

(Answer any four of the following six questions)

1. a. List the following functions by increasing asymptotic growth rate. 5
  - i.  $\lg n$
  - ii.  $n \lg n$
  - iii.  $n(\lg n)^2$
  - iv.  $2^n$
  - v.  $n^3$
- b. Show that, the following equality is incorrect: 3

$$n^2 / \log n = \theta(n^2)$$
- c. Consider a strings consisting the characters '[', ']', '{', '}', '(' and ')' only. Write 5  
an algorithm to check if the string  $s$  is balanced in usual algebraic sense.
- d. Compare between array and link list. 2
2. a. You are given an array  $A = \{4, 5, 3, 1, 2, 6, 7\}$ . Simulate quick sort on the 6  
given array. Show each intermediate step.
- b. You are given an array of  $N$  elements. Each elements is guaranteed to be in 6  
the range between  $[-50, 100]$ . How can you sort the elements using Counting  
sort? What will be the complexity of the sort?
- c. We are given  $N$  nuts of different sizes and  $N$  corresponding bolts, and we 3  
must match these together, determining for each nut the unique bolt of the  
same size. However, it is difficult to compare two nuts or two bolts - it is  
only possible to compare a nut against a bolt to see if the nut fits the bolt, if it  
is too small, or if it is too large. Describe a randomized algorithm running in  
 $O(N \log N)$  time with high probability that will properly match the nuts and  
bolts.
3. a. Design stack and queue ADT using linked list. You should assume that you 6  
are given a linked list ADT with the following methods (assume  $x$  is an  
object of linked list ADT):
  - **$x.insert\_first(int\ val)$** : Inserts  $val$  in the first position of  $x$ .  
Complexity is  $O(1)$ .
  - **$x.insert\_last(int\ val)$** : Inserts  $val$  in the last position of  $x$ . Complexity  
is  $O(N)$ .
  - **$x.get\_first()$** : Gives you the value of the first node in  $x$ . Complexity is  
 $O(1)$ .
  - **$x.get\_last()$** : Gives you the value of the last node in  $x$ . Complexity is  
 $O(N)$ .
  - **$x.delete\_first()$** : Deletes the first node in  $x$ . Complexity is  $O(1)$ .
  - **$x.delete\_last()$** : Deletes the last node in  $x$ . Complexity is  $O(N)$ .

For both stack and queue design the following methods. Mention the



complexity of each method. You must use the linked list ADT whenever possible.

- **void push(int val):** Pushes val.
- **void pop():** Pops an element.
- **int peek():** Shows you the topmost/front value.
- **bool isEmpty():** Returns true when the stack/queue is empty. False otherwise.

- b. Evaluate the given expression after converting in postfix. Show each step of the algorithm. 6

$$3 + (2 * (7 - 2) * 5 - 2) * 3$$

- c. Given an array, print the Next Smaller Element for every element. The Next Smaller Element for an element **X** is the first smaller element on the right side of **X** in array. Elements for which no smaller element exist, consider next smaller element as -1. Give an algorithm which will work in **O(N)** for the whole array. 3

4. a. Given the following integers in order, insert them in a max-heap and draw the tree after each insertion. The input integers are: **2, 7, 26, 25, 19, 17, 1, 90.** 6

- b. Write an algorithm for extracting the **3<sup>rd</sup> highest** element of a max-heap. 5  
Analyze complexity.

- c. Write a recursive algorithm to check whether a given string is a palindrome or not. 4

5. a. Given the following integers in order, insert them in a Binary Search Tree and draw the tree after each insertion. The input integers are: **15, 23, 6, 7, 4, 5, 71, 50.** 6

- b. Write an algorithm to find the smallest and largest element in a BST. 5  
Analyze complexity.

- c. Using a sorted array, make the most balanced BST. You can insert the values of the array in any order. Write the algorithm and analyze the complexity. 4

6. a. Given a graph in **Figure 1** simulate breadth first search and depth first search on the graph. Output the nodes in order of their traversal for both search algorithms. You should assume that the adjacent nodes of a particular node are being visited in increasing order. For example, say we are currently at node **11**. Its adjacent nodes are **12, 10** and **6**. So from node **11**, we will first visit **6** (if it's not visited already), then **10** and then **12**. 6

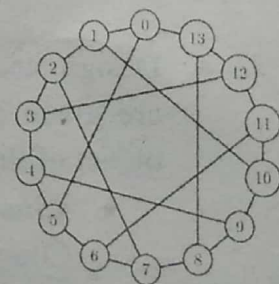


Figure 1

- b. Write a program to identify if a given undirected graph has any cycle. 5
- c. Given a binary tree with **N** nodes, find the center of the tree. The center of a tree is a node such that, if we remove that node and its edges, the tree will be divided into three equal sized subtrees. Write an algorithm of complexity **O(N)**. 4



# University of Dhaka

## Department of Computer Science and Engineering

### Special B.Sc. (Hons.) Final Examination 2018

#### CSE 2102: Object Oriented Programming

Total Marks: 60

Credits: 3

Time: 3 Hours

(Answer any Four (4) of the following Questions)

1. a) What are the core parts of OOP? Describe them in brief with proper examples. [4]  
b) Define the following classes. You have to use super() & write a proper main function. [4]
- 'Product' class with the following characteristics
    - member variables for product name and price.
    - a parameterized constructor with two parameters that initializes the member variables
  - 'Inventory' class with the following characteristics
    - inherits 'Product' class
    - member variable for product stock
    - a parameterized constructor with three parameters to initialize the member variables
  - 'Revenue' class with the following characteristics
    - inherits 'Inventory' class
    - member variables to count buy and sell
    - a parameterized constructor to initialize all five member variables
    - no other class should inherit this class.
    - a member function to display the Product Name, price, and revenue (revenue=total selling price total buying price)
- c) Consider the following code: [4]
1. class c1 { }
  2. class c2 { }
  3. interface i1 { }
  4. interface i2 { }
  5. class A extends c2 implements i1 { }
  6. class B implements i1 implements i2 { }
  7. class C implements c1 { }
  8. class D extends c1, implements i2 { }
  9. class E extends i1, i2 { }
  10. class F implements i1, i2 { }
- State with proper clarifications & reasons, which classes will NOT compile?
- d) What steps do you need to do to setup event sources and event listeners in Java? [3]
2. a) Consider the following class: [7]
- ```
class Circle{
    double center_x;
    double center_y;
    double radius;
    public Circle(double a,double b,double c){
        center_x=a;
        center_y=b;
        radius=c;
    }
}
```
- Write a class "CircleRecord" to hold any number of Circle using **Java collection**. The class will have the following methods.
- CircleRecord () - initialize the list to hold circles.
  - insert(Circle c) - will insert a Circle at the start of list .
  - remove() - will delete a Circle from the end of the list.
  - display() - will display all the information of each circle (center coordinate and radius).
  - double distance (int pos1, int pos2) - will return the distance between the two circles of pos1 and pos2. The distance between two circles is the distance of their centers.
- b) In reference to the question 2.a, suppose you want to sort the circles with respect to x and y coordinates. Write two comparators to sort the circles. One comparator will sort the circles according to their x coordinates and other one will sort according to y coordinates. [2]
- c) Write a program in Java that will calculate the summation of each column of a 3×3 matrix. [6]  
Your program should create 3 threads named one, two and three from the main thread. Each of the threads will calculate the summation of a specific column. The column number is

passed as parameter to a thread. After summing an element of a specific column the thread will print the name of the thread and the partial sum and then sleep for 500 milliseconds. Main thread will wait for the termination of the child thread.

3. a) What are the properties of static variables and methods? [2]  
 b) How can threads be synchronized? What are the two methods by which threads can be stopped? [3]  
 c) Define a class named classA in a package pA. This class will contain two public data member a, b and an abstract method compute(). Now define three classes named classB, classC and classD in packages pB, pC and pD, respectively. Each of the class is a subclass of classA and will implement the compute() method. The classB will compute the sum of a and b, classC will compute the product of a and b and classD will compute the result of subtraction. Now write a Java program that will generate call to the compute() method of each class. [4]  
 d) Write a program that will read an integer number and a file name as input from the keyboard. [6]  
 The input should first take an integer number and then a file name. For example:  
 1543729 c:\temp12.txt  
 Your program should generate a user-defined exception InvalidInput if the input is given in wrong order. For example:  
 c:\temp12.txt 1543729  
 Your program should also check whether the file exists. If invalid then generate a user-defined exception InvalidFileName. Your program should add the number at the end of the file, with a comma every third digit from the right. For example:  
 "1, 543, 729"

4. a) Consider the "Calculator" class. Now write a java program that create three threads, each of which accessing the same 'Calculator' object. Each of these threads should do the following 4 tasks. Ensure that, while one thread is working on the object, others wait for the successful execution of the current one. [6]  
 • Take two numbers from the user.  
 • Print their sum.  
 • Print their multiplication.  
 • Print their division.

```
class Calculator{
    double Add (double x, double y){
        return x+y;
    }
    double Multiply(double x, double y){
        return x*y;
    }
    double Divide(double x, double y){
        return x/y;
    }
}
```

- b) Consider the following code: [2]  

```
3. public class Drip extends Thread {
4. public static void main(String[] args) {
5.     Thread t1 = new Thread(new Drip());
6.     t1.start();
7.     t1.join();
8.     for(int i = 0; i < 1000; i++) // Loop #1
9.         System.out.print(Thread.currentThread().getName() + " ");
10. }
11. public void run() {
12.     for(int i = 0; i < 1000; i++) // Loop #2
13.         System.out.print(Thread.currentThread().getName() + " ");
14. }}
```

Explain the output of this code fragment.

- c) Identify errors in the following program and state the reasons. [5]  

```
1 import java.io.*;
2 class A {
3     int p = 120;
4     public void print() { System.out.println("p:" + p); }
5 }
```



```

6 abstract class B extends A {
7     int d = 525;
8     public void print() { System.out.println("d:" + d); }
9     public void print(int k) { System.out.println("In B"); }
10    abstract int add();
11 }
12 class C extends B {
13     int m = 424;
14     public void print() { System.out.println("m:" + m); }
15 }
16 class test {
17     public static void main(String[] args) {
18         A a = new A();
19         B b = new B();
20         C c = new C();
21         c = a;
22         c.print();
23         a = b;
24         a.d = 230;
25         a.print();
26         a.print(120);
27         b = c;
28         b.add();
29     }
30 }

```

- d) Java does not allow a class to extend more than one class. In this regard, mention how we can achieve multiple inheritance in Java. Discuss with an example. [2]
5. a) Suppose there is a server running at a computer with ip address 172.20.0.3 in port 33333. The server can serve multiple clients. After the connection is established client sends a String to the server and the server returns the reverse of the String the client sends. The client then displays the reverse String with the original String it sends in its console. Write java codes for the above mentioned scenario. [6]
- b) Which is more efficient way to display the elements of a list- a *for loop* or using an *Iterator*? Explain with example. [3]
- c) Write a Java code segment that will display the contents of a directory. [2]
- d) What is the difference between an *abstract class* and an *interface*? [2]
- e) Consider the following code segment & state the output: [2]
- ```

1. class MyException extends RuntimeException { }
2. public class Houdini {
3.     public static void main(String[] args) throws Exception {
4.         throw new MyException();
5.         System.out.println("success");
6.     } }

```
6. a) There is a file named "text.txt". Write a program that read each line of the file at a time and prints the line number or the first occurrence of the word "Bangladesh". [5]
- b) Consider a **MyStack** class implemented with array and with the following functions: [10]
- void push (Object o) - this method pushes an Object o into the stack
  - Object pop () - this method pops an Object from the stack
  - Object top () - returns the Object in the top of the stack without modifying the stack
  - boolean isEmpty () - this method returns true if the stack is empty, otherwise false

**MyStack** class has the following instance variables:

- final int CAPACITY = 100 - capacity of the stack
- Object [] s - the array to hold the stack
- int top - the top of the stack

Here are the restrictions:

- In MyStack, pop() and top() cannot be performed if the stack is empty. In that case it will trigger StackEmptyException with the message 'Stack is Empty'.
- In MYStack, push() cannot be performed if the stack is full. In that case it will trigger StackFullException with the message 'Stack is full'.

Write Java code for the custom exceptions mentioned above. You also need to write the MyStack class to trigger these exceptions when needed.

**University of Dhaka**  
**Department of Computer Science and Engineering**  
**2<sup>nd</sup> Year 1<sup>st</sup> Semester B. Sc. Final Examination 2018**  
**EEE-2103: Electronic Devices and Circuits**

**Duration: 3 hours**

**Credits: 3**

**Full Marks: 60**

(Answer any four of the following six questions)

1. a. Describe the difference between *n*-type and *p*-type semiconductor materials. 5  
 b. Describe the difference between donor and acceptor impurities. 5  
 c. Sketch the atomic structure of silicon and insert an impurity of arsenic and indium. 5
2. a. Describe the conditions established by forward- and reverse-bias situation on a *p-n* junction diode and how the resulting current is affected. 5  
 b. Determine the diode current at 20°C for a silicon diode with  $I_S = 0.1$  A at a reverse-bias potential of -10V. Is the result expected? Why? 5  
 c. For the network in Fig. 2(c):  
     i. Determine  $V_L$ ,  $I_L$ ,  $I_Z$  and  $I_R$  if  $R_L = 180 \Omega$ .  
     ii. Determine the value of  $R_L$  that will establish maximum power conditions for the Zener diode.  
     iii. Determine the minimum value of  $R_L$  to ensure that the Zener diode is in the "on" state.

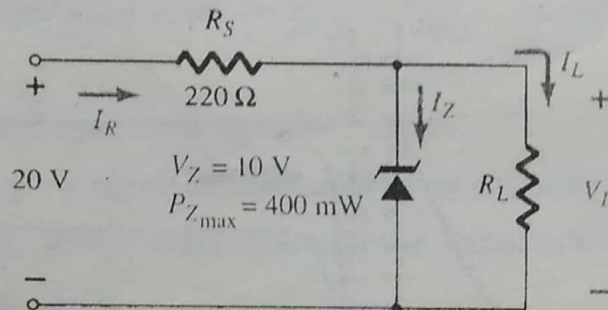


Fig. 2(c)

3. a. Determine the ac or dynamic resistance of the diode at a forward voltage of 0.7 volt in the following figure 3(a). 5

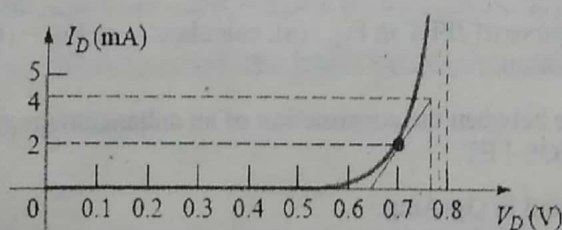


Figure 3(a)

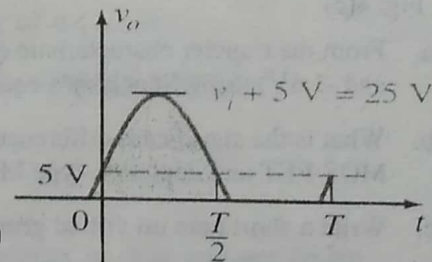
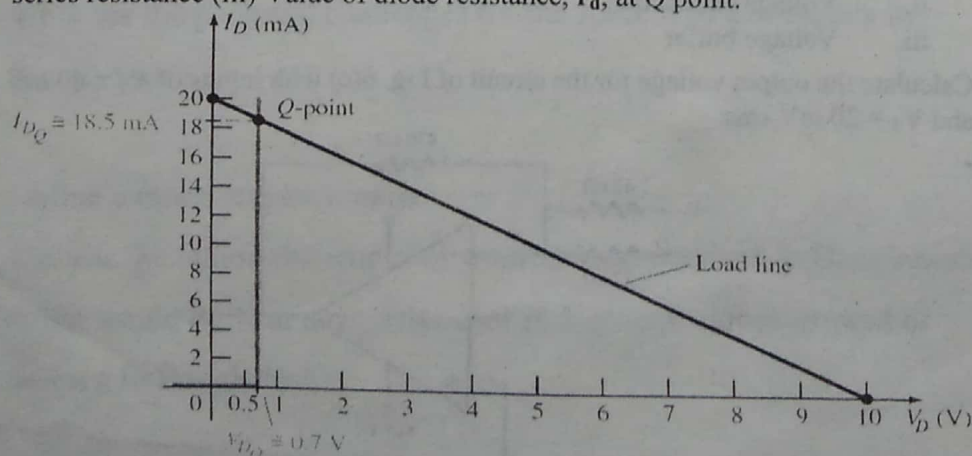


Figure 3(b)

- b. For the waveform given in Fig 3(b) draw the corresponding clipper circuit. 5
- c. In the following figure of diode load line determine (i) Supply voltage (ii) Value of series resistance (iii) Value of diode resistance,  $r_d$ , at Q point. 5



4. a. Explain amplifying action of bi-polar transistor with a suitable diagram. 5



- b. Using characteristic curves below determine (i)  $I_C$  at  $I_B = 30 \mu A$  and  $V_{CE} = 10V$  5  
(ii)  $I_C$  at  $V_{BE} = 0.7 V$  and  $V_{CE} = 10V$

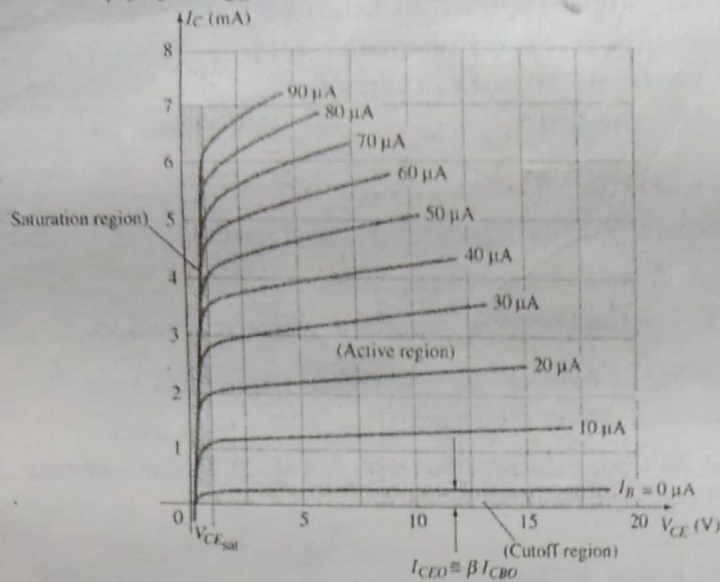


Fig. 4(b). i

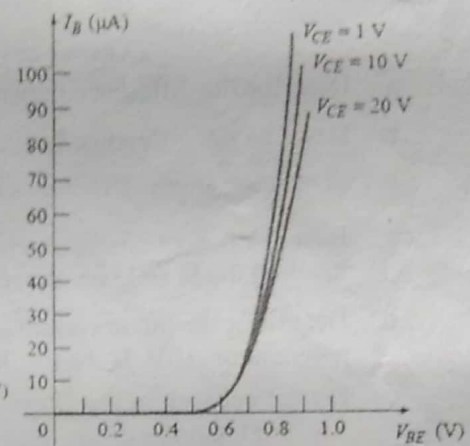


Fig. 4(b). ii

- c. For the voltage divider bias configuration circuit in Fig. 4(c), determine: 5  
i.  $I_{BQ}$  ii.  $I_{CQ}$  iii.  $V_{CEQ}$  iv.  $V_B, V_C, V_E$

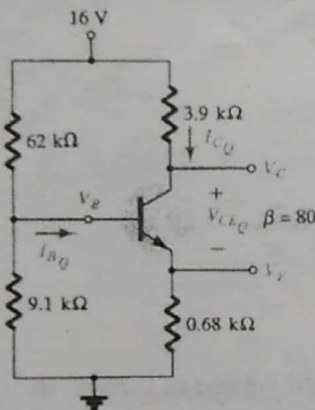


Fig. 4(c)

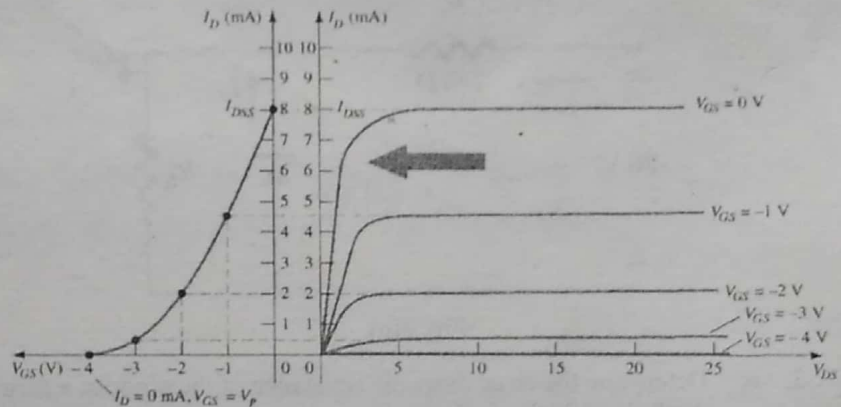


Fig. 5(a)

5. a. From the transfer characteristic curve of JFET in Fig 5(a), calculate  $I_D$  at  $V_{GS} = (0V, V_P$  5  
and  $-1.5V)$  using Shockley's equation.  
b. What is the significant difference between the construction of an enhancement-type 5  
MOS-FET and depletion-type MOS-FET.  
c. Write a short note on virtual ground in Op-Amp. 5  
6. a. Describe how Op-Amp acts as a differential amplifier circuit using a DC bias of 5  
differential amplifier circuit.  
b. How the following operations are conducted using Op-Amp? 6  
i. Voltage summing  
ii. Voltage subtraction  
iii. Voltage buffer  
c. Calculate the output voltage for the circuit of Fig. 6(c) with inputs of  $V_1 = 40 mV$  rms 4  
and  $V_2 = 20 mV$  rms.

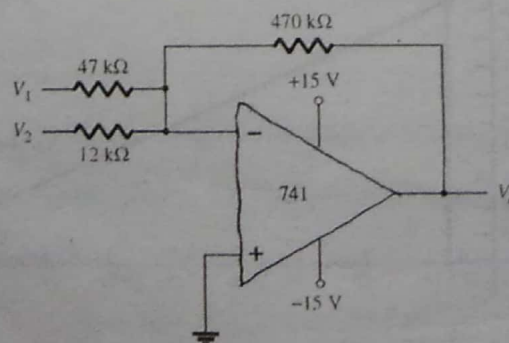


Fig. 6(c)

**University of Dhaka**  
**Department of Computer Science and Engineering**  
**2<sup>nd</sup> Year 1<sup>st</sup> Semester B. Sc. Final Examination 2018**  
**GED-2104: Bangladesh Studies**

**Duration: 2.5 hours**

**Credits: 2**

**Full Marks: 60**

(Answer any four of the following six questions)

1. a. Briefly describe the origin of ombudsman. 4  
b. Discuss constitutional provisions for ombudsman in Bangladesh. 5  
c. On which consideration do you think that the office of an ombudsman is necessary for Bangladesh? 6
2. a. Define a constitution. 3  
b. Delineate the fundamental features of the 1972 constitution of Bangladesh. 9  
c. Is Bangladesh 'a secular state' in light of her present constitution? 3
3. a. What do you mean by rights? 3  
b. Make a comparison between fundamental rights and human rights. 5  
c. Describe the fundamental rights illustrated in the constitution of Bangladesh. 7
4. a. How would you define the foreign policy of a country? 3  
b. Discuss various elements of foreign policy of a country. 6  
c. Describe, in brief, the basic principles of the foreign policy of Bangladesh. 6
5. a. Discuss the meaning and concept of democracy as it is suggested by Robert A. Dahl (1989). 4  
b. What are the major types of democracy? 3  
c. What are the potential challenges for the success of democracy in Bangladesh? 8
6. a. Define women empowerment. 3  
b. Discuss the major challenges of women empowerment in Bangladesh. 6  
c. What would be your suggestions for real-ground empowerment of women in Bangladesh? 6



University of Dhaka  
Department of Computer Science and Engineering  
2<sup>nd</sup> Year 1<sup>st</sup> Semester B. Sc. Final Examination 2018  
MATH 2105: Linear Algebra

Duration: 3 hours

Credits: 3

Full Marks: 60

(Answer any four of the following six questions)

1. a. Define the terms: Euclidean inner product, norm and distance in  $\mathbb{R}^n$ . 7  
 Let  $\underline{u} = (1, -2, 3, -1)$ ,  $\underline{v} = (2, 1, 5, 0)$ ,  $\underline{w} = (5, -3, -1, 1)$ . Find
  - i.  $\|2\underline{u} + 3\underline{v} - 5\underline{w}\|$
  - ii.  $\|\underline{u}\|$
  - iii.  $\|\underline{v}\|$
  - iv.  $\|\underline{u} + \underline{v}\|$
  - v.  $d(\underline{u}, \underline{v})$
- b. Define the trace of a matrix. Consider the matrices  $A = \begin{pmatrix} 3 & 0 \\ -1 & 2 \\ 1 & 1 \end{pmatrix}$ , 5  
 $B = \begin{pmatrix} 1 & 4 & 2 \\ 3 & 1 & 5 \end{pmatrix}$ ,  $C = \begin{pmatrix} 6 & 1 & 3 \\ -1 & 1 & 2 \\ 4 & 1 & 3 \end{pmatrix}$ . Compute the trace of the matrix  $B^T A^T + 2C^T$  (if possible). 3
- c. Write  $A = \begin{pmatrix} 4 & 5 & 4 \\ 1 & 3 & 2 \\ -2 & 6 & 2 \end{pmatrix}$  as the sum of a symmetric matrix and skew-symmetric matrix. 3
2. a. Find the matrix  $P$  that projects every vector  $b$  in  $\mathbb{R}^3$  onto the line in the 4  
 direction of  $a = \begin{bmatrix} 2 \\ 1 \\ 3 \end{bmatrix}$ .  
 b. **(Continuation of part a.)** What is the column space and null space of  $P$ ? 2+  
3  
 c. **(Continuation of part a.)** What are all the eigenvectors of  $P$  and their corresponding eigenvalues? 6
3. a. Suppose  $A$  is a positive definite symmetric  $n$  by  $n$  matrix. Explain why  $A^{-1}$  3  
 will be (or will not be) always positive definite.  
 b. This problem finds the curve  $y = C + D2^{t'}$  which gives the best least 2+  
4  
+3  
 squares fit to the points  $(t, y) = (0, 6), (1, 4), (2, 0)$ .  
 i. Write down the 3 equations that would be satisfied if the curve went through all 3 points.  
 ii. Find the coefficients  $C$  and  $D$  of the best curve  $y = C + D2^t$ .  
 iii. What values should  $y$  have at times  $t = 0, 1, 2$  so that the best curve is  $y = 0$ ?  
 c. Give a basis for the space of 3 by 3 diagonal matrices. 1.5

d. Find the determinant of  $A = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix}$  1.5

4. a. For which numbers  $a$  does elimination breakdown A) permanently B) temporarily? Explain. 1.5 +

$$ax + 3y = -3 \quad 1.5$$

$$4x + 6y = 6$$

- b. (Continuation of part a.) To fix the second breakdown, you need to perform a row exchange. Which permutation matrix would do the required row exchange? 2

- c. Compute the full SVD for the following matrix 7

$$A = \begin{bmatrix} 4 & 0 \\ 3 & -5 \end{bmatrix}$$

- d. Construct the matrix  $A$  with rank 1 that has  $Av = 12u$ , for  $v = \frac{1}{2}(1, 1, 1, 1)$  and  $u = \frac{1}{3}(2, 2, 1)$ . What is/are the value(s) of its singular value(s)? 1.5 + 1.5

5. a. i. Find the LU decomposition of the matrix  $A = \begin{bmatrix} 3 & 3 & 4 \\ 6 & 8 & 7 \\ -3 & 5 & -9 \end{bmatrix}$  6+ 5

ii. Find the determinants of  $L, U, A, U^{-1}L^{-1}$ , and  $U^{-1}L^{-1}A$ .

- b. True or false: If all columns of  $S$  (eigenvectors of  $A$ ) are independent, then 4
- $A$  is invertible
  - $A$  is diagonalizable
  - $S$  is invertible
  - $S$  is diagonalizable

6. a. Let  $u = (1, 2, 1)$ ,  $v = (2, 9, 0)$  and  $w = (3, 3, 4)$ . 9

- Show that the set  $S = \{u, v, w\}$  is a basis for  $\mathbb{R}^3$ .
- Find the coordinate vector of  $v = (5, -1, 9)$  with respect to  $S$ .
- Find the coordinate vector  $v$  in  $\mathbb{R}^3$  whose coordinate vector with respect to the basis  $S$  is  $(v)_S = (-1, 3, 2)$ .

- b. Determine the rank and nullity of the matrix  $A = \begin{pmatrix} 2 & 0 & -1 \\ 4 & 0 & -2 \\ -2 & 1 & 0 \end{pmatrix}$ . Hence 6
- verify that the  $\text{rank}(A) + \text{nullity}(A) = n$ , where  $n$  is the number of columns of  $A$ .