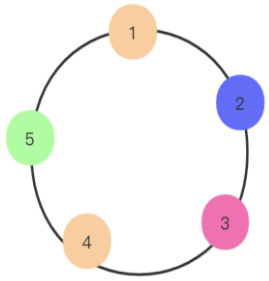
University of Dhaka
Department of Computer Science and Engineering
2nd Year 1st Semester B. Sc. Final Examination, 2020
CSE-2101: Data Structures and Algorithms

Total Marks: 70 **(Answer any Three (3) of the following Questions)** **Time: 2 Hours**

1. a) We all know the basic design of a Tissue Box. What kind of a data structure is this Tissue Box? What operations does it support? What are the complexities of those operations? **8**

   b) Design an approach to sort the nodes of a linked list containing integer values without using any external array. **8**

   c) People are standing in a circle waiting to be executed. Counting begins at the start of the circle and proceeds around the circle from left to right. After a specified number of people are skipped, the next person is executed. The procedure is repeated with the remaining people, starting with the next person, going in the same direction and skipping the same number of people, until only one person remains, and is freed. Given the number of people N, number of people to be skipped K, determine the position in the initial circle which will be freed. **7.33**



   In the picture, N = 5. If K = 3, starting from 1 first three people will be skipped. So, 4 will be executed. Then, 5, 1, 2 will be skipped. So, 3 will be executed next. After that, 5, 1, 2 will be skipped. So, 5 will be executed. Next, after skipping 1, 2, 1, the person at position 2 will be executed. Finally, person at position 1 remains alive and will be freed.

   Write a recursive function which works in O(N) to find the position of the person which will be freed, given N and K.

2. a) You are given an array **{4, 10, 2, -11, 5, 6, 1, -2, 7}.** Simulate merge sort on the array. **8**

   b) What is "In Place" sorting algorithm? What is "Stable" sorting algorithm? Determine if the following sorting algorithms are "In Place" and/or "Stable". Also provide exactly one scenario where the corresponding sorting algorithm will be most useful. **8**

      i. Selection Sort
      ii. Merge Sort
      iii. Quick Sort
      iv. Counting Sort

   c) One example of external sorting is the external merge sort algorithm. It sorts chunks that each fit in RAM, then merges the sorted chunks together. For example, for sorting 900 megabytes of data using only 100 megabytes of RAM: **7.33**

      1. Read 100 MB of the data in main memory and sort by Quick sort.
      2. Write the sorted data to disk.
      3. Repeat steps 1 and 2 until all of the data is in sorted 100 MB chunks (there are 900MB / 100MB = 9 chunks), which now need to be merged into one single output file.
      4. Read the first 10 MB (= 100MB / (9 chunks + 1)) of each sorted chunk into input buffers in main memory and allocate the remaining 10 MB for an output buffer.
      5. Perform a 9-way merge and store the result in the output buffer. Whenever the output buffer fills, write it to the final sorted file and empty it. Whenever any of the

9 input buffers empties, fill it with the next 10 MB of its associated 100 MB sorted chunk until no more data from the chunk is available.

What is the complexity of the above algorithm if it is applied to sort data of length N using a RAM with capacity K?

3. a) Consider the following infix mathematical expression. **8**

$3 - 5 * 7 * (24 - 5 * (3/8) * 7 + 3 * 10)$

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

b) You are given an array which is initially increasing. From a particular index K, it's decreasing. Write an algorithm to find the value of the index K for a given array. For example, if the array is {1, 3, 5, 6, 9, 11, 7, 4, 3} then K is 5, which is the index of the value 11. The first value has the index of 0. **8**

c) You are given a convex (all the internal angles are less than 180 degrees) polygon with N vertices. You can select any three vertices on this polygon and form a triangle. Find such a triangle with maximum area. Analyze the complexity of your algorithm. **7.33**

4. a) You are given the following values: 10, 90, 5, 100, 50, 200, 1, 3, 500, 300. Insert the values in a Binary Search Tree. Simulate each steps. Show the tree for each steps. **8**

b) What are the different cases that can occur during deleting a node in a Binary Search Tree? Give example to each case. **8**

c) You are given a list of numbers L. There will be some queries: **7.33**

- I X: means you need to insert the number X in the list.
- U X: means you need to find how many numbers greater than X are on the list L.
- L X: means you need to find how many numbers less than or equal to X are on the list L.

You are allowed to use only simple Binary Search Tree. Each query must be answered in an online fashion. It means, you need to answer each query first before reading the next query. Write the step by step algorithm on how to do these queries. Analyze the complexity for each type of query of your approach.

5. a) Prove by induction, a binary tree with height H, can have at most $2^{H+1} - 1$ nodes. **8**

b) The two most used ways to represent a binary tree are Linked Lists and Arrays. What are the things to be considered when choosing one or the other? **8**

c) Suppose that you have traversed an unweighted undirected graph, G, using Breadth First Search (BFS) to find the shortest path from a node, x. When you were busy with some other task, one of your friends added a couple of edges in the graph, G. Now explain the scenario whether you can use your previous shortest paths or you have to traverse the graph again to find the shortest path with proper logical explanation. **7.33**

University of Dhaka
Department of Computer Science and Engineering
2nd Year 1st Semester B.Sc (Hons.) Final Examination'2020
Course Code: CSE-2102 Course Title: Object Oriented Programming
Total Mark: 70 (Answer any Three (3) of the following Questions) Total Time: 2 Hours

1. a) Describe and compare the factors that influence the cost of hardware and software maintenance in an organization. 5.33

   b) In terms of software development and maintenance, explain the benefits of the *Object-oriented Programming Concept* over the conventional *Procedural Programming Concept*. 6

   c) With examples, explain the relationship between a class and an object. 5

   d) In C language, we can put both data and code (function) in a struct type definition. Do you think such a struct-type variable in C provides the encapsulation feature of Object-oriented programming? Justify your answer. 7

2. a) **Write** a JAVA program with following properties: 8

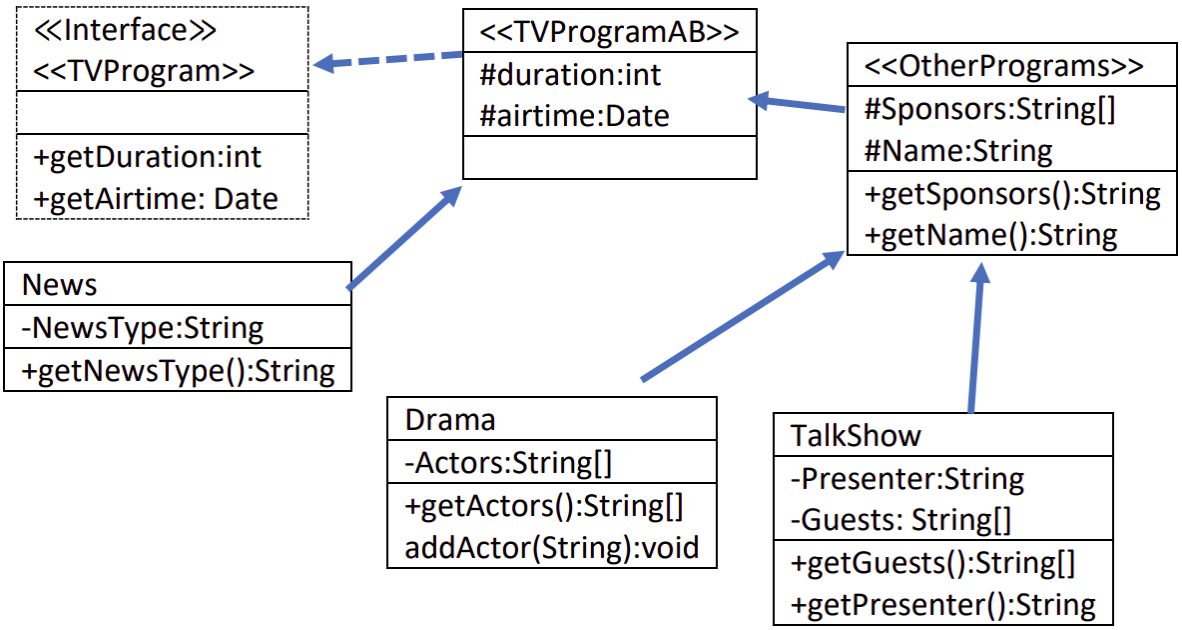
   - Package ***A***:
     i. An interface ***manage_list*** contains an abstract method ***void sort()***.
     ii. Class ***list*** contains two data members ***a[]*** (array of integers) and ***b[]*** (array of String) accessible only by the subclasses. This class should contain a ***toString()*** method.
     iii. Class ***num_list*** is a subclass of ***list*** and implements ***manage_list***. This class arranges the elements of ***a[]*** in ascending order and prints the sorted list using the ***toString()*** method.
   - Package ***B***:
     Class ***name_list*** is a subclass of ***list*** and implements ***manage_list***. This class arranges the elements of ***b[]*** in alphabetic order and prints the sorted list using the ***toString()*** method.
   - Package ***C***:
     Class ***test*** contains the main method to access all of the above-mentioned classes and methods.

   b) Suppose you want to start a website that contains posts from users containing available space for renting. Primarily you want to allow only apartment, office space, and garage renting posts. You want to ensure that if any user wants to put a renting post on the website, s/he must provide description and rent per month information with their post. If the post is about apartments, users will have to give individual information like how number of bedrooms, kitchen size, drawing/dining space size, and description of the flat will be automatically generated from that information. But in the case of office space, the user will have to provide space size and any additional information s/he wants that will be used as a description. On top of that, office space rental posts must have a rental clause that users who want to rent the space can view only. 6

   Design a UML class diagram for the above scenario.

   c) Consider a satellite television channel that offers three types of programs: News, Drama and Talk 9.33

show. Following is a UML class diagram. **Implement** it in JAVA. You may add new attributes or methods if necessary. Note: All attributes will be populated during constructor calls.



3. a) Briefly introduce the *Inheritance* and *Polymorphism* of the Object-Oriented (OO) concept. 5

   b) Suppose a designer has to implement the Circle and Rectangle classes. The designer has decided to use an interface for all kinds of shaper-type classes. The interface declares that every shape-type object will implement at least two methods, namely *getArea()* and *getColor()*. Draw the class diagram with the corresponding Jave code for the design. 6

   c) Apply *function overloading* and *function overriding* on the Java code in your answer for the question no. 3 (b). 6

   d) Explain the benefits of having abstract classes in an OOP design. 6.33

4. Consider that you have to model a set of office equipment for a software written in C++ language. The set of office equipment is {scanner, printer, telephone, fax, copier, multi-function printer}.

   a) Draw the class diagram and corresponding class definition code in C++ using multiple inheritance (if applicable). [You do not need to implement any code in a method]. 6

   b) Suddenly, your manager wants to implement your design in Java (this is a very common practice in real life) and told you to convert the multiple inheritance into a combination of single inheritance and "has a" relations. Write the corresponding Java class definitions (without method implementation). 6

   c) Further, your manager now doesn't like the design and wants you to change the design into a combination of single inheritance with "capabilities". Write the corresponding Java class definition to fulfill the new requirement. 6

   d) Compare the designs you have implemented as per the description in 3(a), 3(b), and 3(c). 5.33

5.	a)	"Exception handling in OOP is a beautiful gift for the programmers"-Do you agree with this statement? Justify your answer with example situations.	6
	b)	Briefly describe the try-catch-finally blocks in exception handling.	5.33
	c)	Write a code in Java/C++ for a savings bank account where the account holder can deposit or withdraw money. The class must raise an exception if the account has an insufficient balance during money withdrawal.	7
	d)	What are the cases when exception handling may fail a graceful exit?	5

University of Dhaka
Department of Computer Science and Engineering
2nd Year 1st Semester B. Sc. Final Examination, 2020
EEE 2103: Electronic Devices and Circuits

Full Marks: 70 **Time: 2 hours**

(Answer any Three (3) of the following Questions)

1. (a) Describe valence band, conduction band and forbidden energy gap using energy band theory. 8

   (b) Sketch the atomic bonding of silicon and insert an impurity of arsenic and indium in it. 8

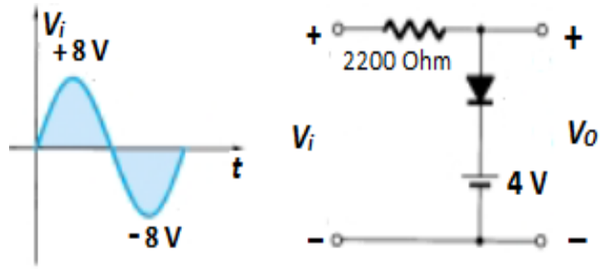
   (c) The reverse saturation current of a silicon p–n junction diode at an operating temperature of 27°C is 50 nA. Compute the dynamic forward and reverse resistances of the diode for applied voltages of 0.8V and -0.4V respectively. 7.33

2. (a) Draw the integrator circuit using op-amp and derive its output voltage equation. 8

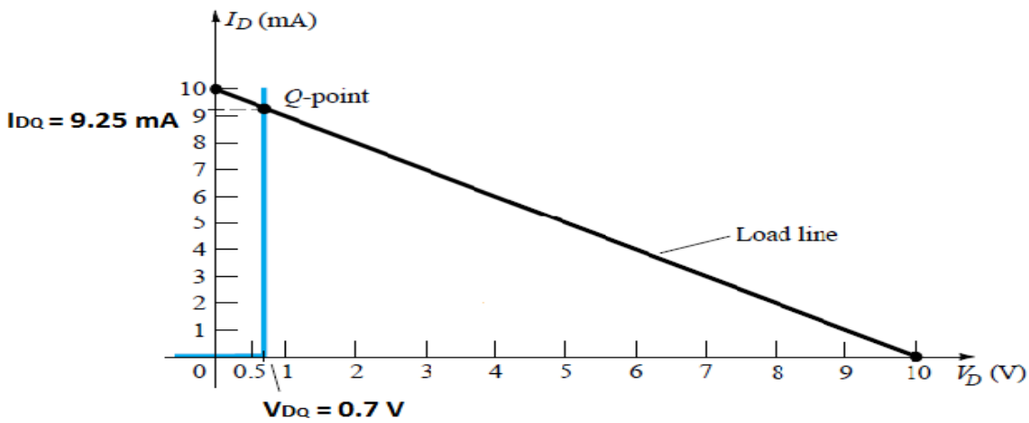
   (b) Draw the phase-shift oscillator circuit diagram and describe its operation in brief. 8

   (c) Describe static and dynamic resistance of a diode with figure. 7.33

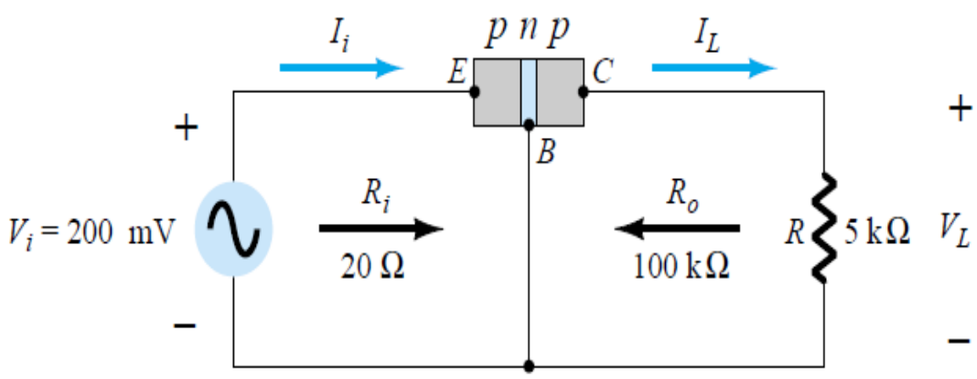
3. (a) Draw the input and output voltage graph for the following circuit considering ideal Si diode. 8



   (b) 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. 8



   (c) Explain amplifying action of bi-polar transistor using following figure. 7.33



4. (a) Using characteristic curves below determine (i) I_C at I_B = 30 μA and V_{CE} = 10V (ii) I_C at V_{BE} = 0.7V — 9

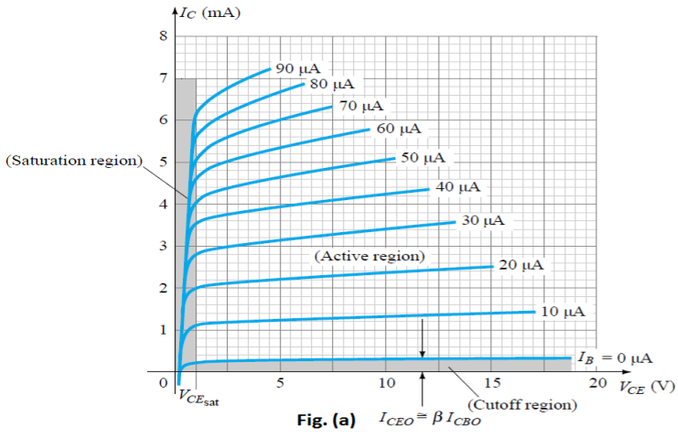


Fig. (a)

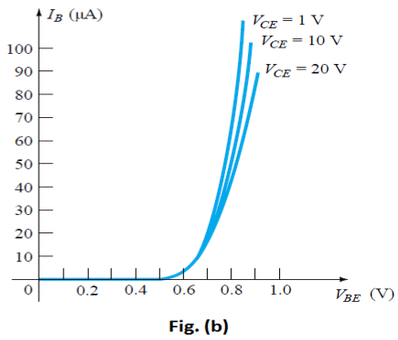
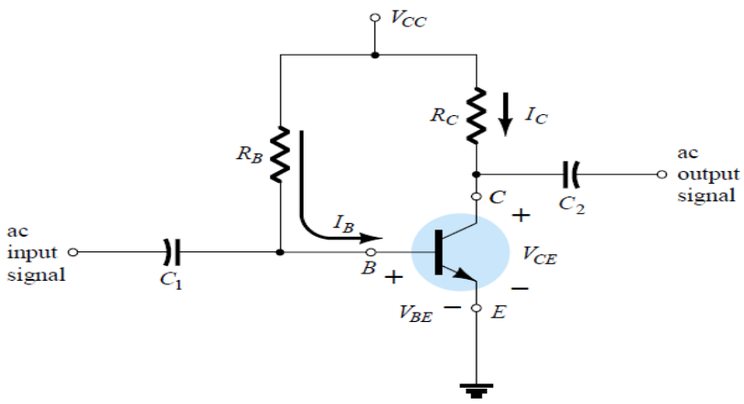


Fig. (b)

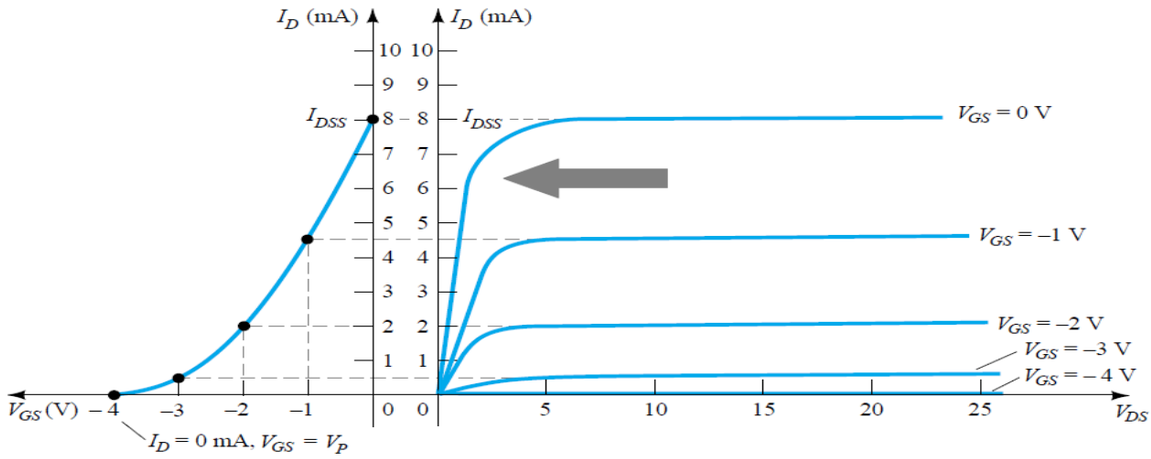
(b) With the help of input and output characteristics, explain the operation of a BJT in Common Emitter Configuration. — 8

(c) In the following figure, R_B = 240 KΩ, R_C = 2.2 KΩ, V_{CC} = +12V and β = 50. Determine I_{BQ}, I_{CQ} and V_{CEQ}. — 6.33



5. (a) Explain the significance of threshold voltage of a MOSFET. Discuss the methods to reduce threshold voltage, V_T. — 8

(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. — 8



(c) Draw (i) pnpn construction of SCR (ii) its two transistor analogy (iii) its V-I characteristic curve. — 7.33

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2nd Year 1st Semester B. Sc. Final Examination, 2020

GED-2104: Bangladesh Studies

Total Marks: 70 **(Answer any Three (3) of the following Questions)** **Time: 2 Hours**

1. Explain the importance of the following in the development of Bengal in the colonial regime: 23.33
   - Bengal Renaissance in the Nineteenth Century
   - War of Independence, 1857
   - Establishment of the University of Dhaka

   Explain your answer with reference to all of the above.

2. What were the underlying reasons for the Partition of Bengal in 1905? Why did the partition fail? Evaluate the effect of this Partition in setting the tone of the politics of India for the next four decades. 23.33

3. a) What is the main theme of Bangladesh's foreign policy? 6
   b) Discuss Bangladesh's role in UN peace keeping mission. 7
   c) What is the vision-2021? What do we want to see in 2021? Explain. 10.33

4. What would be the impact of Covid-19 pandemic on the current trend of Bangladesh's development? How could the CSE graduates contribute in achieving the target of industrial revolution 4.0? Explain with examples. 23.33

5. Write short notes (**any two**) 23.33
   a) Six Points of Bangabandhu
   b) Mass Upsurge of 1969
   c) Rohingya Crisis in Bangladesh
   d) Natural Disasters in Bangladesh

University of Dhaka
Department of Computer Science and Engineering
2nd Year, 1st Semester B.Sc (Hons.) Final Examination'2020
Course Code: MATH-2105 Course Title: Linear Algebra
Total Mark: 70 **Total Time: 2 Hours**

Answer Any Three (3) Questions

1. a) Find the general solutions of the system whose augmented matrix is given by: 6

$$\begin{bmatrix} 1 & -3 & 0 & -1 & 0 & -2 \\ 0 & 1 & 0 & 0 & -4 & 1 \\ 0 & 0 & 0 & 1 & 9 & 4 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

b) If B is the inverse of A^2, show that AB is the inverse of A. 3.33

c) Find the solution of the following system of linear equations. 10

i) $x_1 - 2x_2 + x_3 - x_4 = 3$
$x_1 + x_2 + x_3 - x_4 = 1$
$x_1 - x_3 - x_4 = 2$

ii) $x_1 - 2x_2 + x_3 - x_4 = 3$
$2x_1 - 4x_2 + x_3 + x_4 = 2$
$x_1 - 2x_2 - 2x_3 + 3x_4 = 1$

d) The following 4 by 4 matrix will need elimination matrices E_{21}, E_{32} and E_{43}. What are those matrices? 4

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

2. a) Define row space, column space, null space and rank of a matrix. Find the rank of the matrix A where 11.33

$$A = \begin{bmatrix} 3 & 4 & 5 & 6 & 7 \\ 4 & 5 & 6 & 7 & 8 \\ 6 & 7 & 8 & 9 & 10 \\ 8 & 9 & 10 & 11 & 12 \\ 12 & 13 & 14 & 15 & 16 \end{bmatrix}.$$

b) Working within the vector space C^3, determine if $b = \begin{bmatrix} 4 \\ 3 \\ 1 \end{bmatrix}$ is in the subspace W, 4

$$W = \left\{ \begin{bmatrix} 3 \\ 2 \\ 3 \end{bmatrix}, \begin{bmatrix} 1 \\ 0 \\ 3 \end{bmatrix}, \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix}, \begin{bmatrix} 2 \\ 1 \\ 3 \end{bmatrix} \right\}$$

c) Consider the following system, where the variables are x, y, z. 8

$$\begin{cases} (k+2)x + 2ky - z = 1 \\ x - 2y + kz = -k \\ y + z = k \end{cases}$$

i) For each value of $k \in \mathbb{R}$, does the system have a unique solution?

ii) For each value of $k \in \mathbb{R}$, does the system have infinitely many solutions? If any, compute those values of k all the solution of the system.

3. a) Find a basis for each of the four fundamental subspaces of 4

$$W = \left\{ \begin{bmatrix} a+b-2c \\ a+b-2c+d \\ -2a+2b+4c-d \\ b+d \end{bmatrix} \right\}$$

b) In the vector space of polynomials P_3, determine if the set S is linearly independent or linearly dependent. 4

$$S = \{2 + x - 3x^2 - 8x^3, 1 + x + x^2 + 5x^3, 3 - 4x^2 - 7x^3\}$$

c) Find the inverse of the matrix, 3

$$A = \begin{bmatrix} 1 & -2 & -1 \\ -1 & 5 & 6 \\ 5 & 4 & 5 \end{bmatrix}$$

d) If S is the subspace of R^3 containing only the zero vector, what is $S^{\perp}$? If S is spanned by (1, 1, 1), what is $S^{\perp}$? If S is spanned by (1, 1, 1) and (1, 1, -1), what is a basis for $S^{\perp}$? 4

e) Project the vector $b = (1, 1)$ onto the line through $a_1 = (1, 0)$ and $a_2 = (1, 2)$. Draw the projections P_1 and P_2 and add $P_1 + P_2$. The projections do not add to b because the a's are not orthogonal. 8.33

4. a) Use determinants to determine which of the following matrices are invertible. 4

i) $\begin{bmatrix} 4 & -8 \\ 2 & 4 \end{bmatrix}$ ii) $\begin{bmatrix} 4 & -2 \\ -8 & 4 \end{bmatrix}$

b) Consider the following system in which S is an unspecified parameter. Determine the values of S for which the system has a unique solution and use Cramer's rule to describe the solution. 6

$$3sx_1 - 2x_2 = 4$$
$$-6x_1 + sx_2 = 1$$

c) Find A^{-1} from the cofactor formula C^T / det A. 5.33

$$A = \begin{bmatrix} 1 & 2 & 0 \\ 0 & 3 & 0 \\ 0 & 7 & 1 \end{bmatrix}$$

d) State dimension theorem. 4

e) Use determinant to decide if v_1, v_2, v_3 are linearly independent, when 4

$$v_1 = \begin{bmatrix} 5 \\ -7 \\ 9 \end{bmatrix}, v_2 = \begin{bmatrix} -3 \\ 3 \\ -5 \end{bmatrix}, v_3 = \begin{bmatrix} 2 \\ -7 \\ 5 \end{bmatrix}$$

5. a) Let $A = \begin{bmatrix} 3 & -2 \\ -2 & 3 \end{bmatrix}$, $u = \begin{bmatrix} -1 \\ 1 \end{bmatrix}$, and $v = \begin{bmatrix} 2 \\ 1 \end{bmatrix}$. Are u and v eigenvectors of A? 4

b) When $a + b = c + d$, show that (1, 1) is an eigenvector and find both eigenvalues where 4

$$A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$$

c) Find the orthogonal matrix Q that diagonalizes the following symmetric matrix 6

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

d) Find all eigenvalues and associated eigenvectors of the matrix 9.33

$$A = \begin{bmatrix} 4 & 3 \\ 2 & 5 \end{bmatrix}$$

Is A diagonalizable? If so, find an invertible matrix P that diagonilazes A.