University of Dhaka
Department of Computer Science and Engineering
2nd Year 1st Semester Final Examination, 2022
EEE-2103: Electronic Devices and Circuits (3 Credits)

Total Marks: 70 Time: 3 Hours

Answer any 5 (five) of the following questions

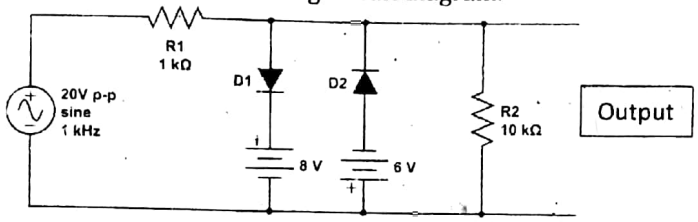
1 **(a)** Explain the conductivity of metal, semiconductor, and insulator with the help of energy band diagram. [4]

(b) What is the *base-width modulation* of a BJT? Mention the effects of base-width modulation. [4]

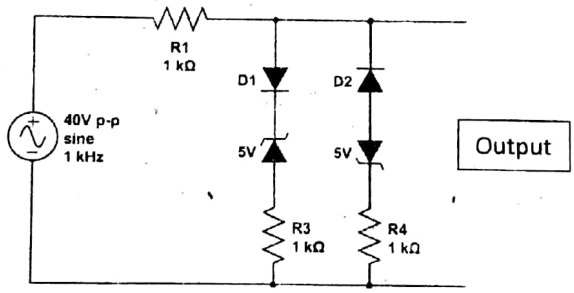
(c) What happens if the collector region of a BJT is made thinner than emitter or base region? Will it lose its property? [4]

(d) Why do Silicon transistors prevail over Germanium types? [2]

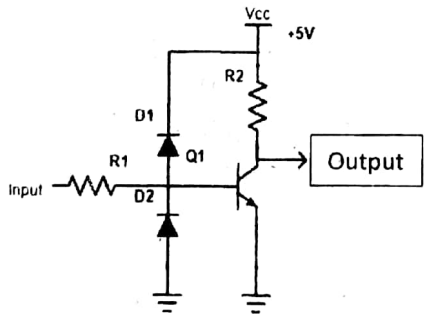
2 **(a)** Draw the output waveform of the following circuit diagram. [3]



(b) Determine the output waveform in the following circuit with the given input. You need to consider the effect of the resistors. You need to explain about the output waveform. [5]

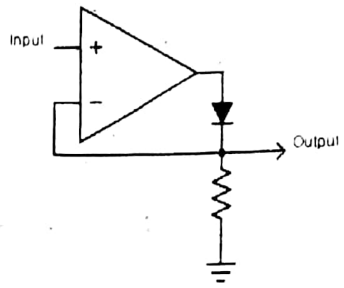


(c) Draw the output waveform in the following circuit diagram. Assume a 1KHz sine wave with 20V p-p as input. [3]

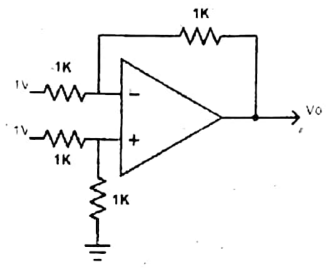


(d) Sketch a voltage Tripler circuit and explain its operation. [3]

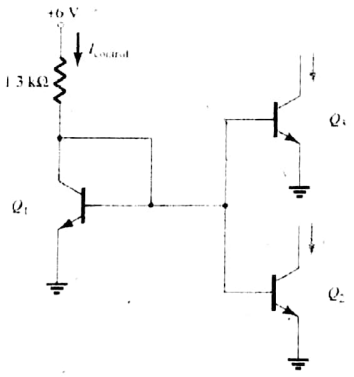
3 **(a)** Draw the output waveform of the circuit below. Also explain the operation of the circuit. Assume a 1KHz sine wave with 10V p-p as input. [5]



(b) Calculate the V_O of the circuit below: [5]

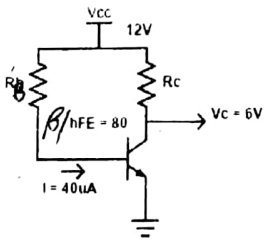


(c) Calculate the current I through each of the transistor Q_2 and Q_3 in the circuit below. Assume Q_1, Q_2, and Q_3 are identical. [4]

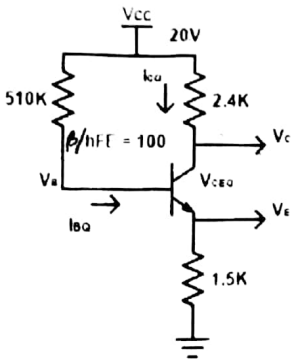


4 **(a)** Draw the circuit diagram of a CE voltage-divider configuration circuit and derive the value of V_{CE} and I_C. [4]

(b) Determine the following values of the circuit below: [4]
i) I_C, ii) R_C, iii) R_B, and iv) V_{CE}

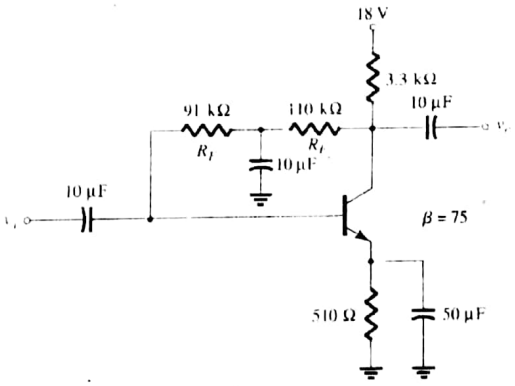


(c) Determine the following values of the circuit below: [6]
i) I_{BQ}, ii) I_{CQ}, iii) V_{CEQ}, iv) V_C, v) V_B, and vi) V_E

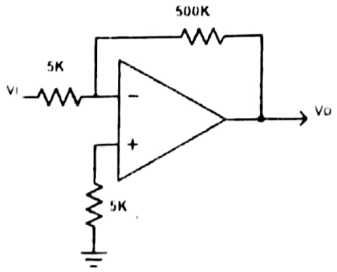


5 (a) Explain the working principle of an n-channel JFET with various values of V_{GS} and V_{DS}. Draw the transfer characteristics curve of an n-channel JFET. [6]
(b) Describe the basic construction of a depletion-type MOSFET. [5]
(c) What are the differences between a JFET and a MOSFET? [3]

6 (a) What do you understand by thermal runaway? Mention a way to prevent it in a CE BJT amplifier. [5]
(b) What is the significance of emitter bypass capacitor? [3]
(c) Determine the DC level of I_B and V_C of the following circuit. [6]



7 (a) What is CMRR? Derive the value of A_c and A_d to calculate the value of CMRR. [1+2]
(b) Determine the output voltage of an Op-Amp for input voltages of V_{i1} = 150μV, V_{i2} = 140μV. The amplifier has a differential gain of A_d = 4000 and the value of CMRR is: (i) 100, and (ii) 10^5 [2+2]
(c) Explain how Op-amps can be used to design an Integrator. [4]
(d) Calculate the total offset voltage for the circuit below for an Op-amp with the specified values of input offset voltage, V_{IO} = 4 mV and input offset current, I_{IO} = 150 nA. [3]



University of Dhaka
Department of Computer Science and Engineering
2nd Year 1st Semester Final Examination, 2022
MATH-2105: Linear Algebra (3 Credits)

Total Marks: 70 Time: 3 Hours

Answer any 5 (five) of the following questions

1. a) Find parametric solution of the homogeneous linear system Ax = 0 where [6]

$$A = \begin{bmatrix} 6 & -8 & -4 & 5 & -4 \\ 2 & 7 & -5 & -6 & 4 \\ 0 & -1 & -8 & 2 & 2 \\ -1 & -2 & 4 & 4 & -8 \end{bmatrix}$$

b) State the shape of the vector subspace formed by the span of the following four vectors with proper explanation. [4]

v1 = [3 4 6 1]^T
v2 = [1 3 2 4]^T
v3 = [5 10 10 9]^T
v4 = [-6 -13 -12 -13]^T

c) Suppose A is a 4 x 3 matrix and b is a vector in R^4 with the property that Ax = b has a unique solution. What can you say about the reduced echelon form of A? Justify your answer. [4]

2. a) Generate a chain of elementary matrices, multiplying which with the following matrix A will generate A^{-1} [6]

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

b) Find the LU factorization of the matrix given below. [6]

$$\begin{bmatrix} 1 & 4 & -1 & 5 \\ 3 & 7 & -2 & 9 \\ -2 & -3 & 1 & -4 \\ -1 & 6 & -1 & 7 \end{bmatrix}$$

c) Explain the scenarios with examples when LU factorization is not possible. [2]

3. a) Calculate determinant of the following matrix by reducing it to echelon form. [5]

$$\begin{vmatrix} 1 & -1 & -3 & 0 \\ 0 & 1 & 5 & 4 \\ -1 & 0 & 5 & 3 \\ 3 & -3 & -2 & 3 \end{vmatrix}$$

b) Derive a formula to calculate the inverse of a matrix using Cramer's rule. [6]

c) What does determinant of a 2x2 matrix represent geometrically? Explain with a graphical demonstration. [3]

4. a) What are the properties of a vector subspace? For what value(s) of h will y be in the subspace of R^3 spanned by v_1, v_2, v_3, if [5]

v1 = [1 -1 -2]^T v2 = [5 -4 -7]^T v3 = [-3 1 0]^T and y = [-4 3 h]^T

b) Determine whether w is in the column space of A, the null space of A, or both, where [5]

$$w = \begin{bmatrix} 1 \\ 1 \\ -1 \\ -3 \end{bmatrix}, \quad A = \begin{bmatrix} 7 & 6 & -4 & 1 \\ -5 & -1 & 0 & -2 \\ 9 & -11 & 7 & -3 \\ 19 & -9 & 7 & 1 \end{bmatrix}$$

c) Let $S = \{ v_1, v_2, ..., v_p \}$ be a set in V, and let $H = \text{Span}\{ v_1, v_2, ..., v_p \}$. If one of the vectors in S —say, v_k —is a linear combination of the remaining vectors in S, then prove that the set formed from S by removing v_k still spans H. [4]

5. a) Find all eigenvalues and corresponding eigenvectors of the following matrix [5]

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

b) Let A be a transformation matrix that rotates a 2-dimensional vector x by 30 degrees. Can x be an eigenvector of A? If yes, show an example. [4]

c) Let $H = I - 2u\,u^T$ and $||u|| = 1$. The vector u is an eigenvector of H. Find the corresponding eigenvalue. [5]

6. a) Prove that for a square matrix A with orthonormal columns, $A^T = A^{-1}$. [3]

b) Use the Gram–Schmidt process to produce an orthogonal basis for the column space of the matrix given below. [8]

$$\begin{bmatrix} -10 & 13 & 7 & -11 \\ 2 & 1 & -5 & 3 \\ -6 & 3 & 13 & -3 \\ 16 & -16 & -2 & 5 \\ 2 & 1 & -5 & -7 \end{bmatrix}$$

c) Find the QR factorization of the matrix from Question No. 6.b). You can also use the values calculated in that question if needed. [3]

7. a) Find a least square solution for $Ax = b$ for [7]

$$A = \begin{bmatrix} 1 & 1 & 0 \\ 1 & 0 & -1 \\ 0 & 1 & 1 \\ -1 & 1 & -1 \end{bmatrix}, \mathbf{b} = \begin{bmatrix} 2 \\ 5 \\ 6 \\ 6 \end{bmatrix}$$

b) Find singular value decomposition of the matrix given below [7]

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

University of Dhaka
Department of Computer Science and Engineering
2nd Year 1st Semester Final Examination, 2022
CSE-2101: Data Structures and Algorithms (3 Credits)

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

Answer any 5 (five) of the following questions

1. **a)** Explain the definition of Big O complexity in understanding a code's performance. [2]

b) You are given the following code segment. Calculate the Big O runtime complexity with respect to input size N. [6]

```
void function(int arr[], int N){
    // arr denotes an array, N denotes the size of the array
    for(int i=0; i<N; i++){
        for(int j=0; j<=sqrt(i); j++){
            /*** doing something here in constant time ***/
        }
    }
    for(int i=0; i<N; i++){
        int st = i;
        while(st <= N){
            /*** doing something here in constant time ***/
            st *= 2;
        }
    }
}
```

c) You are given a function, $f(n) = 7n^3 + 9n + 5$, representing a code fragment's actual runtime complexity. "The big theta (θ) complexity of the function is n^2." Justify the argument using your own words. [3]

d) You will be given N numbers, and each number can be either positive or negative. You need to calculate the number of non-repetitive positive even numbers observed in your input. You also need to analyze the memory complexity in terms of Big O for your proposed solution. [3]

2. **a)** "Within the context of binomial trees, the root of B_k has a degree less than or equal to **k**, and all other nodes in B_k have a degree smaller than **k**." – is the statement true? [4]
   - If it is true, then generate a binomial tree (**T1**) using any 16 nodes and relate it to the statement.
   - If not, revise the statement and use any 16 nodes to generate a binomial tree(**T1**) that relates to the correct statement.

b) Considering **T1** from **2.a)** as an input, [4]

I. Create one or more binomial trees with three additional nodes and merge it with **T1** to form the binomial heap **H1**.

II. Add another B_2 binomial tree with **H1**.

c) We are aware that the exact-min operation is used to sort an unsorted list of elements. Discuss the effect of the introduction of a binomial heap instead of a binary heap on the worst-case complexity of the heap sort. [2]

d) Is there any operation in which a binary heap performs better than a binomial heap? You must use the current state of **H1** [from **2.b)**] to support your position. [2]

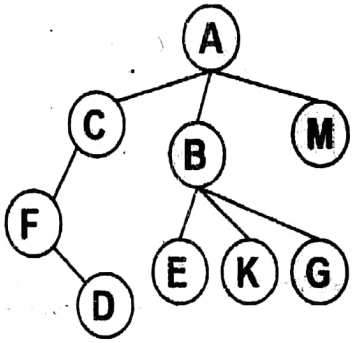
e) Compare the worst-case complexity of the union or merge operation of a binary and a binomial heap. [2]

3. a) The following pseudocode is intended to find the **square root** of a given number using the binary search algorithm. If you notice any errors in the pseudocode, then you should correct them. [2]

```
def find_square_root(number):
    low = 0
    high = number
    while low <= high:
        mid = (low + high) / 2
        if mid * mid == number:
            return mid
        elif mid * mid < number:
            low = mid + 1
        else:
            high = mid - 1
    return low - 1
```

Tailor the above (or corrected) pseudocode so it can be used to find the **nth root.** [3]

b) In the following graph, assume that if there is ever a choice amongst multiple nodes, both the **BFS** and the **DFS** algorithms will choose the left-most node first.



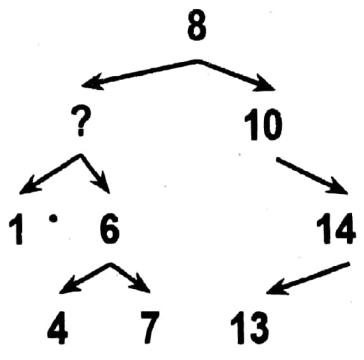
I. Contrast the **BFS** and the **DFS** algorithms in terms of the data structures required for their implementations. [3]

II. Starting from the node **A** at the top, which algorithm will visit the least number of nodes before visiting the goal node **G**? [2]

III. Identify which of the graph representation mechanisms is best-suited for the preceding graph and why. [2]

IV. Insert only one additional edge and assign integer weight in the range [-1, +1] to each edge of the above graph so that the resulting graph has a negative cycle. [2]

4. a) Consider the given tree,

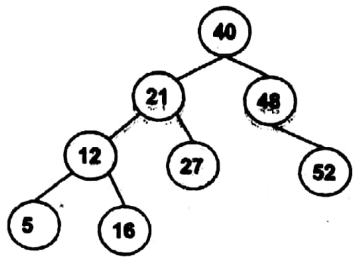


I. Which value in the "?" node would make the above tree a binary tree but not a binary search tree. [1]

II. Use an appropriate value ***P*** in the "?" node to make it a binary search tree. [1]

III. Reconstruct two binary search trees after deleting ***P*** using both "in-order predecessor and in-order successor" schemes. [3]

b) Consider a binary search tree as follows:



I. Insert a node (e.g., 3) into the above binary search tree, and then determine the balance factor for each node. [2]

II. Now, if you find any issues with the updated tree's balancing property, then balance it using the concept of AVL tree properties. [4]

III. Write a pseudocode outlining your actions, which must reflect the previously determined balance factor. [3]

5. a) We know that a queue can be implemented using various data structures, including arrays and linked lists.

I. Is there any relationship between the above statement and the nature of queues being an Abstract Data Type (ADT)? You should start your answer with the proper introduction of ADT. [4]

II. With a suitable example, discuss how the implementation choice of an ADT can impact the benefits of a circular queue. [4]

b) You have been provided with a linked list **L1** and two integers, **M** and **N**. You are tasked with implementing a *function* (provide a pseudocode) that generates a new linked list **L2** from **L1** based on the following guidelines: [6]

- Retain the first M nodes in the linked list
- Delete the next N nodes
- Connect the remaining nodes to the first M nodes
- Finally, make the resulting linked list as a circular linked list

6. a) Carefully consider an array of size 5 so that it reflects the following property:

Quick sort is sensitive to the order of input data and, as such, experiences poor worst-case complexity compared to merge sort or heap sort algorithms.

I. You need to provide the detailed output of each step to relate that so-called worst-case complexity. [4]

II. Now, mention why quick sort is still widely used despite this poor performance. [2]

III. Finally, comment on whether quick sort maintains the "in-place" property, referencing the preceding example in your response. [2]

b) Merge sort is a sorting algorithm involving divide, conquer, and combine operations.

I. Which of these mentioned steps is associated with its base case swapping? [1]

II. In which case, based on the size of the input data, may merge sort not be as efficient or suitable as compared to sorting algorithm having quadratic complexity algorithms? And why? Mention names of two such algorithms. [3]

III. Under what circumstance(s) is the counting sort algorithm inappropriate? [2]

7. a) Write an algorithm to calculate the postfix expression from an infix expression. Simulate your algorithm based on the following input infix expression. [7]

3 ^ 7 - 5 / 7 + 3 * 4 / 5 + 6 * 2

b) Write an algorithm to calculate the value of a postfix expression. Based on the converted postfix expression in **7.a)**, simulate the output using your designed algorithm. **[Use integer operations only]** [7]

University of Dhaka
Department of Computer Science and Engineering
2nd Year 1st Semester Final Examination, 2022
CSE-2102: Object Oriented Programming (3 Credits)

Total Marks: 70 Time: 3 Hours

Answer any 5 (five) of the following questions

1. a) What is constructor overloading? Give an example. What happens when a return type, even void, is specified for a constructor? [4]

   b) Discuss how each of the following terms and concepts applies to the notion of a watch: **object**, **attributes**, **behavior**, **class**, **inheritance**, and **encapsulation**. [4]

   c) Design a class named **Student** that has two private data - student id and score. The class should contain a parameterized constructor to initialize its data members and one method to display the information. Now, write a Java program that will use an array of the **Student** objects to represent information about **n** number of students. Your program should take input from the keyboard and display the students' information. [6]

2. a) Discuss two ways through which Java achieves the OOP feature of polymorphism. [4]

   b) Explain the two main benefits of nested classes. Give an example code that demonstrates these benefits. [4]

   c) Mention three cases where the **final** keyword is used. [3]

   d) From the code snippet given below, write down the relationships (for example, inheritance, composition) among the classes/interfaces **FileReader**, **TextFileReader**, **CSVFileReader**, and **ExcelFileReader**. Briefly explain your reasoning. [3]

```
class FileReaderFactory {
    public FileReader createReader(String fileType) {
        if(fileType.equals("text")) {
            return new TextFileReader();
        } else if(fileType.equals("csv")) {
            return new CSVFileReader();
        } else if(fileType.equals("excel")) {
            return new ExcelFileReader();
        } else {
            throw new IllegalArgumentException("Unsupported file
type");
        }
    }
}
```

3. a) Explain the different types of polymorphism that are available in Java with an example. [4]

   b) Suppose a subclass inherits a method implementation from a superclass, and implements a Java interface (that's the interface keyword) that contains a method with the same name and prototype. [4]

      I. Will Java compile the result? What if the method declaration in the interface has a different return type?

      II. What if the method declaration in the interface has the same return type, but a signature with a different parameter type?

   c) Consider the following statement - [2]

      public static void main(String args[])

      Describe why the main method should always be public and static.

   d) Describe the scope of public, private, protected, and default access modifiers. [4]

4. a) Consider the following facts: [8]

Humans breath, eat, move(walk), talk
Birds breath, eat, move(fly), chirp
Fishes breath, eat, move(swim)
Dogs breath, eat, move(run), bark

Design the class/interface hierarchy and then write Java code that reflects the OOP principles.
Hint: You may create separate classes/interfaces for humans, birds, fishes, dogs, and possibly some more as per your needs. The actions of an animal may be represented by a single-statement method, for example, to implement human's breathing action, you may write the statement:

```
System.out.println("Breathing…");
or
System.out.println("Human is breathing…");
```

In your code, you should practice OOP principles as much as possible.

b) Explain the concept of the "**super**" keyword in Java. How is it used in method overriding? [6]

5. a) I. Explain the purpose of packages in Java and how they can be used to organize and manage large-scale Java projects. [2]

II. Provide an example of a package hierarchy that you might use for a project involving user authentication, product management, order processing, and customer support. You need to write the package names and their member classes. Suppose the available classes are: [4]

- `ProductManager.java`,
- `User.java`,
- `Inventory.java`,
- `Order.java`,
- `PaymentProcessor.java`,
- `AuthenticationManager.java`,
- `Product.java`,
- `Customer.java`,
- `OrderManager.java` and
- `SupportTicket.java`

b) I. What are the main benefits of using multithreading in Java? [3]

II. Explain how the following code snippet creates a new thread and starts it: [5]

```
Thread thread = new Thread(() -> {
    // some code to be executed in a separate thread
});
thread.start();
```

6. a) What is the difference between checked exceptions (e.g., IOException) and unchecked exceptions (e.g., ArithmeticException) in Java, and how are they handled differently in the code? [5]

b) Suppose you are building a weather application that retrieves weather data from different APIs. The APIs can return different exceptions, such as **`NetworkException`**, **`DataFormatException`**, and **`UnauthorizedException`**, where **`DataFormatException`** and **`UnauthorizedException`** inherit **`NetworkException`**. In addition to these exceptions, other exceptions may be generated as well. Write a try-catch block to handle each of these exceptions separately and provide appropriate error messages. Briefly explain your code. [4]

c) Explain the difference between the "throw" and "throws" keywords in Java exception handling with example codes. [5]

7. a) Generate the output of the following Java program and state the reason for your result: [4]

```
public class A{
    A(){
        System.out.println("Constructor of A");
    }
    void print(){
        System.out.println("Inside print method of A");
    }
}

public class B extends A{
    B(){
        System.out.println("Constructor of B");
    }
    void print(){
        System.out.println("Inside print method of B");
    }
    public static void main(String[] args){
        A a = new B();
        a.print();
    }
}
```

b) Create a Shape interface with two methods, draw() and area(). Implement two classes (**Rectangle** and **Circle**) those implement the Shape class. The first method exhibits a print statement to show a certain figure is drawn, and the other method calculates the area. Each class (**Rectangle** and **Circle**) should take enough input to calculate the area for a certain shape. Your task is to design the classes based on the given scenario. [6]

c) What is the difference between method overriding and method overloading? Explain with examples. [4]

University of Dhaka
Department of Computer Science and Engineering
2nd Year 1st Semester Final Examination, 2022
GED-2104: Bangladesh Studies (3 Credits)

Total Marks: 70 Time: 3 Hours

Answer any 5 (five) of the following questions

1. a) Mention the major sea ports of Bangladesh and their strategic advantages in managing the export-import of Bangladesh. [4]

   b) Briefly discuss the chain of events starting from 1952 language movement that led to the independence of Bangladesh in 1971. [7]

   c) Discuss the climate of Bangladesh. [3]

2. a) Bangladesh's government is investing massively in ICT sector. Discuss how ICT can be effectively used to solve the traffic problem in the big cities. [6]

   b) What are the features of Bangladeshi cuisine? [4]

   c) What role was played by the Razakar force in 1971? [4]

3. a) What is meant by public administration? Discuss the Administrative geography of Bangladesh with numbers. [1+4]

   b) Describe the new National Curriculum of Education in Bangladesh. [4]

   c) Explain how modern computing technology such as Artificial Intelligence can help the healthcare sector of Bangladesh. [5]

4. a) What is the vision of Smart Bangladesh by 2041? What do we want to see in 2041? Explain. [4+3]

   b) Explain the social classes and stratification in Bangladesh. [7]

5. a) Discuss the five major river networks of Bangladesh. [3]

   b) Discuss Bangladesh's role in the UN peace keeping mission. [5]

   c) *Dhaka University campus can be considered as a museum of the liberation war of Bangladesh* – explain this statement. [6]

6. a) Write a short note on the Banking sector of Bangladesh. [4]

   b) Discuss the importance of agriculture in Bangladesh's economy especially in reducing rural poverty. [5]

   c) Describe the contribution of the apparel manufacturing sector on the economy of Bangladesh. [5]

7. a) Describe the Revolutionary movement against British rule in Bengal. [7]

   b) Discuss the Direct Action Day in 1946. [3]

   c) Mention the causes of the mass uprising in East Pakistan in 1969. [4]