University of Dhaka

Department of Computer Science and Engineering

2nd Year 1st Semester B. Sc. First Semester Final Examination, 2021

CSE 2101: Data Structures and Algorithm

Full Marks: 70

Time: 3 Hours

Answer any 5 five of the following questions

1. a) We all know the basic design of a backpack. What kind of data structure is this backpack? What operations does it support? What are the complexities of those operations? 5

   b) An n-square matrix array A is said to be symmetric if $A[j, k] = A[k, j]$ for all j and k. Suppose A and B are two n-square symmetric matrices. Describe an efficient way of storing A and B in memory. 5

   c) Distinguish among O, Ω and Θ-notation. Order the following terms in ascending order O(n), O(100), O(n logn), O(log n), $O(n^2)$. 4

2. a) Consider a circular queue as shown in Figure: 1. Demonstrate the following operations. 5

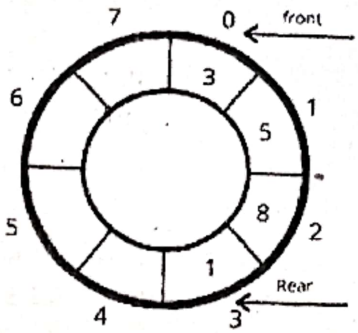


Figure: 1.

Step1: dequeue(), dequeue()

Step2: enqueue(45), enqueue(55), enque(65), enqueue(75)

Step3: enqueue(85), enque(95), enque(105)

You have to show the resultant queue as well as the value of two pointers – Front and Rear after completion of each step.

   b) Consider a case of linear queue. Suppose the rear pointer is increased by one before each enqueue operation and the front pointer is increased by one after each dequeue operation. Show an example that claims the queue is full but still there is space? How to solve it in linear queue? 5

   c) Assume that a stack is implemented by a singly linked list. Write down a pseudocode of push and pop operation of the stack. 4

3. a) Write down an iterative algorithm for linear search. Convert the iterative algorithm into a recursive one by answering the following question. 6

   i) Determine the size factor.

   ii) Determine base case(s).

   iii) Determine general case(s) and merge.

   iv) Verify the algorithm (three question method).

   b) Write down an algorithm to find the second largest element of a given singly linked list. 4

   c) Write down a psedocode for Depth First Search (DFS) of a given graph. 4

4. a) Write down a recursive algorithm to construct a binary tree from a given preorder and inorder traversing sequence of the tree. Apply this algorithm to construct binary tree from the given following sequences. 6

   Preorder sequence: A C E H B D G F

b) Write down the algorithms to find the following from a given binary search tree. 6

i) The largest element of the tree

ii) The smallest element of the tree

iii) The inorder successor of a given key of the tree

iv) Sorted list of the keys of the given tree.

c) Mention the advantages and disadvantages of binary search tree over linked list and array. 2

5. a) Consider the following infix mathematical expression.

$$13 - 7 * 3 * (11 - 5 * (23/11) * 7 + 3 * 19)$$

- Convert the infix expression into a postfix expression. Show all the steps. 3
- Evaluate the expression using the generated postfix expression. Show all the steps. 3

b) Suppose that there are only two stacks as a data structure in the land of Dark Algorithms. But you have to solve a very important problem which can only be solved using a queue efficiently. So, you can understand that you have to implement the queue first using stack in order to solve the problem.

- Implement a queue using only stack. 4
- Analyze the time and space complexity of your algorithm. 4

6. a. Construct a binary search tree with the following keys. 5+3

40, 20, 10, 25, 30, 22, 50

Determine the balance factor of each node. Is it an AVL tree? If yes, done. If no, construct the AVL tree with these keys. Please show each of the imbalance and rotation applied to balance it after insertion of each node.

b) An auction is a sales event wherein potential buyers place a competitive price for a particular product. Each price is associated with the buyer name. A buyer may revise his price. Buyer who offered the highest price won the bid. Give an algorithm having sub-quadratic time complexity with suitable data structures to implement an auction. 6

7. a) What is bit mask? Mention the motivation for using bit mask. 3

b) How do you represent set {1, 5} using bit mask? 2

c) What is a masking bit? How do you generate a masking bit? 2

d) Show the following operation using bit mask. 7

i. Add the j-th object to the subset.

ii. Remove the j-th object from the subset.

iii. Check whether the j-th object is in the subset

iv. Turn on all bits in a set of size n.

v. Iterate through all subsets of a set of size n.

University of Dhaka
Department of Computer Science and Engineering
2nd Year, 1st Semester Final Examination, 2021
CSE-2102: Object Oriented Programming

Full Mark: 70 Time: 3 Hours

Answer any 5 (five) from the following questions

1. (a) What do you understand about platform independence of a programming language? How does Java achieve this? 4

(b) Briefly explain the following concepts of Object-Oriented Programming (OOP): abstraction, encapsulation, inheritance, and polymorphism. 4

(c) The following is a typical implementation of stack data structure written in procedural language (C in this case): 6

```
void push (int st[], int tos, int num){
     st[tos] = num;
}
int pop(int st[], int tos){
     return st[tos];
}
main(){
   int stack[5];
   int tos=0;
   push(stack, tos, 45);
   tos++;
   push(stack, tos, 4);
   tos++;
   tos--;
   int item = pop(stack, tos);
   printf("%d", item);
   tos--;
   int item = pop(stack, tos);
   printf("%d", item);
}
```

Rewrite the above code in Java so that the OOP principles are enforced as much as possible.

2. (a) Write down the differences between the four access modes of Java: default case, private, protected, and public. (You do not need to give examples, just answer in text.) 4

(b) Mention three cases where the `final` keyword is used and why. 4

(c) When is a static block of code executed? Write down the output of the following code segment: 2+4

```
class A {
   static int a;
   static int b;

   static {
      System.out.println("a: " + a + ", b: " + b);
```

```
    {
        b++;
        System.out.println("b in block: " + b);
    }
    public A(){
        System.out.println("constructor");
    }
    public static void main(String[] args) {
        System.out.println("Some text.");
        A ob = new A();
        A ob2 = new A();
    }
}
```

3 (a) Consider the following code. Rewrite the code using inheritance and the keyword super. You must write optimal code in terms of OOP principles. You should not use more classes than A, B, C and Demo. 5

```
class C{
  int a, b, c;
  C(int a, int b, int c){
     this.a=a; this.b=b; this.c=c;
  }
}
class B {
  int a, b, c, d, e;
  B(int a, int b, int c, int d, int e){
     this.a=a; this.b=b; this.c=c; this.d= d; this.e=e;
  }
}
class A {
    int a, b, c, d, e, f;
    A(int a, int b, int c, int d, int e, int f){
        this.a=a; this.b=b; this.c=c;
        this.d= d; this.e=e; this.f=f;
    }
}
class Demo {
    public static void main(String[] args) {
        A a = new A(3, 4, 5, 6, 7, 8);
        B b = new B(2, 1, 2, 3, 4);
        C c = new C(4, 5, 2);
    }
}
```

(b) What is the difference between method overloading and method overriding? Explain with appropriate example codes in Java. 6

(c) The same class may create different objects in different ways and under different conditions. OOP languages allow different constructors in a class to create different objects of the same class. Differentiate between the default constructor and explicit constructor of a class. What happens to the default constructor in Java if we write an explicit constructor in a class? 3

4. (a) (I) Why does Java not allow two classes to be inherited by the same class? Explain the problem (with appropriate example code) that may ensue if one class inherits two classes. 5+5

II) Explain in the light of your example given in your answer to (I) as to how using the interface avoids the problem.

(b) Explain the benefits of abstract classes to represent mixed-type components of an object. (For example, a document file like .docx or .odt file is an object with mixed-type components such as texts, images, lists, etc.) 4

5. (a) What are the two ways in Java a thread can be created? Why does Java offer these two ways instead of one only? 6

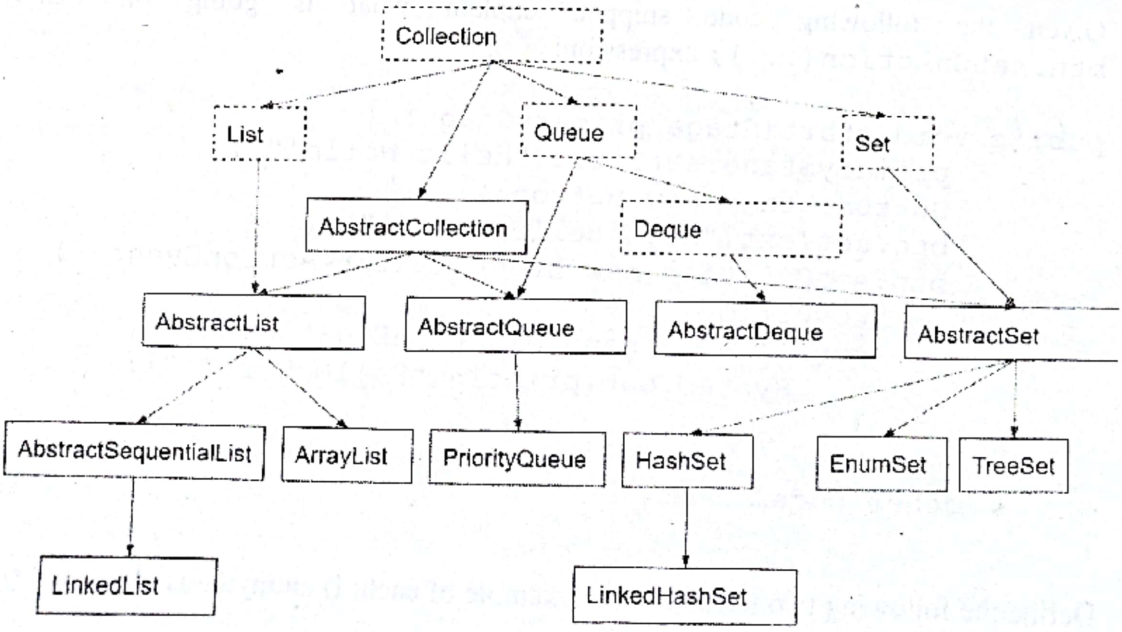
(b) Put appropriate exception handling code in the following code snippet. You must use the best practice of exception handling. 8

```
public static void main(String args[]{
 int i=0;
 FileInputStream fin= new FileInputStream(filename);
//may throw IOException

 do {
   i = fin.read();//may throw IOException
   if(i != -1) System.out.print((char) i);
 } while(i != -1);

 fin.close();//may throw IOException
}
```

6. (a) The following is the class hierarchy of Java's Collection framework. A dotted-lined box and solid-lined box indicate an interface and a concrete/abstract class, respectively. An arrow from one box to another indicates that the former box is inherited/implemented by the latter box. 3+3+4



I) You want to write a code that uses a HashSet data structure. What are the types of reference variables you can use?

```
List L = new Collection();
L.add(56);
System.out.println(L);
```

III) Someone wrote the following code snippet:

```
ArrayList L1 = new ArrayList();
LinkedList L2 = new LinkedList();
if (user_input == 1) {
 L1.add(45);
 if (L1.get(0) == 45)
   System.out.println("45 found.");
}
else if (user_input == 2) {
 L2.add(45);
 if (L2.get(0) == 45)
   System.out.println("45 found.");
}
```

As you have probably guessed already, the code does not look like it was written by a professional OO programmer. Rewrite the code leveraging the class hierarchy so that the code size is minimized.

(b) Suppose your code may throw multiple exceptions E1, E2, E3 and E4 where E2 inherits E1, and E3 and E4 inherits E2. Write the try-catch ladder to catch each of these exceptions for your code. 4

7. (a) Suppose `Language` is a class that is inherited by three classes namely `Bangla`, `English`, and `Arabic`. `Bangla` class is further inherited by two classes: `Cholti` and `Shadhu`. For the sake of simplicity, assume that each of these classes has only a single constructor which takes a string as parameter and sets it to a local variable. 5

Write a generic class named `AnyLang` that works on only types of objects of `Language` class or any of its subclasses. `AnyLang` has only a single data structure which is an array of the object. In its constructor, it takes an array of objects as a parameter and assigns it to the local array reference variable. In another class called `Demo`, in the main function, create two objects of `AnyLang` class with `Language` and `Bangla` classes, respectively.

(b) Given the following code snippet, explain what is going on inside `btn.setOnAction(...);` expression: 5

```
public void start(Stage primaryStage) {
        primaryStage.setTitle("Hello World!");
        Button btn = new Button();
        btn.setText("Say 'Hello World'");
        btn.setOnAction(new EventHandler<ActionEvent>() {
            @Override
            public void handle(ActionEvent event) {
                System.out.println("Hello World!");
            }
        });
    //other code... ... ...
}
```

(c) Define the following two terms with an example of each: i) anonymous class, and (ii) functional interface. 2+2

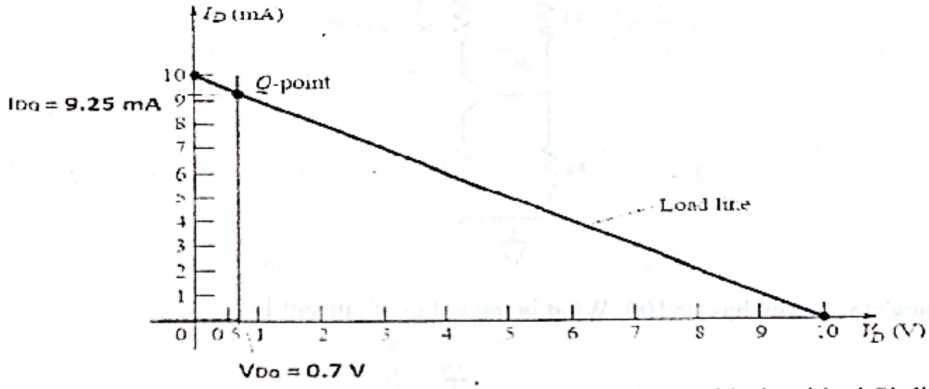
University of Dhaka
Department of Computer Science and Engineering
2nd Year 1st Semester Final Examination, 2021
EEE-2103: Electronic Devices and Circuits

Full Marks: 70 Time: 3 Hours

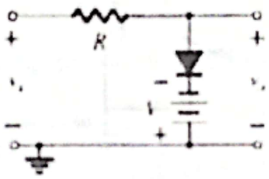
Answer any 5 (five) from the following questions

1 a Explain the conductivity of metal, semiconductor and insulator with the help of energy band diagram. 5

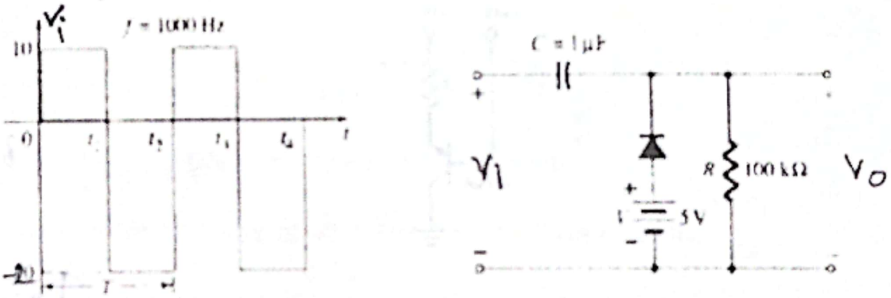
b In the following figure of diode load line, determine (i) Supply voltage (ii) Value of series resistance, and (iii) Value of diode resistance, r_d, at Q point. 5



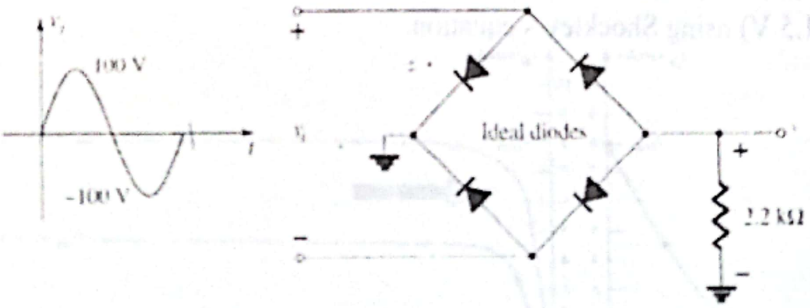
c Draw the output voltage graph for the following circuit considering ideal Si diode. Assume sinusoidal input with peak voltage greater than V. 4



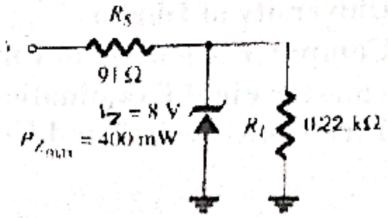
2 a Determine output voltage graph in the following circuit with given input. 5



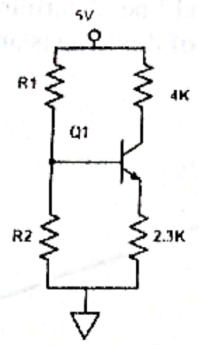
b Determine v_o graph and the required PIV rating of each diode for the configuration of figure below. In addition, determine the maximum current through each diode. 5



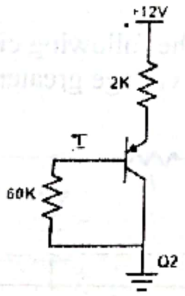
c For the network below, determine the range of V_i that will maintain V_L at 8 V and not exceed the maximum power rating of the Zener diode. 4



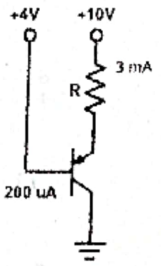
3 a The transistor below has β=50. If we desire a collector current of 1mA, what are appropriate values for R1 and R2? 5



b The transistor below has β=100. What is the value of current I? 4



c In the following transistor biasing circuit, V_{BE} (on) = - 0.6V. What is the value R? 5



0/4

4/4

8

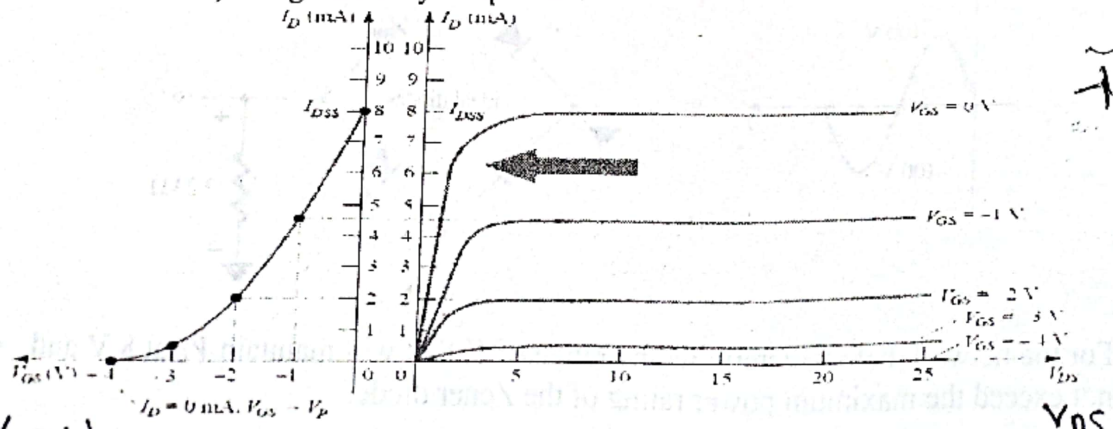
0

$I_D = I_{DSS}(1 - \frac{V_{GS}}{V_P})^2$

4 a Why does the drain current in JFET saturate after pinch off? 5

b From the following transfer characteristic curve of JFET, calculate I_D at V_{GS} = (0V, V_P and – 1.5 V) using Shockley's equation. 5

-1.5, 3, 4



V_{GS} (v)

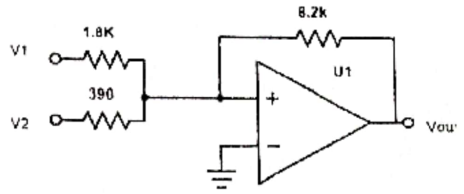
V_{DS}

c Draw the block diagram, symbol, transfer and drain characteristic of n-channel depletion type MOSFET. 4

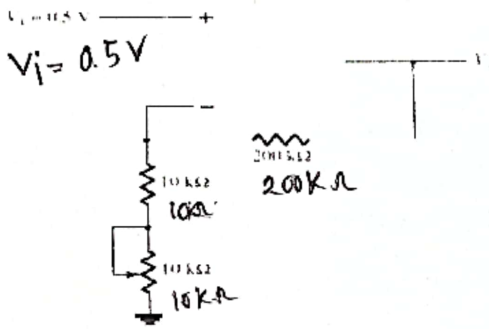
5 a What is the significance of *slew rate* of an Op Amp? 4

d Suppose you need to measure the *slew rate* and *settling time* of an Op Amp. Describe how to do so. In particular focus on the circuit diagram, input and output signal, and measurement procedure. 5

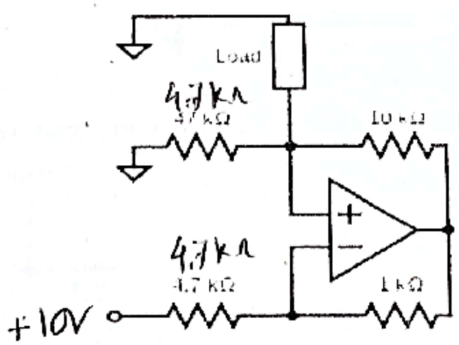
e Calculate output voltage V_{out} of the following circuit. 5



6 a Calculate the range of output voltage in the following circuit 5



b In the circuit below calculate the current through the load. 5



c Construct a voltmeter using op-amp and describe its operation. 4

7 a Explain the general concept of feedback with block diagram. 5

b Draw a voltage series feedback circuit and calculate its feedback voltage gain, A_f. 5

c State four advantages of negative feedback. 4

University of Dhaka
Department of Computer Science and Engineering
2nd Year 1st Semester Final Examination, 2021
GED-2104: Bangladesh Studies

Full Marks: 70 Time: 3 Hours

Answer any 5 (five) from the following questions

1	a	What is the meaning of the word 'Bangla'? What are the GI products of Bangladesh?	2+3
	b	Mention the meanings of the seven towers of the National Memorial Monument.	4
	c	What is meant by administration? Show the outline of five tiers of government in Bangladesh.	5
2	a	Which one is the first school of Bangladesh?	1
	b	How many international Universities are there in Bangladesh? Who fund these?	3
	c	Discuss thoroughly about the problems of the education systems in Bangladesh	10
3	a	Mention the inheritance right of women in Bangladesh.	2
	b	Discuss about the status of family, household, and kinship in Bangladesh.	8
	c	In Bangladesh, rate of divorce is increasing day by day. Mention the causes.	4
4	a	Discuss about the impact of climate change on Bangladesh.	5
	b	Describe the human geography of Bangladesh.	2
	c	Explain the points of the six-point-movement in 1966.	7
5	a	Briefly discuss the chain of events starting from the 1952 language movement that led to the independence of Bangladesh in 1971.	10
	b	How is Bangladesh dealing with the refugees who fled from Myanmar? What steps should be taken to successfully resolve this crisis?	4
6	a	The government of Bangladesh is investing massively in the ICT sector. Discuss how ICT can be effectively used to solve the traffic problem in big cities like Dhaka.	7
	b	What do you understand by 'Digital Bangladesh'? What major development projects have led us towards Digital Bangladesh in the last few years?	7
7	a	What would be effect of COVID-19 pandemic on the current development trend of Bangladesh? How could the CSE graduates contribute to achieve the goals of the industrial revolution 4.0 ?	8
	b	What was the most severe natural disaster that occurred in Bangladesh? How does the government of Bangladesh deal with this type of natural disaster?	6

University of Dhaka
Department of Computer Science and Engineering
2nd Year 1st Semester Final Examination 2021
MATH-2105: Linear Algebra

Full Marks: 70 Time: 3 hours

Answer any 5 (five) of the following questions

1. (a) Explain why a set { v1, v2, v3, v4 } in R^5 must be linearly independent when { v1, v2, v3} is linearly independent and v4 is not in Span { v1, v2, v3} . [3]

(b) Find a column of the matrix given below that can be deleted and yet have the remaining matrix columns still span R^4 . [5]

$$\begin{bmatrix} 12 & -7 & 11 & -9 & 5 \\ -9 & 4 & -8 & 7 & -3 \\ -6 & 11 & -7 & 3 & -9 \\ 4 & -6 & 10 & -5 & 12 \end{bmatrix}$$

(c) Find the general solution of the linear system given below. [6]

$$\begin{aligned} x_1 - 2x_2 - x_3 + 3x_4 &= 0 \\ -2x_1 + 4x_2 + 5x_3 - 5x_4 &= 3 \\ 3x_1 - 6x_2 - 6x_3 + 8x_4 &= 2 \end{aligned}$$

2. (a) Identify the following statements as TRUE or FALSE and justify your answer. [3]

I. Each matrix is row equivalent to one and only one reduced echelon matrix.

II. Any system of n linear equations in n variables has at most n solutions.

III. If the equation A x D 0 has a nontrivial solution, then A has fewer than n pivot positions. AxD=0

(b) Prove the following statement. [5]

"An nXn matrix A is invertible if and only if A is row equivalent to I_n, and in this case, any sequence of elementary row operations that reduces A to I_n also transforms I_n into A^{-1}."

(c) Find bases for column space and null space of the following matrix. [6]

$$\begin{bmatrix} 1 & 2 & -5 & 0 & -1 \\ 2 & 5 & -8 & 4 & 3 \\ -3 & -9 & 9 & -7 & -2 \\ 3 & 10 & -7 & 11 & 7 \end{bmatrix}$$

3. (a) Find the volume of the parallelepiped with one vertex at the origin and adjacent vertices at (1, 0, 3) , (1, 2, 4) , and (5, 1, 0) . [3]

(b) Prove that If A and B are nXn matrices, then det AB = (det A)(det B) [5]

(c) Calculate the adjugate and inverse of the following matrix using Cramer's Rule. [6]

$$\begin{bmatrix} 1 & 1 & 3 \\ -2 & 2 & 1 \\ 0 & 1 & 1 \end{bmatrix}$$

4. (a) Given the following A, u and v matrices, determine whether u and v belong to the colA. [3]

$$A = \begin{bmatrix} 2 & 4 & -2 & 1 \\ -2 & -5 & 7 & 3 \\ 3 & 7 & -8 & 6 \end{bmatrix} \quad \mathbf{u} = \begin{bmatrix} 3 \\ -2 \\ -1 \\ 0 \end{bmatrix} \quad \mathbf{v} = \begin{bmatrix} 3 \\ -1 \\ 3 \end{bmatrix}$$

(b) Find a basis for the space spanned by the following vectors. [5]

$$\begin{bmatrix}1\\0\\0\\1\end{bmatrix},\begin{bmatrix}-2\\1\\-1\\1\end{bmatrix},\begin{bmatrix}6\\-1\\2\\-1\end{bmatrix},\begin{bmatrix}5\\-3\\3\\-4\end{bmatrix},\begin{bmatrix}0\\3\\-1\\1\end{bmatrix}$$

(c) Find the coordinate vector $[x]_B$ of x relative to basis $B=\{b_1, b_2, b_3\}$ [6]

$$\mathbf{b}_1=\begin{bmatrix}1\\-1\\-3\end{bmatrix},\mathbf{b}_2=\begin{bmatrix}-3\\4\\9\end{bmatrix},\mathbf{b}_3=\begin{bmatrix}2\\-2\\4\end{bmatrix},\mathbf{x}=\begin{bmatrix}8\\-9\\6\end{bmatrix}$$

5. (a) Show that λ is an eigenvalue of A if and only if λ is an eigenvalue of A^T. [3]

(b) Diagonalize the following matrix if possible. Eigenvalues of the matrix are: 1, 2 and 3. [5]

$$\begin{bmatrix}-1 & 4 & -2\\-3 & 4 & 0\\-3 & 1 & 3\end{bmatrix}$$

(c) Find all eigenvalues of the following matrix. [6]

$$\begin{bmatrix}6 & -2 & 0\\-2 & 9 & 0\\5 & 8 & 3\end{bmatrix}$$

6. (a) Determine whether the following vectors form an orthogonal set or not. [3]

$$\begin{bmatrix}3\\-2\\1\\3\end{bmatrix},\begin{bmatrix}-1\\3\\-3\\4\end{bmatrix},\begin{bmatrix}3\\8\\7\\0\end{bmatrix}$$

(b) Derive the formula to calculate orthogonal projection of an arbitrary vector y onto W which is a subspace of R^n. [5]

(c) Find an orthogonal basis for the column space of the following matrix. [6]

$$\begin{bmatrix}-1 & 6 & 6\\3 & -8 & 3\\1 & -2 & 6\\1 & -4 & -3\end{bmatrix}$$

7. (a) For which right sides (find a condition on b_1, b_2, b_3) the following system is solvable? [4]

$$\begin{vmatrix}1 & 4\\2 & 9\\-1 & -4\end{vmatrix}\begin{vmatrix}x_1\\x_2\end{vmatrix}=\begin{vmatrix}b_1\\b_2\\b_3\end{vmatrix}$$

(b) Find the complete solution to [5]

$$\begin{vmatrix}1 & 3 & 1 & 2\\2 & 6 & 4 & 8\\0 & 0 & 2 & 4\end{vmatrix}\begin{vmatrix}x\\y\\z\\t\end{vmatrix}=\begin{vmatrix}1\\3\\1\end{vmatrix}$$

(c) Reduce to $U_x=c$ (Gaussian elimination) and then $R_x=d$ (Gauss-Jordan): [5]

$$Ax=\begin{vmatrix}1 & 0 & 2 & 3\\1 & 3 & 2 & 0\\2 & 0 & 4 & 9\end{vmatrix}\begin{vmatrix}x_1\\x_2\\x_3\\x_4\end{vmatrix}=\begin{vmatrix}2\\5\\10\end{vmatrix}=b$$