BAYERO UNIVERSITY, KANO

FACULTY OF COMPUTER SCIENCE AND INFORMATION TECHNOLOGY

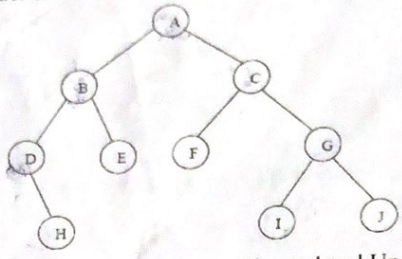
DEPARTMENT OF COMPUTER SCIENCES.

2020/2021 First Semester Examinations

CSC2253/CSC2251/SWE2303 - Data Structures and Algorithms

Instruction: Answer any four (4) questions **Time Allowed**: 2 Hours

1. a. Give the Preorder, Inorder and Postorder traversal sequences of the binary tree below. **(9 marks)**



b. With the aid of a diagram, differentiate between Directed and Undirected Graph **(5 marks)**

c. What is the advantage of implementing a queue in the form of a circular array, instead of a linear array structure? **(3.5 marks)**

2. a. Suppose STACK is allocated N = 6 memory cells and initially STACK is empty, or in other words TOP = 0. Find the output of the following module: **(9 marks)**

i. Set AAA = 2 and BBB = 5

ii. Call PUSH (STACK, AAA)
Call PUSH (STACK, 4)
Call PUSH (STACK, BBB + 2)
Call PUSH (STACK, 9)
Call PUSH (STACK, (AAA + BBB) * 2)

iii. Repeat while TOP != 0:
Call POP (STACK, ITEM)
Write: ITEM
[End of loop]

iv. Return

b. Using a linked list add the following polynomials: **(6 marks)**

$10x^5 + 5x^4 + x^3 + 3x^2$ and $9x^6 + 6x^4 + 2x^3 + 3x^2 + 3x$

c. How does the implementation of a linked list differ from that of linked queue? **(1.5 marks)**

3. a. Consider the following queue where QUEUE is allocated 8 memory cells: **(9 marks)**

Front = 2 Rear = 5 QUEUE = __, __, London, Berlin, Rome, Paris, __, __.

Describe the queue, including Front and Rear as the following operations take place

i. Athens is added
ii. Two cities are deleted
iii. Madrid is added
iv. Moscow is added
v. Three cities are deleted
vi. Oslo is added

b. Consider the linear array AAA= [5:50]. Suppose Base(AAA) = 300 and w = 4 words per memory cell for AAA. Find the address of: **(6 marks)**

i. AAA[15] ii. AAA[35] iii. AAA[55]

c. Suppose we have an array implementation of a stack, with ten items in the stack stored at data[0] through data[10]. The CAPACITY is 20. Where does the push member function places the new entry in the array? **(2.5 marks)**

30th November 2022

4. a. You have to apply linear search for an element in array containing 5000 elements. If at the end of the search, you find that the element is not present in the array, how many number of comparisons would you have made to search the required element in the given list? **(2 marks)**

b. Convert the Expression **(A+ B) * C + D/(E + F * G) – H + (I ^ (J * K))** from infix to postfix. **(10 marks)**

c. Draw the binary tree corresponding to the following algebraic expressions: **(5.5 marks)**

$$(2a+5b)^3(x-7y)^4$$

5. a. Consider the following sorted linear array. Find the element '15' using binary search algorithm:

3	10	15	20	35	40	60
a[0]	a[1]	a[2]	a[3]	a[4]	a[5]	a[6]

(5 marks)

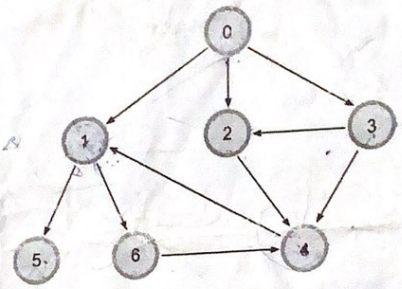
b. Construct the binary tree with the following traversal sequences: **(10 marks)**

Pre-order: 1, 2, 4, 8, 9, 10, 11, 5, 3, 6, 7

In-order: 8, 4, 10, 9, 11, 2, 5, 1, 6, 3, 7

c. Write down the algorithm for Bubble Sort. **(2.5 marks)**

6. Use the graph below to answer question 6a, 6b and 6c:



a. Traverse the graph using Depth First Search Traversal (starting vertex = 0) **(9 marks)**

b. What is the adjacency matrix representation of the graph? **(4.5 marks)**

c. What is the adjacency list representation of the graph? **(4 marks)**

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2020/2021 First Semester Examinations

CSC2253/CSC2251/SWE2303 - (Data Structures and Algorithms)

Instruction: Answer Any Four (4) Questions Time Allowed: 2 Hours

1) a) Consider the general Tree T in Figure 1. Find the corresponding binary tree T'. **(6 marks)**

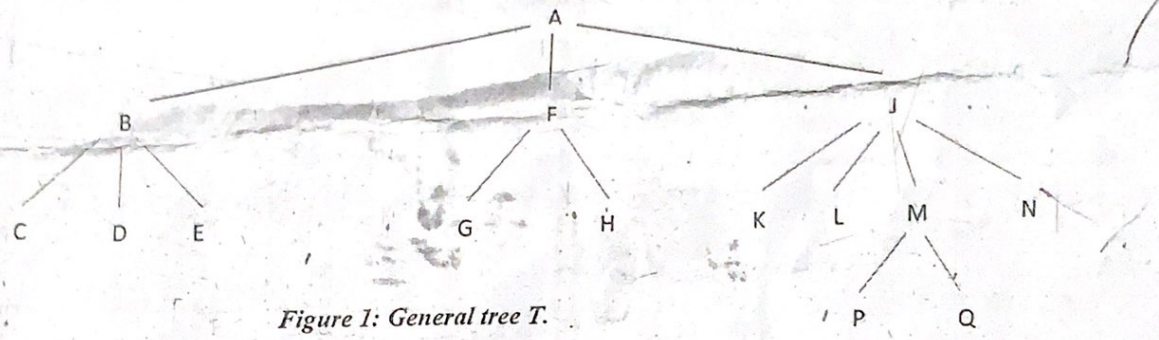

Figure 1: General tree T.

b) Traverse the above general tree T in:

(i) Preorder (ii) Post-order **(6 marks)**

c) Give the In-order algorithm for traversing a binary tree T. **(5.5 marks)**

2) a) Suppose the following sequences list the nodes of a binary tree T in preorder and in-order, respectively:

Pre-order: G,B,Q,A,C,K,F,P,D,E,R,H

In-order: Q,B,K,C,F,A,G,P,E,D,H,R

Draw the diagram of the tree. **(5.5 marks)**

b) Draw the binary tree corresponding to each of the following algebraic expressions:

i) $E_1 = (a-3b)(2x-y)^3$ **(4 marks)**

ii) $E_2 = (2a+5b)^3(x-7y)^4$ **(4 marks)**

c) Give the pre-order traversal of each of the trees. **(4 marks)**

3) a) Consider the graph G in figure 2.

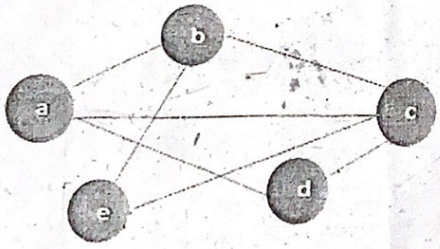

Figure 2: Graph G

i) Describe G formally in terms of its set V of nodes and its set E of edges. **(2.5 marks)**

ii) Find the degree of each node. **(5 marks)**

b) i) Give the breadth-first search algorithm for traversing a graph. **(3 marks)**

ii) Use the algorithm to traverse the above graph. **(3 marks)**

c) What is the adjacency matrix representation of the graph in figure 2? **(4 marks)**

4) a) An automobile company uses an array SIMPLE to record the number of automobile sold each year from 1956 through 2010. What is the length of this array? **(4 marks)**

b) ABC +* CBA-+* is a postfix expression with the assumption A = 2, B = 3, and C = 4. If the above postfix expression is evaluated, the final stack value is? **(7 marks)**

c) Show that {({{{(A+B)-(CxD)}}}} is a valid expression. **(6.5 marks)**

5) a) Consider the following queue which can be allocated eight integers and five operations.

front = 3 rear = 6 Queue = - , - , 2 , 4 ,5, - , - , -

(for notational convenience " – " used to denote an empty cell)

The following operations have to be performed.

(i) 6 is added to the queue.
(ii) Two elements are deleted from the queue.
(iii) 10 and 12 are added to the queue.
(iv) Two elements are deleted from the queue.
(v) 2 and 3 are added to the queue.

What are the final front and rear values when the above operations are performed into a circular queue? **(10 marks)**

(Show the state of the stack after each operation)

b) Explain any two (2) advantages of a link list. **(2 marks)**

c) With the aid of diagrams, differentiate between Linked List and Stack **(5.5 marks)**

6) a) Convert the Expression **(A+ B) * C + D/(E + F * G) – H + (I ^ (J * K))** from infix to postfix. **(10 marks)**

b) I have implemented queue with a linked list, keeping track of a front pointer and a rear pointer. Use example to show that both pointers will change during insertion into the EMPTY queue. **(4 marks)**

c) Write an algorithm for inserting a node between two nodes in a singly linked list. **(3.5 marks)**

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FACULTY OF COMPUTER SCIENCES AND INFORMATION TECHNOLOGY
DEPARTMENT OF COMPUTER SCIENCE
CSC2323- Discrete Structures Test

Instruction: Answer all questions Time Allowed: 35 Minutes Type A

1. Use **Gauss-Jordan Method** to solve the following system of linear equation

$$3x_1 + 3x_2 + 4x_3 = 1$$
$$2x_1 + 4x_2 - 2x_3 = 2$$
$$2x_1 + x_2 + 4x_3 = 2$$

2. Show that the product of two odd integers is odd whereas the product of two integers is even if either of the integers is even
3. Using Euclidean Algorithm, find the greatest common divisor of 1491 and 2331

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FACULTY OF COMPUTER SCIENCE AND INFORMATION TECHNOLOGY
DEPARTMENT OF COMPUTER SCIENCES
2018/2019 First Semester Examination
CSC2321- Discrete Mathematics

Instruction: answer any five (5) questions Time Allowed: 3HRS

1. a. Check the validity of the following arguments

   i. $p \rightarrow (q \vee r)$
   $\neg q \wedge \neg r$
   $p \vee r$
   $\therefore p \wedge q \wedge r$

   ii. $\neg r$
   $p \rightarrow q$
   $q \rightarrow r$
   $p \wedge r$
   $\therefore \neg p$

   b. Verify the following logical equivalence using truth table

   $$\neg p \wedge (q \vee \neg r) \equiv (\neg p \wedge q) \vee \neg(p \vee r)$$

2. a. Prove that $4^n + 6n - 1$ is divisible by 3 for all $n \in N$

   b. Show that $1 + 2^3 + 3^3 + \cdots + n^3 = (1 + 2 + 3 + \ldots + n)^2$ for all $n \in N$

3. a. Test the validity of the following argument:

   If I study, then I will not fail mathematics.

   If I do not play basketball, then I will study.

   But I failed mathematics.

   ∴ Therefore, I must have played basketball

   b. Check whether each of these is a tautology, a contradiction or neither

   i. $(\neg p \wedge r) \vee (r \vee \neg p)$
   ii. $(p \vee r) \wedge (\neg p \vee \neg r)$
   iii. $(r \vee p) \vee (\neg p \wedge \neg r)$

4. a. Consider the **Z** of integers and an integer $m > 1$. We say that x is congruent to y $modulo$ m, written

   $$x \equiv y \pmod m$$

   if $x - y$ is divisible by m. Show that this defines an equivalence relation on **Z**

   b. Let A be the set {1,2,3,4,5}, Let the following relations be on the set A. List the pairs that are in each of the relations

   i. $R1 = \{(a, b) | a \leq b\}$
   ii. $R2 = \{(a, b) | a = b + 1\}$
   iii. $R3 = \{(a, b) | a + b \leq 6\}$

5. (a) Let $A = \begin{bmatrix} -2 & 4 \\ 0 & 3 \end{bmatrix}$ and $B = \begin{bmatrix} -6 & 2 \\ 4 & 0 \end{bmatrix}$. Find each value.

(i) $-4A + 5B$ (ii) $7A^T - 3B^T$ (iii) $2B - 2A^T - 4B^T$

(b) Let $A = \begin{bmatrix} -2 & 4 \\ 1 & 3 \end{bmatrix}$, $B = \begin{bmatrix} -2 & 1 \\ 3 & 6 \end{bmatrix}$ and $C = \begin{bmatrix} 1 & 3 & 5 & 2 \\ -2 & 4 & -1 & 0 \end{bmatrix}$.

(i) Find AB. (ii) Find BA. (iii) Find $AC - BC$ (iv) Find $C^TA + C^TB$

6. (a) Find the inverse, if it exists, for each matrix.

(i) $\begin{bmatrix} 1 & 1 \\ 2 & 3 \end{bmatrix}$ (ii) $\begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 1 & 0 & 1 \end{bmatrix}$ (iii) $\begin{bmatrix} 1 & 3 & -2 \\ 2 & 7 & -3 \\ 3 & 8 & -5 \end{bmatrix}$

(b) Solve the following systems of equation.

(i)
$$\begin{aligned} x + y + 2z &= -1 \\ 2x + 2y + 2z &= 2 \\ \frac{3}{5}x + \frac{3}{5}y + \frac{3}{5}z &= \frac{2}{5} \end{aligned}$$

(ii)
$$\begin{aligned} x - 2y + z - 4w &= 1 \\ x + 3y + 7z + 2w &= 2 \\ 2x + y + 8z - 2w &= 3 \end{aligned}$$

7. Use Gauss-Jordan row reduction to solve the given systems of equation

(a)
$$\begin{aligned} x - y + z - u + v &= 1 \\ y + z + u + v &= 2 \\ z - u + v &= 1 \\ u + v &= 1 \\ v &= 1 \end{aligned}$$

(b)
$$\begin{aligned} x - y + z - u + v &= 0 \\ y - z + u - v &= -2 \\ x - 2v &= -2 \\ 2x - y + z - u - 3v &= -2 \\ 4x - y + z - u - 7v &= -6 \end{aligned}$$

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FACULTY OF COMPUTER SCIENCE AND INFORMATION TECHNOLOGY

DEPARTMENT OF COMPUTER SCIENCE

2020/2021 First Semester Examinations

CSC2323/CSC2321 - Discrete Structures

Instruction: Answer any five (5) questions **Time Allowed: 3 Hours**

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1. a. Check the validity of the following argument

$$p \rightarrow (q \vee r)$$
$$\neg q \wedge \neg r$$
$$\therefore \neg p$$

b. Verify the following logical equivalence using truth table

$$\neg p \wedge (q \vee \neg r) \equiv (\neg p \wedge q) \vee \neg(p \vee r)$$

2 a. Prove by induction that $4^n + 6n - 1$ is divisible by 3 for all $n \in N$

b. Prove the following by induction

$$\sum_{i=1}^{n} \left(\frac{1}{i*(i+1)}\right) = \frac{n}{n+1}$$

3. a. Test the validity of the following argument:

If I study, then I will pass mathematics.

If I do not play basketball, then I will study.

But I failed mathematics.

∴ Therefore, I must have played basketball

b. Check whether each of these is a tautology, a contradiction or neither

i. $(\neg p \wedge r) \vee (r \vee \neg p)$

ii. $(p \vee r) \wedge (\neg p \vee \neg r)$

iii. $(r \vee p) \vee (\neg p \wedge \neg r)$

4. a. Consider the following matrices

$$B = \begin{matrix} 5 & 0 \\ 7 & -1 \end{matrix}$$

$$C = \begin{matrix} 1 & -3 \\ 4 & 2 \\ 6 & -5 \end{matrix}$$

$$D = \begin{matrix} 3 & -1 & -8 \\ 7 & 4 & 9 \end{matrix}$$

Find

i. $2C - (3D)^T$

ii. $BD - C^T$

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b. Find the Determinant of the matrix below

$$A = \begin{matrix} 1 & 3 & 0 \\ 2 & 7 & -3 \\ 3 & 0 & -5 \end{matrix}$$

5. a. Check whether the following matrix is a singular matrix or not

$$Z = \begin{matrix} 1 & 0 & 2 \\ 3 & 4 & -2 \\ 2 & 1 & 3 \end{matrix}$$

b. Use **Gaussian Elimination Method** to solve the following system of linear equations

$$x_1 + x_2 - x_3 = 7$$

$$x_1 - x_2 + 2x_3 = 3$$

$$2x_1 + x_2 + x_3 = 9$$

6. a. Show that ***congruences modulo m*** is an equivalence relation

b. Use the Sieve of Eratosthenes to find the list of all the prime numbers between 50 and 150

7. a. Using Euclidean Algorithm, find the greatest common divisor of the following

i. **270** and **192**

ii. **1424** and **3084**

b. Write the gcd in (ai) as a linear combination of its respective integers

23rd November 2022

TARGET

BAYERO UNIVERSITY, KANO
FACULTY OF COMPUTER SCIENCES AND INFORMATION TECHNOLOGY
DEPARTMENT OF COMPUTER SCIENCE
CSC2323- Discrete Structures Test

Instruction: Answer all questions Time Allowed: 35 Minutes Type B

1. Use **Gauss-Jordan Method** to solve the following system of linear equation

$$3x_1 + x_2 + 4x_3 = 7$$
$$2x_1 - 3x_2 + x_3 = -8$$
$$3x_1 + 3x_2 - 6x_3 = 3$$

2. Show that the product of two odd integers is odd whereas the product of two integers is even if either of the integers is even
3. Using Euclidean Algorithm, find the greatest common divisor of 149 and 233

BAYERO UNIVERSITY, KANO
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DEPARTMENT OF INFORMATION TECHNOLOGY
2018/2019 Academic Session - First Semester Examinations
ITC2321, CBS2321 & SWE2302: Discrete Structure

Instructions: *Attempt Five (5) Questions* Time Allowed: *3 Hours*

1. a) If a | b and a | c, then show that a | b ± c *(∀ a, b, c ∈ ℤ)*. [4 Marks]
   b) A Division Algorithm state that: Given any integers *a* and *b* with $b \neq 0$, there exist unique integers *q* (*"quotient"*) and *r* (*"remainder"*) such that $0 \leq r < |b|$ and $a = bq + r$.
   Use the above Algorithm to compute the greatest common divisor *gcd(206, 73)*. [6 Marks]
   c) State and prove DeMorgan s Laws. [4 Marks]

2. a) The of Law of syllogism state that: $[(P \rightarrow Q) \wedge (Q \rightarrow R)] \rightarrow (P \rightarrow R)$, show that the law is always true. [4 Marks]
   b) Show that $P \vee (Q \wedge R)$ and $(P \vee Q) \wedge (P \vee R)$ are logically equivalent. [4 Marks]
   c) Construct a truth table for $(\sim Q \wedge \sim R) \leftrightarrow (\sim P \rightarrow (Q \vee R))$. [5 Marks]

3. a) Show that the square matrix $B = \begin{pmatrix} 3 & 2 & 4 \\ 1 & 5 & 3 \\ -1 & 8 & 2 \end{pmatrix}$ is a singular matrix. [4 Marks]

   b) If $A = \begin{pmatrix} -2 & 3 & 1 \\ -3 & 2 & 0 \\ -2 & 1 & 2 \end{pmatrix}$ and $B = \begin{pmatrix} -1 & 0 & 3 \\ 3 & 2 & 1 \\ 1 & 3 & 0 \end{pmatrix}$
   i. Find $A*B$ [5 Marks]
   ii. Find $A^{T}*B$ [5 Marks]

4. a) If $A = \begin{pmatrix} 2 & -1 & 1 \\ 3 & -2 & 2 \\ 4 & 2 & -1 \end{pmatrix}$. Find A^{-1} and $A*A^{-1}$ [8 Marks]
   b) Solve the below set of linear equations by a matrix method.
   $x_1 + x_2 + x_3 = 2$
   $2x_1 - x_2 + 3x_3 = -3$
   $3x_1 + 2x_2 + 4x_3 = 3$ [6 Marks]

5. a) If $B = \begin{pmatrix} 1 & -5 & 3 \\ 3 & 4 & -2 \\ 0 & -1 & 2 \end{pmatrix}$ find *adj B* [5 Marks]

   b) For the following set of simultaneous equations.
   $x_1 + 3x_2 + 2x_3 = 3$
   $2x_1 - x_2 - 3x_3 = -8$
   $5x_1 + 2x_2 + x_3 = 9$
   i) Form the augmented coefficient matrix. [2 Marks]
   ii) Solve the set of equations by Gaussian elimination. [7 Marks]

6. a) For $a, b \in \mathbb{R}$ define $a \simeq b$ to mean $a - b \in \mathbb{Z}$. Prove that the $\simeq$ is an equivalence relation on $\mathbb{R}$. [5 Marks]

b) Prove that the congruence modulo n is an equivalence relation on $\mathbb{Z}$. [5 Marks]

c) Find all integers x such that $7x \equiv 2x \pmod 8$. [4 Marks]

7. a) Use the Principle of Induction to prove the following results.

i. $\sum_{j=1}^{n} j^3 = \frac{n^2(n+1)^2}{4}$ [5 Marks]

ii. $\sum_{i=1}^{n} x^i = \frac{1-x^{n+1}}{1-x}$ *(for $x \neq 1$ and integers $n \geq 0$)* [5 Marks]

b) Express the following in summation notation.

i. $1 + 6 + 27 + 126 + 626$. [4 Marks]