University of Dhaka
Department of Computer Science and Engineering
2nd Year 2nd Semester B. Sc. Final Examination 2021
CSE 2201: Database Management Systems-I

Total Marks: 70 Time: 3 Hours

[Answer any Five (5) of the following Questions]

1. a) Suppose you are going to design a database from scratch for a school management system. What are the major steps you need to take? Briefly explain each of them. 4

   b) Explain the difference between two-tier and three-tier application architectures. Which is better suited for web applications? Why? 4

   c) What are the Data Definition Language (DDL) and Data Modification Language (DML) in the context of Structured Query Language (SQL)? 3

   d) Mention the major roles of a database administrator (DBA). 3

2. a) Mention how the following relational operations deal with null values: 2
   i) select, and ii) aggregate.

   b) Write relational algebra operators for the following queries. The schemas to consider are from a bank: 3x3=9

   branch (branch_name, branch_city, assets)
   account (account_number, branch_name, balance)
   customer (customer_id, customer_name, customer_street, customer_city)
   loan (loan_number, branch_name, amount)
   depositor (customer_id, account_number)
   borrower (customer_id, loan_number)

   i) Find all customers who have both a loan and an account at the bank.
   ii) Find the names of all branches with customers who have an account in the bank and who live in Rajshahi.
   iii) Find the accounts with balances over 50,000 taka receive 6 percent profit, whereas all others receive 5 percent.

   c) Explain the differences between join and outer join with a real-world example. 3

3. a) Outer join expressions can be computed in SQL without using the SQL **outer join** operation. To illustrate this fact, show how to rewrite each of the following SQL queries without using the **outer join** expression based on the schemas: 3

   Student (ID, name, dept_name, tot_cred)
   Takes (ID, course_id, sec_id, semester, year, grade)

   i) **select * from** *student* **natural left outer join** *takes*
   ii) **select * from** *student* **natural full outer join** *takes*

   b) Consider a view *v* whose definition references only relation *r*. 3
   i) If a user is granted **select** authorization on *v*, does that user need to have **select** authorization on *r* as well? Why or why not?
   ii) If a user is granted **update** authorization on *v*, does that user need to have **update** authorization on *r* as well? Why or why not?
   iii) Give an example of an **insert** operation on a view *v* to add a tuple *t* that is not visible in the result of **select * from** *v*. Explain your answer.

   c) What is a trigger? Mention an example of using a trigger. 2

   d) Describe the circumstances in which you would choose to use embedded SQL rather than SQL alone or only a general-purpose programming language. 3

   e) Differentiate between embedded SQL and dynamic SQL. 3

4. You have to create a *family* database of your own. It includes your parents and your siblings (brothers/sisters). It will extend up to your maternal/paternal uncle/aunt and their children (your cousins). The database will include educational information related to institutions (school/college/university) as well as degree levels at secondary, higher-secondary, graduate and post-graduate for all the persons residing in the database. The database does not limited to the said domain but you can assume more parameters and make the database richer. It is expected that your database should include composite, multivalued, derived, descriptive attributes and also weak entity set.

a) Create Entity-Relationship diagram explicitly mentioning the primary key, foreign key, mapping cardinality and participation constraints. 7

b) Convert the E-R diagram created in 4(a) to schema diagram. 4

c) Do you think your design is a good one? Explain why? 3

5. a) What is a weak entity set? How can its "weakness" be removed? 3

b) Explain with an example the distinctions among the terms *primary key*, *candidate key*, and *superkey*. 3

c) Consider two entity sets A and B that both have the attribute X (among others whose names are not relevant to this question).

i) If the two Xs are completely unrelated, how should the design be improved? 1

ii) If the two Xs represent the same property and it is one that applies both to A and to B, how should the design be improved? Consider three subcases: 3

- X is the primary key for A but not B
- X is the primary key for both A and B
- X is not the primary key for A nor for B

d) Design a generalization–specialization hierarchy for a motor vehicle sales company. The company sells motorcycles, passenger cars, vans, and buses. Justify your placement of attributes at each level of the hierarchy. Explain why they should not be placed at a higher or lower level. 4

6. a) 'r **satisfies** F' or 'F **holds on** R' – which one is desirable in designing a database and explain why, where r (relation instance), R (relation schema) and F (set of functional depencies) carry usual meaning. 3

b) Use Armstrong's axioms to prove the soundness of the union, decomposition and pseudotransitivity rules. 3

c) Compare BCNF and 3NF including relative advantages and disadvantages. 3

d) Show that every schema consisting of exactly two attributes must be in BCNF regardless of the given set F of functional dependencies. 2

e) List the three design goals for relational databases, and explain why each is desirable. 3

7. Consider a schema $R = (A, B, C, D, E)$ and set of functional dependencies $F=\{A \rightarrow BC, CD \rightarrow E, B \rightarrow D, E \rightarrow A\}$ holds on R.

a) Find the candidate key/s for R. 3

b) Is R in 3NF? Explain why? 2

c) Show whether a functional dependency $BC \rightarrow DE$ is in F^+. 1

d) Give a lossless join decomposition into BCNF of schema R. Is the decomposition dependency preserving? Explain. 3

e) Find a nontrivial functional dependency containing no extraneous attributes that is logically implied by the above four dependencies and explain how you found it. 1

f) Find canonical cover, F_C for given F. Why you might get a different set of FDs as canonical cover? 3+1=4

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2nd Year 2nd Semester B.Sc. Final Examination 2021
CSE-2202: Design and Analysis of Algorithms – I

Total Marks: 70 **Time: 3 Hours**

[Answer any Five (5) of the seven following Questions]

1. a. It is apparent that the substitution method can provide a succinct proof that a solution to a recurrence is correct. However, we might have trouble coming up with a good guess to effectively use that method. To find a way around, let's construct a solution for the following recurrence relation using the recursion tree method: [4+4]

$$T(n) = 4T\left(\frac{n}{2}\right) + n^2$$

Now, utilize **your solution** to determine a tight asymptotic **lower bound (Ω)** for the above recurrence relation using the substitution method.

b. The master method provides a cookbook method for solving all the recurrences of the following form: [2+4]

$$T(n) = aT(n/b) + f(n)$$

where $a \geq 1$ *and* $b > 1$ are constants and $f(n)$ is an asymptotically positive function.

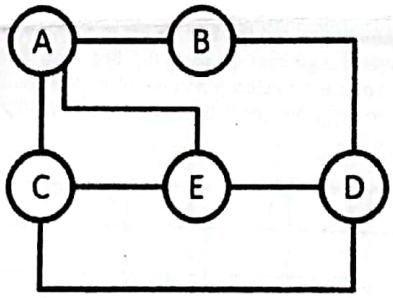
Is the aforementioned assertion true and sufficient? Defend your position.

Now, use the master method to give tight asymptotic bounds for the following recurrences:

I. $T(n) = 4T\left(\frac{n}{2}\right) + \frac{n^2}{lgn}$

II. $T(n) = 7T\left(\frac{n}{3}\right) + n^2$

2. a. [5+3]



I. Show all the steps of an algorithm capable of finding articulation points in the above undirected graph G (V, E) having upper bound time complexity of $V + E$ (i.e. $O(V + E)$. Note that, you must start traversing with the following sequence A, C, E, and so on.

II. Explain how the function low()'s relation with discovery time facilitates the determination of a graph's articulation points. How can this relation be modified to locate the bridges of a graph? Do we need to handle the root differently when locating articulation points and bridges, defend your stance?

b. Let's consider a weighted graph G (V, E). In which situation, the time complexity of Johnson's algorithm becomes the same as the Floyd Warshall's algorithm? Also, in which condition, the algorithm performs much better than Floyd Warshall's algorithm. Why would Johnson's algorithm need to use Bellman-Ford Algorithm, and how many times it calls Bellman-Ford to achieve this. Finally, how many time the Dijkstra algorithm is called. Discuss all the above to finally generate the time complexity of Johnson's algorithm. [6]

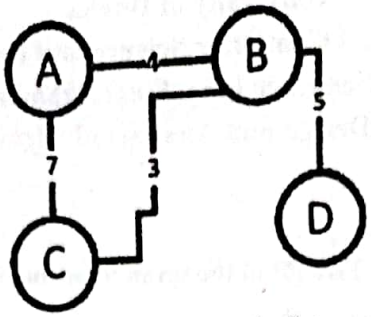
3. a. I. "Given a weighted graph in which the weights of all edges are distinct (no two edges have identical weights), there is always a unique shortest path from source to destination." – Is this assertion accurate in context of the Dijkstra algorithm? Use a small graph with three nodes and three edges to demonstrate the relevance of your claim. [4+2+2]

II. "The data structure Fibonacci Heap is used implement Bellman-Ford algorithm to run in linear time." – is this statement correct?

III. What are the primary advantages of Bellman-Ford versus Dijkstra with regard to applicability?

[6]

b.



Using Floyd-Warshall Algorithm, find the shortest path distance between every pair of vertices. You need to show all the steps of the algorithm. Is Floyd-Warshall Algorithm applicable to an undirected graph with positive cycle(s)?

4. a. Any DP algorithm can be implemented with either Bottom-up (also known as tabulation) or Top-down (also known as memoization) method. A bottom-up implementation's runtime is usually faster, as iteration does not have the overhead that recursion does. [5]

I. If we are to convert a top-down dynamic programming solution into a bottom-up dynamic programming solution, what change(s), if any, do we need to make in the base case(s) and the recurrence relation?

II. Apart from what you mentioned in Question 4a(i), do you have to perform any mandatory task(s) if we are to convert a top-down dynamic programming solution into a bottom-up dynamic programming solution?

b. [9]

Item	Weight	Value
1	3	2
2	4	3
3	6	1
4	5	4

Given the aforementioned information and the 8kg weight of a bag, you need to use a bottom-up (tabular) dynamic programming algorithm to pack the bag with things whose overall value maximizes profit. Note that you cannot select a portion of an item. Initially, write the recurrence relation that will be used to populate the table. The first few steps are provided for your convenience.

	0	1	2	3	4	5	6	7	8
0	0	0	0	0	0	0	0	0	0
1	0	0	0	2	2	2	2	2	2
2	0	0	0	2	3	3	3	5	5
3	0								
4	0								

Does your solution maintain the so-called overlapping subproblems property? Defend your position, and you need to specifically state what the intuition of this property is in this context.

[6]

5 a. Consider the adjacency matrix of the weighted undirected graph, G. Run Kruskal 's algorithm to find the Minimum Spanning Tree. [6]

	A	B	C	D	E	F
A	--	13	7	--	--	--
B	13	--	13	--	11	--
C	7	13	--	17	--	--
D	--	--	17	--	13	7
E	--	11	--	13	7	11
F	--	--	--	7	11	--

b. Assume we have a chain or series made up of the four matrices A, B, C and D. Find the smallest number of scalar multiplications necessary to parenthesize them by using the matrix chain multiplication algorithm. The following figure can help you get a sense of their dimensions. [8]

$$_{10}\mathbf{A}_{15}\,\mathbf{B}_{5}\,\mathbf{C}_{6}\,\mathbf{D}_{8}$$

6. a. Algorithms for optimization problems typically go through a sequence of steps, with a set of choices at each step. For many optimization problems, using dynamic programming to determine the best choices is overkill; simpler, more efficient algorithms will do. A greedy algorithm always makes the choice that looks best at the moment. That is, it makes a locally optimal choice in the hope that this choice will lead to a globally optimal solution. [4]

Discuss the two most important constraints required for a greedy algorithm to be used to solve an optimization problem.

b. Following is a table reporting the start (s_i) and finish times (f_i) of each task i. Use any greedy algorithm maintaining the constraints discussed in Question 6 (a) to find the maximum number of activities that can be completed. Finally, write a formal pseudo-code that corresponds to the simulation you just completed. [10]

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

7. a. Assume that Nameera (N) and Ruzain (R) must share two types of chocolates (Dairy milk (D) and KitKat (K)) among them. Nameera, the older sister, desires two Dairy milk and two KitKat, whereas Ruzain desires one of each type. While their mother has five pieces of Dairy Milk and five pieces of KitKat, only Nameera is permitted to consume no more than three chocolates. On the contrary, she had no objection to Ruzain taking two chocolates. [3+7]

I. Design a flow diagram considering the above scenario. Can we consider the flow diagram as an extended bipartite matching problem?

II, To distribute the chocolates among the siblings, use the Edmonds-Karp algorithm or the Ford-Fulkerson algorithm. None of the restrictions outlined in the aforementioned story may be compromised. You must show all the steps of your chosen algorithm, along with residual networks for each step.

b. Consider the two strings A ="disco" and B="dancer". Find the longest common subsequence of A and B. [4]

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2nd Year 2nd Semester Final Examination, 2021
CSE-2203: Data and Telecommunications

Time: 3 Hours

Full Marks: 70

Answer any of the following five questions

1 a What are the phase shifts for the following? 3
   i) A sine wave with maximum amplitude at time zero
   ii) A sine wave with maximum amplitude after ¼ cycle
   iii) A sine wave with zero amplitude after ¼ cycle and increasing

b What is the bandwidth of a signal that can be decomposed into five sine waves with frequencies at 0, 20, 50, 100, and 200 Hz? All peak amplitudes are the same. Draw the bandwidth. 2

c A computer monitor has a resolution of 1200 by 1000 pixels. If each pixel uses 1024 colors, how many bits are needed to send the complete contents of a screen? 2

d We need to upgrade a channel to a higher bandwidth. Answer the following questions: 4
   i) How is the rate improved if we double the bandwidth?
   ii) How is the rate improved if we double the SNR?

e i) What does the Nyquist theorem have to do with communications? 3
   ii) What does the Shannon capacity have to do with communications?

2 a In a digital transmission, the sender clock is 0.2 percent faster than the receiver clock. How many extra bits per second does the sender send if the data rate is 1Mbps? 2

b We need to send data at a 1-Mbps rate. We have two options: i) a combination of 4B/5B and NRZ-I, and ii) Manchester encoding. Compare and contrast the two options in terms of required bandwidth and DC component. 4

c How do scrambling techniques overcome the baseline wandering problem of AMI encoding? 2

d We have sampled a low-pass signal with a 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

3 a Which characteristics of an analog signal are changed to represent the low pass analog signal in each of the following analog-to-analog conversions? 3
   a) AM
   b) FM
   c) PM

b Which of the three analog-to-analog conversion techniques (AM, FM, PM) is the most susceptible to noise? Defend your answer. 3

c A corporation has a medium with a 1-MHz bandwidth (low pass). The corporation needs to create 10 separate channels each capable of sending at least 10 Mbps. The company has decided to use QAM technology. What is the minimum number of bits per baud for each channel? What is the number of points int eh constellation diagram for each channel? Let d = 0. 4

d Draw the constellation diagram for the following: 4
   i) ASK, with peak amplitude values of 1 and 3
   ii) BPSK, with a peak amplitude value of 2
   iii) QPSK, with a peak amplitude value of 3
   iv) 8-QAM with two different peak amplitude vales, 1 and 3, and four different phases

4 a 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

b Consider a channel with a 1-MHz capacity and an SNR of 63. 3
   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?

c Suppose that a digitized TV picture is to be transmitted from source that uses a matrix of 480x500 picture elements (pixels), where each pixel can take on one of 32 intensity values. Assume that 30 pictures are sent per second. Assume that the TV picture is to be transmitted over channel with 4.5 Mhz bandwidth and a 35 dB signal-to-noise ratio. Find the capacity of the channel (bps)? 3

d 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 1011001) is inserted for each 48 data bits. The reframing algorithm (at the receiving demultiplex) is as follows: 5

1) Arbitrarily select a bit position
2) Consider the block of 7 contiguous bits starting with that position
3) Observe that block of 7 bits each frame for 12 consecutive frames
4) 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?

5 a For $g(x) = 11001$ and $d(x) = 111010011$, find the CRC using long division. 3

b What is the purpose of using modulo 2 arithmetic rather than binary arithmetic in computing FCS? 2

c In CRC, we have chosen the generator 11101010111. What is the probability of detecting a burst error of length 10? 3

d 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 17? Is it a good CRC code? 4

e Calculate the hamming pairwise distances along the following codewords {00100000, 01001001, 11011010, 11000110, 01001000}. How many error bits can be corrected by these codewords 2

6 a Define a frame format in bit-oriented protocol. Show the bit stuffing and unstuffing for the data 000111111111000111110011. Assume that 01111110 is considered as the flag. 3

b How do flow control and error control are achieved in the following protocols? 5

i) Stop-and-Wait ARQ
ii) Go-Back-N ARQ

c Using 4-bit sequence numbers, what is the maximum size of the send and receive windows for each of the following protocols? 6

i) Stop-and-Wait ARQ
ii) Go-Back-N ARQ
iii) Selective-Repeat ARQ

Defend your answer.

7 a i) Why does a circuit-switched network need end-to-end addressing during the setup and teardown phases? Why are there no addresses needed during transfer phases of this type of network? 2 +1 +1

ii) Why does a datagram network need only end-to-end addressing during the data transfer phase.

iii) Why does a virtual-circuit network need addresses during all three phases (setup, data transfer and teardown)?

b We need a three-stage space-division switch with N=100. Answer the following questions using Clos criteria. 2 +2 +1 +1 +1

i) Draw the configuration diagram
ii) Calculate the total number of crosspoints
iii) Find the possible number of simultaneous connections
iv) Find the possible number of simultaneous connections if we use a single crossbar (100x100)
v) Find the blocking factor, the ratio of the number of connections in part iii) and in part iv)

c What is TSI and what is its role in time-division switching? 3

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2nd Year 2nd Semester B.Sc. Final Examination 2021
CSE 2204: Computer Architecture and Organization

Total Marks: 70 **Time: 3 hours**

[Answer any Five (5) of the following Questions]

1. a) Discuss the advantages of 2's Complement code. Show the memory configuration after storing $(2BDE78AF)_{16}$ using the Little Endian Storage method. 1.5+2.5 = 4

   b) Discuss the advantage of a carry lookahead adder over the parallel adder. Discuss the basic idea to achieve this advantage. Write down the carry bits generated by this adder for n=4. 1+3+2 = 6

   c) Suppose W = 10101, X = 11011, and Y = 010100. Discuss the concept of carry save addition using W, X, and Y. 4

2. a) Show the steps needed to calculate Z = X / Y using the non-restoring division algorithm, where X = 13 and Y=3. You should state the operation of each step. 7

   b) Multiply the numbers 23 and -9 using Booth's algorithm, showing each step clearly. 7

3. a) Draw a 1-bit ALU that performs AND, OR, NOR, and the addition of signed numbers. Finally, draw a 32-bit ALU using the above 1-bit ALU that supports **slt** MIPS instruction. You should explain the necessary logic where required. 6

   b) Define normalization and biasing with examples. 3

   c) Why is it required to eliminate the explicit encoding of the next state in an FSM controller? Draw the address select logic of a control unit and explain its operation. 5

4. a) Write the decimal code for the following instructions. You should show the instruction format for each one. 6

   (i) lw $t0, 150 ($t1) [Opcode for lw = 35]

   (ii) bne $s0, $s1, Exit [Opcode for bne = 5, Exit=200]

   (iii) sub $s1, $s2, $s3 [Opcode for sub = 0, funct = 34]

   b) Write the MIPS instructions corresponding to the following C code: 4

```
int i=0, sum=0;

while(i<5)
{
  sum = sum + a[i];
  i++;
}
```

   c) Discuss different MIPS instructions used to handle a function call. 4

5. a) Explain the load use data hazard with appropriate example. Discuss different techniques to handle this hazard. 3+3=6

   b) Consider the sequence of the following instructions that are executed in a pipelined 1.5+2.5+1=5

single-cycle processor:

lw $t0, 10($t1)

sw $t3, 20($t4)

add $t5, $t6, $t7

sub $t8, $t9, $t10

(i) How many clock cycles will be required to complete the execution of this sequence?

(ii) Explain the state of the pipelined processor at clock cycle 4. You have to explain the operation of each instruction in the processor at this clock cycle.

(iii) In what cycle will the calculation of the address of *sw* instruction take place?

c) Draw the architecture of a multi-port register set. Discuss how data is read and write from this register set. 3

6. a) *Briefly explain compulsory miss, capacity and conflict miss. How can each of these misses be reduced?* 5

b) Suppose you need to store 32KB of data in a cache memory where the block size is 4 words. The length of the memory address is 32 bits. Calculate the total number of bits required for (i) direct-mapped cache, (ii) 2-way set associative cache, and (ii) fully associative cache. 9

In each case, explicitly specify the size of the index and tag.

7. a) With suitable diagrams/examples, explain how virtual memory works. 6

b) Why is memory protection needed when using virtual memory? Describe three basic capabilities that the hardware must provide to enable the operating system to implement protection 4

b) What is direct memory access? Why is it used? Discuss its advantages and disadvantages. 4

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CSE 2205: Introduction to Mechatronics

Total Marks: 70 Time: 3 Hours

[Answer any Five (5) of the following Questions]

1. a) Why Mechatronics is called an interdisciplinary field? What are the basic elements of a mechatronics system? 2+2=4
   b) Mention the advantages and disadvantages of a mechatronic system. 5
   c) What is meant by Mechanics? Classify engineering mechanics. 5
2. a) Distinguish among ideal fluid, viscous fluid and Newtonian fluid. 4.5
   b) Define proximity sensor with an application. 3
   c) Distinguish between active and passive transducers. 4
   d) What is meant by thermal conductivity? 2.5
3. a) Describe the structure and working principle of a pneumatic actuator. 8
   b) Distinguish between the hydraulic actuator and pneumatic actuator. 6
4. a) What is a servo motor? Describe the working principle of a servo motor. 7
   b) Mention applications of servo motors 3
   c) Write a short note on PID controller. 4
5. a) Describe the functional elements of a measurement system. 5
   b) What is the function of a summing point in a block diagram of a control system? Explain it with a suitable diagram. 5
   c) Convert the RC circuit as shown in Fig. 5c into a block diagram. 4

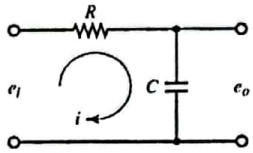

Fig. 5c

6 a) Define PLC. Mention some design and maintenance practices that are critical to a successful implementation of PLC. 4
   b) Consider a drinks machine that allows the selection of tea or coffee or soft drink (Coke or Fanta or Sprite), milk or no milk, sugar or no sugar, and will supply the required drink on the insertion of a coin. Show the ladder logic for this application. 6
   c) Distinguish between on-delay timer and off-delay timer. 4
7 a) What does gear ratio mean? Explain it with a suitable diagram 4
   b) As shown in Fig.7b, the angle between a vertical boom AB and guy wire AC is 25°. If the tension in AC is 400 N, calculate: 6
   i). x, y, and z components of the force exerted on the vertical boom at point B.
   ii). The angles θx, θy, and θz.

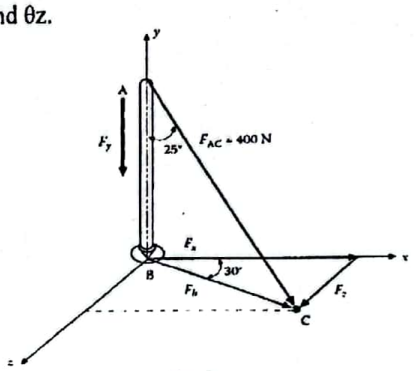

Fig. 7b

   c) Using a flowchart show the steps of dynamic system investigation of a mechatronic system. 4