University of Dhaka

Department of Computer Science and Engineering

2nd Year 2nd Semester B.Sc. Final Examination, 2018

CSE-2201: Database Management Systems - I

Full Marks: 60 **Time: 3 hours**

Answer any **four (4)** of the following questions:

1. a) What is Database Management Systems (DBMS)? List the advantages of the DBMS. 2

   b) Consider the following scenario.

   Day by day, people are being engaged in different social media. As a result, a number of unwanted occurrences e.g., spreading false news, online harassment, fake profile generation etc are increasing rapidly. So, the government thinks that it is the time to control the online activity of the mass people for the betterment of the upcoming generations. In addition, one of the popular social media has stepped ahead to help the government and it takes the initiatives to ensure the privacy and security of its users. At this stage, they need to gather the personal data to analyze the suspicious occurrences. You being an expert and obedient citizen of the country is assigned to design the database efficiently. You should get the chance as you will be awarded by the knowledge that what types of information the government are going to be provided by the social media about you.

   In this database, the information of a user: name, social media id, photo, email, phone number, friend list, personal messages, time line posts, time line shares, reactions to other posts, connected apps, geographic locations etc will be stored. Messages will be identified by message id, sending time, message details etc. Moreover, suspicious occurrences will be stored with occurrence id, time, occurrence type, occurrence details etc.

   Now, answer the following questions.

   i. Draw an Entity Relationship Diagram (ERD) to design a relational database for the given scenario. Point out all of your assumptions clearly. 6

   ii. Find the primary keys of all the relationship table from your ERD. 2

   c) Briefly discuss on Key Constraints (Super key, Candidate key and Primary key) in relational database systems with single suitable example. List some disadvantages of having no primary key. 3 + 2

2. Consider the following schemas.

   - **Movies(<u>movieTitle</u>, <u>releaseYear</u>, length, genre, studioName, producerName, totalIncome)**
   - **StarsIn(<u>movieTitle</u>, <u>releaseYear</u>, <u>starName</u>)**
   - **MovieStar(<u>starName</u>, address, gender, dateOfBirth)**
   - **Producers(<u>producerName</u>, address, netWorth)**

   Now, write SQL queries and Relational Algebra Expression for the following questions.

   a) Find all the animation movies released in 2017 by Marvel. 3

   b) Find all the producers who have produced any action movies acted by Nicolas Cage. Show the total length of all the movies produced by the producer. 3

   c) List the number of movies produced by Stan Lee with the total number of different movie stars in those movies. 3

   d) Make a statistical report with the number of movies, different female stars and different male stars for each year. 3

   e) List the movie which contributes more than 25% of the net income of its producer. Show the list according to the non-decreasing release year. In case of same release 3

year show them according to the increasing order of its title.

3. a) What is materialized view? List the characteristics and applications of materialized view. 3

b) Make a list of the responsibilities of a database administrator (DBA). Discuss on the security related works of a DBA. 3

c) What is stored procedure? How can it be helpful in a database system? 3

d) Point out the advantages and disadvantages of relational algebra. 3

e) List different types of database models with example. Point out the advantages of Object Oriented Database (OODB) model. 3

4. a) Define trivial functional dependency. List all nontrivial functional dependencies (with no common attributes) satisfied by the following relation: 1 + 3

A	B	C
a1	b1	c1
a1	b1	c2
a2	b1	c1
a2	b1	C3

b) Use Armstrong's axioms to prove the soundness of Union, Decomposition and Pseudotransitivity rule. 3

c) What is 'closure of set of attributes', α^+? What are the usage of α^+? 4

d) Consider a relation schema R = (A, B, C, D) with F = {A→BC, B→D, D→B}. Is it possible to meet all the design goals by a smart decomposition of R into R_1 and R_2? Explain why or why not. 4

5. a) Define normalization. Discuss different anomalies in database systems. 3

b) Differentiate between 3NF and BCNF. What do you prefer (3NF or BCNF) in your design? Give supportive arguments on your answer. 5

c) Normalize the given relation (R) into 3NF and BCNF for the set of functional dependencies (F). 5

$$R = \{A, B, C, D, E, F\}$$
$$F = \{AB \rightarrow DE, C \rightarrow EF, DE \rightarrow F, CD \rightarrow B\}$$

d) What is 4NF? Point out the necessity of 4NF. 2

6. a) Let Employee = (emp_id, designation, department) is a relation schema with *emp_id* as a candidate key. The relation r(R) is sorted on attribute *department*. Draw an index on *emp_id* and another on *designation* filling required data for different attributes. 5

b) For B^+-tree index structure, search key value size = 12 bytes, pointer size = 8 bytes, block size = 388 bytes and there are 1000 search key values. How many nodes are required to access for an index lookup for the worst case? 2

c) What are the differences between B^+-tree structure and in memory tree structure? 2

d) What are the causes of bucket overflow in a hash file organization? 3
What can be done to reduce the occurrence of bucket overflow? 2

e) Why dynamic hashing is preferable than static hashing? 1

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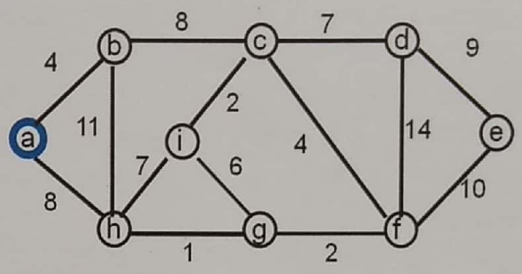
Course Code: CSE-2202 **Course Title: Design and Analysis of Algorithms-I**
Total Marks: 60 **Time: 3 Hours**

Answer any 4(four) of the following questions

1. a) Simulate Prim's minimum spanning tree algorithm in the following graph starting from the node 'a' and compute the following table. You can assume that the symbols used in the following table have their usual meaning. [4]

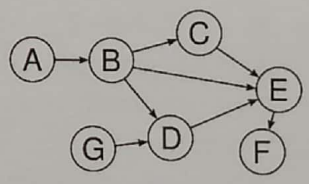
V	a	b	c	d	e	f	g	h	i
T	1	0	0	0	0	0	0	0	0
Key	0	-	-	-	-	-	-	-	-
π	-1	-	-	-	-	-	-	-	-



b) We know about the algorithms for single source shortest path. But what about single source longest path? Try to discuss it and an algorithm to find single source longest path for a given positive weighted directed acyclic graph. [5]

c) You are given n events where each takes one unit of time. Event i will provide a profit of g_i dollars ($g_i > 0$) if started at or before time t_i where t_i is an arbitrary real number. (Note: If an event is not started by t_i then there is no benefit in scheduling it at all. All events can start as early as time 0.) Give an algorithm that can find a schedule which will maximize the profit. [6]

2. a) Find topological order of the nodes in the following graph using DFS. Show each intermediate steps. [5]



b) How can you use Bellman Ford algorithm to find a positive cycle in a directed weighted graph? Analyze the time complexity of your algorithm. [5]

c) Give an algorithm that determines whether or not a given undirected graph G = (V, E) contains a cycle. Your algorithm should run in O(V) time. Justify the running time of your algorithm. [5]

3. a) Suppose, A is a 10 × 30 matrix, B is a 30 × 5 matrix, and C is a 5 × 60 matrix. You have to find the most efficient way to multiply these matrices together. The problem is not actually to perform the multiplications, but to decide in which order to perform the multiplications so that the number of operations (scalar multiplications) are optimum. [4]

b) Given two strings S and T, device an algorithm to find the length of the shortest subsequence in S which is not a subsequence in T. If no such subsequence is possible, return -1. A subsequence is a sequence that appears in the same relative order, but not necessarily contiguous. [5]

c) Given an array of integers. Find the maximum sum sub array among all the possible sub arrays by using divide and conquer approach. For example, input is A[ ] = {2, -4, 1, 9, -6, 7, -3} and output is 11 which is marked as underline. Can we actually solve this problem [6]

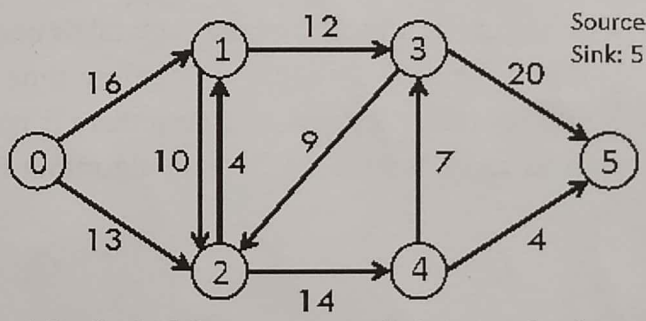
by using divide and conquer approach? Justify your claim (by trying to give a design approach by using divide and conquer) or give counter example by using above input/output scenario.

4. a) You are given a set of coins {2, 7, 11, 17}, each with infinite frequency. You are trying to make an amount X using these coins in a greedy fashion, where you choose the biggest possible coin which is not greater than X. Then you follow the same algorithm for the rest of the amount. [4]
   Give three examples, where this algorithm will fail to produce X, while in reality, it was actually possible.

   b) You are given an NxN grid, where each square (i, j) contains c(i, j) gold coins, where (i, j) is the j^{th} square of i^{th} row. Assume that $c(i, j) \geq 0$ for all squares. You must start in the upper-left corner (1, 1) and end in the lower-right corner (N, N), and at each step you can only travel one square down or right. When you visit any square, including the starting or ending square, you may collect all of the coins on that square, only if the number of coins on that square is even. Write an algorithm to find the maximum number of coins you can collect if you follow the optimal path. Mention the time and memory complexity of your algorithm. [5]

   c) Given an arithmetic expression with N integers and N – 1 operator between them, put brackets in such a way that the result of the expression becomes maximum. The operator can only be either + (plus) or – (minus). Write an algorithm and analyze the time and memory complexity of your algorithm. [6]

5. a) Simulate Edmond Karp algorithm to find maximum flow in the following graph. Show each intermediate steps. [5]



   b) Given a directed graph and two nodes S and D, find if there are two disjoint paths from S to D. Disjoints paths don't have any edge in common. Write an algorithm, and analyze the time complexity of your algorithm. [5]

   c) Given an NxN matrix, you are given the sum of elements for all N rows and sum of elements for all N columns. You need to retrieve the original matrix from this information. Write an algorithm. Analyze the complexity of your algorithm. [5]

6. a) Define big-O, big-Ω and big-Θ in terms of algorithm complexity analysis. [3]

   b) Describe master method. Find a divide and conquer based algorithm for multiplying two N-bit numbers. Analyze its complexity using master method. [6]

   c) Given an undirected graph, add minimum number of edges so that the graph doesn't have any bridge. Write an algorithm. Analyze the complexity of your algorithm. [6]

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CSE-2203: Data and Telecommunications

Full Marks: 60 **Time: 3 hours**

Answer any **four (4)** of the following questions:

1. a) What do you mean by *line encoding*? 2

   b) What is *baseband* transmission? Give an example of a *baseband* transmission system. 2

   c) We have a sampled low-pass signal with bandwidth of 200KHz using 1024 levels of quantization. 6

      i. Calculate the bit rate of the digitized signal.

      ii. Calculate the SNR_{db} for this signal.

      iii. Calculate the PCM bandwidth of this signal.

   d) What is the significance of multiplying two signals in frequency modulation technique? 2

   e) What is the period of the function $f(t) = (10\cos t)^2$? 3

2. a) A synchronous nonstatistical TDM is to be used to combine four 4.8-kbps and one 9.6-kbps signals for transmission over a single leased line. For framing, a block of 7 bits (pattern 1011101) is inserted for each 48 data bits. The reframing algorithm (at the receiving demultiplex) is as follows: 5

      - Arbitrarily select a bit position.
      - Consider the block of 7 contiguous bits starting with that position.
      - Observe that block of 7 bits each frame for 12 consecutive frames.
      - If 10 of the 12 blocks match the framing pattern, the system is "in-frame"; if not, advance one bit position and return to step 2.

      i. Draw the multiplexed bit stream (note that the 9.6kbps input may be treated as two 4.8-kbps inputs).

      ii. What is the % overhead in the multiplexed bit stream?

      iii. What is the multiplexed output bit rate?

   b) Compare the statistical TDM with synchronous TDM. 4

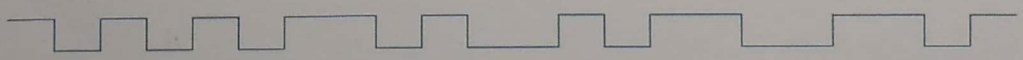
   c) Why bit padding is used in multiplexing? A multiplexer combines four 100Kbps channels using a time slot of 2 bits. What is the frame rate? What is the bit duration? 6

3. a) With the help of constellation diagram, explain the operation of a 16-QAM. 3

   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 $s_2(t)$. 5

   c) Why do you need analog-to-analog conversion data communication? 2

   d) The waveform below belongs to a Manchester encoded binary data stream. Determine the beginning and end of bit periods (i.e., extract clock information) give the data sequence. 3



   e) Give a scenario where delta modulation performs poorly. 2

4. a) Can an FHSS and DSSS co-exist? Justify your answer. 2

   b) Explain the Near-Far problem of CDMA scheme. 3

c) Describe the sliding-window flow control. What is the advantage of sliding window flow control over the stop-and-wait flow control? 7

d) In a Bus CSMA/CD network with a data rate of 10Mbps, a collision occur $20\mu s$ after the first bit of the frame leaves the sending station. What should be the frame length so that the sender can detect the collision? 3

5. a) For $g(x) = 110011$ and $d(x) = 11100011$, find the CRC using long division. 3

b) In CRC, we have chosen the generator 11101010111. What is the probability of detecting a burst error of length 10? 2

c) The polynomial of a CRC generator code is: $x^{16} + x^{14} + x^4 + 1$. Does it detect a burst error of size 6? Does it detect any odd number of error bits? Defend your answer. Also find the probability of failing to detect a burst error of length 20? Is it a good CRC code? 5

d) Calculate the hamming pairwise distances along the following codewords {000000, 010101, 101010, 110110}. 3

e) Explain why a generator polynomial in CRC almost always contains the x^0 term. 2

6. a) Both Nyquist's and Shanon's theorem place upper bounds on the bitrate of a channel based on two different approaches. How are the two related? 3

b) Given a bit pattern 001001, encode this data using ASK, BFSK, BPSK, and QPSK. 4

c) Why do one need an MLT-3 encoding scheme that maps 1 bit data element to 1 bit signaling element? 2

d) With appropriate illustrations, explain why the bipolar schemes do not have DC components? 2

e) The minimum bandwidth requirements of Manchester and differential Manchester is greater than that of NRZ. So, why should we choose Manchester coding schemes instead of NRZ? 2

f) A modified NRZ code known as enhanced-NRZ (E-NRZ) is sometimes used for high-density magnetic tape recording. E-NRZ encoding entails separating the NRZ-L data stream into 7-bit words; inverting bits 2, 3, 6, and 7; and adding one parity bit to each word. The parity bit is chosen to make the total number of 1s in the 8-bit word an odd count. Convert 101100010 in E-NRZ. 2

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Course Code: CSE-2204 Course Title: Computer Architecture and Organization

Full marks: 60 Duration: 3 hours

Answer any 4 (four) of the following questions

1. a) Draw a diagram that depicts the basic functional units of a computer and explain the difference between CPU and microprocessor. [3]

   b) Draw the flowchart that represents typical CPU operations and explain how load and store operation works. [3]

   c) What do you understand by processor performance? Describe a law to estimate processor performance. Explain the impact of each parameter. [3]

   d) What is pipeline processing? Briefly explain the operation of a five-stage instruction pipeline processor. Explain how does it increase the performance. [3]

   e) What are the basic types of instructions of a modern processor? Briefly describe the specifications of ALU and branch type instruction considering a pipelined processor. [3]

2. a) A certain computer system that contains n parallel processes can complete a given task Q in $30n^{0.6} + 10log_2 n$ time units.

   i) What is the system's speed up and efficiency when executing Q? [3]

   ii) For what numbers of processors does the efficiency exceed 70 percent? [5]

   b) Briefly describe the design methodology of a microprogrammed control unit for the Booth multiplier. [7]

3. a) A 16 MB main memory has a 32 KB direct mapped cache with 8 bytes per line.

   i) How many lines are there in the cache? [3]

   ii) Explain how the main memory is partitioned. [4]

   b) You are designing a write buffer between a write through L_1 cache and a write-back L_2 cache. The L_2 cache write data bus is 16 B wide and can perform a write to an independent cache address every 4 processor cycles.

   i) How many bytes wide should each write buffer entry be? [4]

   ii) What would be the effect of L_1 misses be on the number of required write buffer entries for systems with blocking and non-blocking caches? Explain it in details. [4]

4. a) What do you understand by instruction flow technique? Draw the control flow graph (CFG) of a program which has one or more branch instructions. Explain the mapping process of CFG to linear memory. [5]

   b) Why branch instruction is so bad in pipeline processing? Explain with diagram branch prediction process considering target address generation and condition resolution algorithm. [7]

   c) What are the causes of register storage conflict? How can we resolve anti dependences and output dependencies in register data flow? [3]

5. a) What is system representation in system design? How many ways we can represent a hardware system? Explain using examples. [6]

   b) What is combinational array multiplier? Briefly explain 4-bit unsigned number multiplication process with necessary diagram. [6]

   c) Briefly explain IEEE 754 standard 32-bit floating point number format. How does floating point addition operation work where base is same but exponent is different? [4]

6. a) What are the limitations of Scalar pipelined processor? Briefly explain rigid pipeline stall policy. [4]

   b) What are the inter-stages buffer? Explain all the inter-stage buffers of a super scalar processor. [3]

   c) What do you understand by dynamic pipeline? Explain its operation with diagram. What happens if completion order or dispatch order of program is not same. [5]

   d) What is hardware fault tolerance system? Explain one hardware fault tolerance system using block diagram. [4]

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CSE-2205: Introduction to Mechatronics

Full Marks: 60 **Time: 2.5 hours**

Answer any **four (4)** of the following questions:

1. a) How has the term "Mechatronics" been formulated? With the help of a diagram show the Mechatronics design process. 5

   b) Write down the properties of super node and super mesh. How does an LED work? Explain with a suitable diagram. 4

   c) Write down the properties of an Op Amp and show the pin configuration with the help of a diagram. 3

   d) Using an ideal Op Amp used in the circuit of the Fig.1, calculate the closed-loop gain v_o/v_s. Find i_0 when $v_s = 3$ V. 3

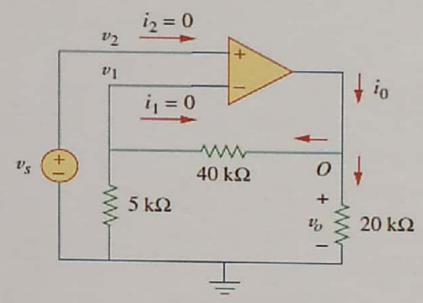

Fig.1.

2. a) What do you mean by Mechanics and Static analysis? 2

   b) As shown in Fig.2, the angle between a vertical boom AB and guy wire AC is 25°. If the tension in AC is 400 N, calculate: 5
   i). *x, y, and z components of the force exerted on the vertical boom at point B.*
   ii). The angles *θx, θy, and θz.*

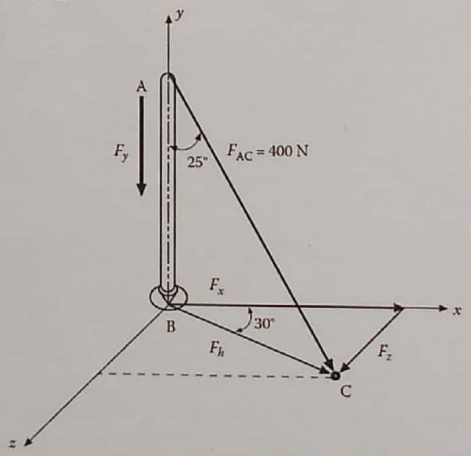

Fig.2

   c) In the engine system shown in Fig.3, determine the velocity of the piston and the angular velocity of connecting rod AB. Assume that when crank angle α = 30°, crank arm CB rotates at 2500 rpm. 8

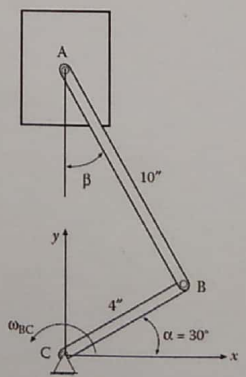

Fig.3

3. a) Show the functional elements of a measurement system with a suitable diagram and write down the functions of them. 3

b) How does the error and uncertainties occur in a measurement system? How these can be reduced? 4

c) Differentiate between closed loop and open loop systems. Write down one advantage of each systems. 2

d) Considering the RC circuit shown in Fig.4, write down the equations for i, e_o and transfer them into Laplace equations with initial zero condition and make block diagrams for the mentioned equations. 6

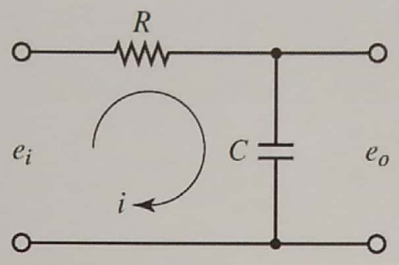

Fig.4

4. a) How does a sensor sense? Show the components of a sensor with a suitable diagram and explain their functions. 3

b) Explain the working principle of a strain-gauge based force/torque sensor. 6

c) Consider the force measurement using a strain gauge on a shaft under compression (Fig.5). Let us consider that the shaft material is steel. The elastic Young's modulus $E = 2 \cdot 108$ kN/m^2, and cross-sectional area of the shaft is $A = 10.0$ cm^2. We have a strain gauge bonded on the shaft in the direction of the tension. The nominal resistance of the strain gauge is $R_0 = 600\Omega$, the gauge factor is $G = 2.0$. The other three legs of the Wheatstone bridge also have constant resistances of $R_2 = R_3 = R_4 = 600\Omega$. The reference voltage for the Wheatstone bridge is 10.0 VDC. If the output voltage measured $V_{out} = 2.0$ mV, what is the force? 6

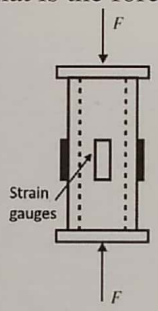

Fig.5

5. a) What are the functions of drives and actuators? 2

b) Explain the components of an actuation system. 5

c) Classify the actuation system with examples. 6

d) What do you mean by servo mechanism? 2

6. a) What is PLC? In a block diagram, show the devices that a PLC interacts with. 4

b) Construct a ladder diagram with a master control relay for the following sequence of operations: 5

i. By pressing start push button switch, a motor starts rotating.
ii. Motor continues to rotate unless stop push button is pressed.
iii. After pressing stop button, the motor turns off and an indicator light turns on to show that the motor is not rotating.
iv. The light remains on unless start button is pressed.

c) Explain following data handlings in PLC: i) data movement ii) data comparison, iii) arithmetic operations. 3

d) Explain the functions of the following registers in microprocessor: i) status register, ii) program counter register, iii) memory address register, iv) stack pointer register. 3