army in the valley. The red army can defeat either of the blue armies separately but will fail to defeat both blue armies if they attack simultaneously. The blue armies communicate via an unreliable communications system (a foot soldier). The commander with one of the blue armies would like to attack at noon. His problem is this: If he sends a message to the other blue army, ordering the attack, he cannot be sure it will get through. He could ask for acknowledgment, but that might not get through. Is there a protocol that the two blue armies can use to avoid defeat? 3
- b) List the major disadvantages of layered approach to protocols. 2
- c) What are the prominent activities of physical layer and data link layer in OSI model? 3
- d) Show the mapping between TCP/IP and OSI model 3
- e) A company developed a private communication software for their own use which allows two parties to talk over internet. The software works flawlessly and efficiently. However, the main problem is that anyone can eavesdrops packets at any point between sender and receiver and can reconstruct the actual voice stream. In order to prevent that the company decided to add end-to-end encryption techniques. Which layer of the OSI model is suitable to work in, considering parameters like development time, software maintainability, and deployment time? Give reasons for your answer. 3
- 2 a) Consider a channel with a 1-MHz capacity and an SNR of 63. 5  
i) What is the upper limit to the data rate that the channel can carry?  
ii) The result of part (i) is the upper limit. However, as a practical matter, better error performance will be achieved at a lower data rate. Assume we choose a data rate of 2/3 of the maximum theoretical limit. How many signal levels are required to achieve this data rate?
- b) A signal travels from point A to point B. At point A, the signal power is 100W. At point B the power is 90W. What is the attenuation in decibels? 2
- c) A non-periodic composite signal contains frequencies from 10 KHz to 30 KHz. The peak amplitude is 10V for the lowest and the highest signals and is 30V for the 20 KHz signal. Assuming that the amplitudes change gradually from the minimum to the maximum, draw the frequency spectrum. 3
- d) We need to upgrade a channel to a higher bandwidth. Answer the following question: 4  
i) How is the rate improved if we double the bandwidth?  
ii) How is the rate improved if we double the SNR?
- 3 a) A character-interleaved time division multiplexer is used to combine the data streams of a number of 110 bps asynchronous terminals for data transmission over a 2400 bps digital line. Each terminal sends asynchronous characters consisting of 7 data bits, 1 parity bit, 1 start bit, and 2 stop bits. Assume that one synchronization character is sent every 19 data characters and in addition, at least 3% of the line capacity is reserved for pulse stuffing to accommodate speed variations from various terminals. 4  
i) Determine the number of bits per character.  
ii) Determine the number of terminals that can be accommodated by the multiplexer.  
iii) Sketch a possible framing pattern for the multiplexer.
- b) We have 14 sources, each creating 500 8-bit characters per second. Since only some of these sources are active at any moment, we use statistical TDM to combine these sources using 4

character interleaving. Each frame carries 6 slots at a time, but we need to add 4-bit addresses to each slot. Answer the following questions:

- What is the size of an output frame in bits?
  - What is the output frame rate?
  - What is the duration of an output frame?
  - What is the output data rate?
- c) In statistical TDM, there may be a length field. What alternative could there be to the inclusion of a length field? What problem might this solution cause and how could it be solved? 3
- d) An asynchronous transmission scheme uses 8 data bits, an even parity bit, and a stop element of length 2 bits. What percentage of clock inaccuracy can be tolerated at the receiver with respect to the framing error? Assume that the bit samples are taken at the middle of the clock period. Also assume that at the beginning of the start bit, the clock and the incoming bits are in phase. 3

- 4 a) Decompose the output signal (see the diagram below) into a linear combination of sinusoidal functions, and find frequency and phase of each component and represent it in frequency domain. Also calculate the peak amplitude of the resultant signal. 4



- b) Why do you need analog-to-analog conversion in data communication? 2
- c) What is the significance of modulation index in AM, PM, and FM? 3
- d) What is the period of the function  $f(t) = (10\cos t)^2$ ? 2
- e) How do frequency modulation and phase modulation relate with each other? 3

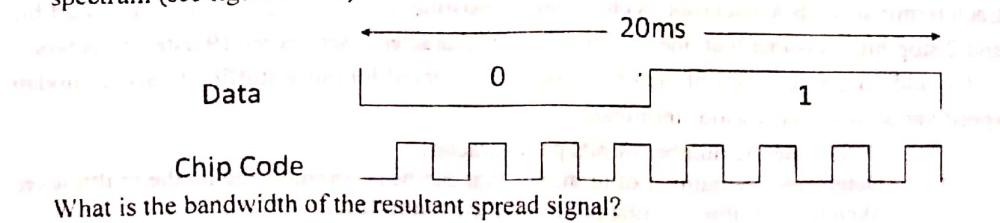
- 5 a) A coding scheme has the following codewords: {1000110, 0100101, 0010011, 0001101}. Explain why its error correcting capability cannot be fully utilized. 2

- b) What happens if we choose codes which are not orthogonal in a CDMA system? 2
- c) Inspired by the Spread Spectrum communication technology, an attacker tried to develop a signal jammer using DSSS technology to jam the entire radio spectrum. Discuss potential flaw of the approach. 3

- d) The chip sequences of four CDMA transmitters are:  
 $A = (-1 -1 -1 +1 +1 -1 +1 +1 -1 +1 -1)$   
 $B = (-1 -1 +1 -1 +1 +1 -1 +1 +1 -1)$   
 $C = (-1 +1 -1 +1 +1 +1 -1 -1 +1 -1)$   
 $D = (-1 +1 -1 -1 -1 +1 +1 -1 +1 -1)$   
 $E = (+1 -1 -1 -1 +1 +1 +1 -1 -1 -1)$

Assume the CDMA receiver gets the following chips:  $(-1 +1 -4 +1 -1 -3 +1 +1 -1 +1 -1)$ . Find out which stations transmitted, and which bits did each one send.

- e) In a typical DSSS, a chip sequence is used to spread the signal over the electromagnetic spectrum (see figure below): 3



What is the bandwidth of the resultant spread signal?

- a) What is the purpose of using modulo 2 arithmetic rather than binary arithmetic in computing FCS? 3
- b) Consider 100000111 as a divisor. Write down the polynomial form of the divisor. Answer the following questions with proper reasoning: 6
- Does it detect a single error?
  - Does it detect two isolated bit errors?
  - Does it detect all odd number of errors?
  - Does it detect a burst error of size 6?
  - What is the probability of detecting burst error of size 9?
  - What is the probability of detecting a burst error of size 15?
- c) For forward error detection, the relation is  $d_{\min} = s+1$  where  $d_{\min}$  is the minimum hamming distance of a code and  $s$  is the no. of errors occurred. Explain the physical significance of this expression. 2
- d) Calculate the hamming pairwise distances along the following codewords {00100000, 01001001, 11011010, 11000110, 01001000}. How many error bits can be corrected by these codewords? 3
- 7 a) Is it possible to change the phase of a signal without changing the instantaneous frequency and vice versa? Justify your answer. 2
- b) Let  $m_1(t)$  and  $m_2(t)$  be message signals and let  $s_1(t)$  and  $s_2(t)$  be the corresponding modulated signals using a carrier frequency of  $f_c$ . Show that if simple AM modulation is used, then  $m_1(t) + m_2(t)$  produces a modulated signal that is a linear combination of  $s_1(t)$  and  $s_2(t)$ . 3
- c) Draw the graph of the following bit stream using NRZ-I, Manchester and AMI encoding scheme. Also find out the bandwidth of the resultant signal:  
i. 00000000 ii. 11111111 iii. 01010101 iv 00110011 3
- d) We have sampled a low-pass signal with a bandwidth of 200KHz using 1024 levels of quantization.  
i. Calculate the bit rate of the digitized signal.  
ii. Calculate the SNR<sub>db</sub> for this signal.  
Calculate the PCM bandwidth of this signal. 3
- e) What will be the shape of the resultant waveform (see the diagram below)? Calculate its frequency phase and peak amplitude. 3

