

Answer any Five(5) of the following questions ( $5 \times 14 = 70$ )

1. (a) Design a linked list with the following methods: [6]

- `insert_first(int val)`: Inserts val in the first position. Complexity is  $O(1)$ .
- `insert_last(int val)`: Inserts val in the last position. Complexity is  $O(N)$ .
- `delete_first()`: Deletes the first node. Complexity is  $O(1)$ .
- `delete_last()`: Deletes the last node. Complexity is  $O(N)$ .

- (b) Convert the given expression in prefix notation. Show each step of the algorithm. [5]

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

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

2. (a) Using Quick Sorting algorithm sort the following array  $S = \langle 5, 1, 10, 9, 4, 10, 2 \rangle$ . Please note that pivot element will be the mid-indexed element of the sequence of the unsorted elements. Show all the intermediate steps. In each step, you can show the following things: selected pivot and modified array after each swapping operations. [6]

- (b) Suppose you have an array of N elements, A, where each of elements is in the range  $[-10^5, 10^5]$ . Write pseudocode of a sorting algorithm to sort the array A, where your proposed algorithm time complexity will be  $O(N)$ . [5]

- (c) Consider an array  $A = \langle 3, 5, 8, 9, 10, 13, 18, 21 \rangle$ . If you apply bubble sort, heap sort and merge sort algorithms to sort the elements of A in ascending order, then which algorithm may perform better in terms of runtime? Justify. [3]

3. (a) Insert the following numbers into an empty AVL Tree: 2,9,10,7,6,11,1,3,4 in that order. Show all the intermediate steps. [6]

- (b) Delete 10 from the above AVL tree. Show all the intermediate steps. [2]

- (c) Write pseudocode to print all the values of an AVL tree in increasing order. [4]



- (d) What can be the maximum and minimum number of elements in an AVL tree of height 6? [2]
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: 12, 70, 6, 250, 19, 171. [6]
- (b) Write an algorithm for extracting the 3rd highest element of a max-heap. Analyze complexity. [4]
- (c) Design the insert function of a min-max heap. A min-max heap is a heap, where in every even level it acts as a min heap, while in every odd level; it acts as a max heap. Note that, the root belongs in level 0. [4]
5. (a) Suppose you have a list of tasks execution constraint T. Each of the constraints is in the following form: X Y, which means that you must execute the task X before Y.
- Design and write a pseudo-code of an approach which will find a valid task execution order of T. Please note that you must execute all the tasks and no task can be executed by violating the proper the task execution order. [7]
  - Will the task order(which is determined from your proposed approach) be always unique for any given task constraints list. Justify your opinion. [2]
  - Can your proposed approach find a valid task order for any given task constraints list? Justify. [2]
- (b) What is the maximum and the minimum number of items that can be stored in a heap with height h? [2]
- (c) Can a shortest path contains cycle? [1]
6. (a) Suppose you are given a graph  $G=(V, E)$ , where V is the list of vertex and E is a list of edges. Now design and write a pseudo-code of an algorithm to determine whether the given graph is a tree. Determine the time and memory complexity of your proposed approach. [7]
- (b) Suppose you have a hash table H and a hash function  $H(K) = K \bmod \text{TableSize}$ . Consider TableSize=9. If you have to show all the intermediate steps for the following first two tasks.
- Insert the following numbers using closed hashing with liner probing approach:  
9,10,18,27,2,3 [2]
  - Insert the following numbers using closed hashing with quadratic probing approach:  
9,10,18,27 [3]
  - Insert the following numbers using open hashing: 9,11,18,27,5,29 [2]

7. (a) Suppose, you are in-charge of CSEDU canteens cash counter. You have to give the change of a certain amount, when a customer pays the bill, using the combination of 50 cents, 25 cents, 10 cents and 1 cent coins. Imagine that CSEDU canteen has the unlimited supply of each of these coins. But the problem is all the time customers want to get the minimum number of coins for their change. Propose an algorithm which can determine the minimum number of coins you will need to give for a certain amount of change. [6]

(b) Perform runtime analysis of the following program and express them in  $\Theta$  notation. [2]

```
void program1(int n){
    for(int i=1, sum=0; i<n; i++)
        for(int j=40; j<n; j*=5)
            sum+=i;
}
```

(c) Suppose you have the following text  $S = \text{"Hatti Maa Tim Tim"}$ , you have to consider the space as a separate character. Now encode the above text using Huffman coding approach. Show all the intermediate stages. [6]



**University of Dhaka**  
**Department of Computer Science and Engineering**  
**2<sup>nd</sup> Year 1<sup>st</sup> Semester Final Examination – 2019**  
**CSE 2102: Object Oriented Programming**

**Full Marks: 70**

**Time: 3 Hours**

*(Answer any 5 Questions)*

1. a) Briefly explain what you understand by software architecture. How do we write/show the architecture of a software? 5
- b) With examples, show how the following OOP features are advantageous in programming:
- i. Encapsulation. 1
  - ii. Inheritance. 2
  - iii. Polymorphism. 2
- c) With example classes, distinguish the scenario when we should inherit a class and when we need to inherit an interface. 4
2. Suppose, your company develops software for a number of online shops, online airline ticketing and online ticketing for movie theaters. All such software use a common set of objects (i.e., classes) with a common or deviated operations. The common objects are (i) customer, (ii) item (a shopping-item or a seat in a flight or a seat in the movie theater), (iii) order, (iv) order detail (list of items in an order) and (v) payment. However, the actual payment can be done through any of the following four types of transactions (a) credit card transaction, (b) cash on delivery, (c) bank check (debit card) transaction or (d) BCash transaction. Since, the set is common for all software application; your company have assigned you to model the generic order-payment system for implementation. You have the freedom to choose the attributes and methods for the classes. Based on the application description, answer the followings:
- a) Draw the UML class diagram for the software application. The design (class diagram) must meet the followings:
- i. The design must have at least one abstract class, one generalization and one composition. 6
  - ii. The associations between the classes must be named and its multiplicity and navigability should be shown. 3
- b) Write Java class declarations for the payment related classes. You do not need to implement any of the methods just use {...} to show the method. 5
3. a) Write a class "Product" with the following characteristics: 5
- i. private member variables for ID, Name, Price
  - ii. a parameterized constructor which takes all member variables
  - iii. get and set methods for each of the member variables.
- b) Consider the following Product Objects of Product class from Question 3(a). 6
- ```
Product p1= new Product(1001, "Television", 20000.00);  
Product p2= new Product(1002, "Laptop", 62000.00);  
Product p3= new Product(1003, "Printer", 3000.00);
```
- Now write a program to write the data of product objects into a file name product.inf. Also write necessary codes to read the same data from that file and output the data according to format specified below:
- | <b>Id</b> | <b>Name</b> | <b>Price</b> |
|-----------|-------------|--------------|
| 1001      | Television  | 20000.00     |
| 1002      | Laptop      | 62000.00     |
| 1003      | Printer     | 3000.00      |
- c) What is access specifier? Distinguish among them with examples. 3



4. a) Write an example code of the try-catch-finally blocks in Java and explain how Java deals with the exceptions. 3
- b) When do you have to use 'throws' clause in declaring a method of a class in Java? 2
- c) Write a Java program to compute the roots of a simple quadratic equation. The program can compute the root if the roots are real (number). It generates an exception "ImaginaryRootException" when the quadratic equation has an imaginary root. Declare and use the exception in your program. 5
- d) What is the problem with the below program and how do we fix it? 4

```
package com.journaldev.exceptions;
import java.io.FileNotFoundException;
import java.io.IOException;
```

```
public class TestException {
```

```
    public static void main(String[] args) {
```

```
        try {
```

```
            testExceptions();
```

```
        } catch (FileNotFoundException | IOException e) {
```

```
            e.printStackTrace();
```

```
        }
```

```
    public static void testExceptions() throws IOException,
    FileNotFoundException{
```

```
    }
```

```
}
```

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

5. a) Consider the "Sales" class. Now write a java program that create three threads, each of which accessing the same 'Sales' 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. 8

- Add 20 to the count.
- Calculate balance of the count
- Calculate 7% vat of the balance
- Print the balance and the vat

```
class Sales{
```

```
    double balance=0;
```

```
    double vat=0;
```

```
    int count=0;
```

```
    void inc(int c){
```

```
        count=count+c;
```

```
    }
```

```
    double calcvat(double percentage){
        vat=balance*percentage/100;
```

```
    }
```

```
    double calcbalance(){
        balance=balance+count*10;
```

```
    }
```

```
}
```

- b) Which is more efficient way to display the elements of a list: for loop or Iterator? Explain with example. 3
- c) Logically explain whether or not we can access non-static fields of a class from a static method. 3



- E a) Briefly explain the following IP networking terminologies:
- i. IP address
  - ii. Host Name
  - iii. Socket
- b) What is the difference between Socket and ServerSocket classes in Java? 4
- c) Why do we need the objects to handle Input and Output Streams when we write networking applications in Java? 3
- d) Write a server-side and client-side java program that communicate with each other. The client-side program sends a number to the server-side program and the server-side program replies with the same number (supplied by the client-side program) of words separated by spaces to the client-side program. 4
7. a) Write a Java program that gives a graphical interface to take a text input from keyboard and showing a label. (Put line number at each line after finishing the code). 5
- b) How would you use the graphical interface with the client-side program of question 6(d)? 5
- c) Briefly explain the purpose of ActionListener interface. 4



Second Year First Semester Final Examination – 2019  
Department of Computer Science and Engineering  
University of Dhaka  
MATH 2105: Linear Algebra  
Total Marks: 70, Credits: 3, Time: 3 hours

Answer any five(5) of the following questions (5X14=70)

- 1 a. Consider the following system of Linear Equations.

[6]

$$\begin{aligned} 2x_0 - x_1 + 4x_3 + 2x_4 &= 0 \\ -x_0 + 2x_1 - x_2 + 3x_3 &= 0 \\ -x_1 + 2x_2 - x_3 &= 0 \\ 6x_0 - 3x_1 - x_2 + 14x_3 - 2x_4 &= 0 \\ x_3 + x_4 &= -7 \end{aligned}$$

Find the pivots and solve the system of linear equations using Gaussian Elimination.

- b. Consider the following matrix.

[2+2  
+4]

$$\begin{bmatrix} 1 & -2 & 9 \\ 3 & 8 & 6 \\ x & 1 & y \end{bmatrix}$$

- List the necessary conditions for the existence of the inverse of a matrix.
- Determine the necessary conditions on the variables  $x, y$  when there exists the inverse of the matrix.
- Give an example value for the pair  $(x, y)$  when there exists the inverse of the matrix. Find the inverse of the matrix for that value of  $(x, y)$  pair.

2. a. Forward elimination changes  $Ax = b$  to a row reduced  $Rx = d$ : the complete solution is

[2+2  
+2]

$$x = \begin{bmatrix} 7 \\ 0 \\ 0 \end{bmatrix} + c_1 \begin{bmatrix} -7 \\ 1 \\ 0 \end{bmatrix} + c_2 \begin{bmatrix} 13 \\ 0 \\ 1 \end{bmatrix}$$

- What is the  $3 \times 3$  reduced row echelon matrix  $R$  and what is  $d$ ?
- If the process of elimination subtracted 3 times row 1 from row 2 and then 5 times row 1 from row 3, what matrix  $E$  connects  $R$  and  $d$  to the original  $A$  and  $b$ ?
- Find  $A$  and  $b$ .

- b. Find  $L$  and  $U$  for the following matrix:

[4+2]

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

Find the conditions on  $a, b, c, d, r, s, t$  to get  $A = LU$  with four pivots.

(c)

Prove that the vector  $b = \begin{bmatrix} 6 \\ 24 \\ 15 \end{bmatrix}$  is in the column space of  $A = \begin{bmatrix} 2 & 1 \\ 6 & 5 \\ 2 & 4 \end{bmatrix}$

[2]

3. a. Construct a matrix whose column space contains  $(1, 1, 1)$  and whose null space is the line of multiples of  $(1, 1, 1, 1)$ .

[2]

- b. Choose the number  $q$  so that (if possible) the rank of  $A$  is

[2]

- 1
- 2
- 3

$$A = \begin{bmatrix} 6 & 4 & 2 \\ -3 & -2 & -1 \\ 9 & 6 & q \end{bmatrix}$$



c. For an  $m \times n$  matrix with rank  $r$ , write all relations between  $r, n$  and  $m$  if  $Ax = b$  has [8]

- i) No solution for some  $b$   $n < m$   $n < n$
- ii) Infinitely many solutions for every  $b$   $n = m < n$
- iii) Exactly one solution for some  $b$ , no solution for other  $b$   $n = n < m$
- iv) Exactly one solution for every  $b$   $n = m = n$

d. Suppose  $A$  is a 4 by 4 identity matrix with its last column removed; i.e.  $A$  is 4 by 3. [2]  
Project  $(1, 2, 3, 4)$  onto the column space of  $A$  (if possible).

4. a. Find a basis for each of the four fundamental subspaces associated with [8]

$$A = \begin{bmatrix} 0 & 1 & 2 & 3 & 4 \\ 0 & 1 & 2 & 4 & 6 \\ 0 & 0 & 0 & 1 & 2 \end{bmatrix}$$

b. Construct a matrix  $A$  whose column space has basis  $(1, 2, 4), (2, 2, 1)$  and whose [2]  
row space has basis  $(1, 0, 0), (0, 1, 1)$ .

c. How would you compute the projection matrix  $P$  onto the plane  $x - y - 2z = 0$ ? [2]

d. Prove that if  $Q_1$  and  $Q_2$  are orthonormal matrices, then so is  $Q_1 Q_2$ . [2]

5. a. Find orthonormal vectors  $q_1, q_2, q_3$  by Gram-Schmidt from [6]

$$a = \begin{bmatrix} 1 \\ 1 \\ 2 \end{bmatrix} \quad b = \begin{bmatrix} 1 \\ -1 \\ 0 \end{bmatrix} \quad \text{and} \quad c = \begin{bmatrix} 1 \\ 0 \\ 4 \end{bmatrix}$$

b. Prove that every orthogonal matrix has determinant 1 or -1. [2]

c. Prove if true, or declare as false [1.5]

i. If  $A$  is not invertible, then  $AB$  is not invertible +1.5]

ii.  $AB$  and  $BA$  have the same determinant

d. Find the coefficients  $C$  and  $D$  of the curve  $y = C + D2^t$  that gives the best least [3]  
square fit to the points  $(t, y) = (0, 6), (1, 4), (2, 0)$ .

a. Factor  $A$  into  $S\Lambda S^{-1}$  [5]

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

b. i. Find the SVD of the following matrix: [7+2]

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

$$A = U\Sigma V^T$$

ii. From the decomposition, identify an orthonormal basis for each of the [3]  
four fundamental subspaces of  $A$ .

a. Solve the following system of Linear Equations using Cramer's Rule. [7]

$$\begin{aligned} 2x_0 + x_1 &= 7 \\ 3x_0 - 2x_2 - x_3 &= 7 \\ 5x_0 + x_1 + x_2 &= 3 \\ 2x_1 + 3x_2 + 10x_3 &= 11 \end{aligned}$$

b. Find the eigenvalues and eigenvectors of the following matrix. [7]

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



Full Marks: 70

Time: 2.5 Hours

(Answer any 5 Questions)

1. a) Discuss the formation and evolution of major political parties of Bangladesh? 7  
b) Briefly explain the most notable constitutional amendments done since independence in 1971. 7
2. a) What are the characteristics of developing countries? How Bangladesh achieved its developing country status? 7  
b) In your opinion, what steps Bangladesh need to complete fully before becoming a developed nation. 7
3. a) What is the role of warrant of precedence? 3  
b) Organize the following positions in correct order (from high to low) according to the warrant of precedence. 4  
*(i) Mayors of municipal corporations (ii) Vice Chancellors of universities (iii) Chairman of District Councils (iv) Deputy Ministers of the Republic (v) Brigadier in the Army (vi) Director General of Anti-Corruption Commission*  
c) Briefly discuss the administrative structure of Bangladesh. 7
4. a) Explain 5 key goals (according to your opinion) of the Sustainable Development Goals (SDG) and discuss few measures which are yet to be done to fulfill the goals of SDG. 5+4  
b) Briefly discuss some key initiatives of Bangladesh government for poverty alleviation. 5
5. a) Briefly discuss the following terms in terms of cultural heritage of Bangladesh. 5x2  
(i) Demography  
(ii) Symbolism  
(iii) Ethnic Relations  
(iv) Urbanization  
(v) Religious Belief and Rituals  
b) What are the three main branches of government? What are the main characteristics of a developing country? 2+2
6. a) Discuss the physical geography of Bangladesh. 4  
b) How many major river networks are there in Bangladesh? Discuss them briefly. 5  
c) Why Bangladesh is believed to be the most affected country from the hazard of climate change? Discuss with examples. 5
7. a) Briefly discuss the foreign policy of Bangladesh. 4  
b) ICT is one of the most developing sector of Bangladesh. Mention in your own words how it can solve any particular national problem (for example road safety, healthcare, education etc.) [Discuss solutions for only one problem] 6  
c) What do you mean by the term 5 year Plan? Why it is necessary to incorporate SDG in such kind of national level plan? 4

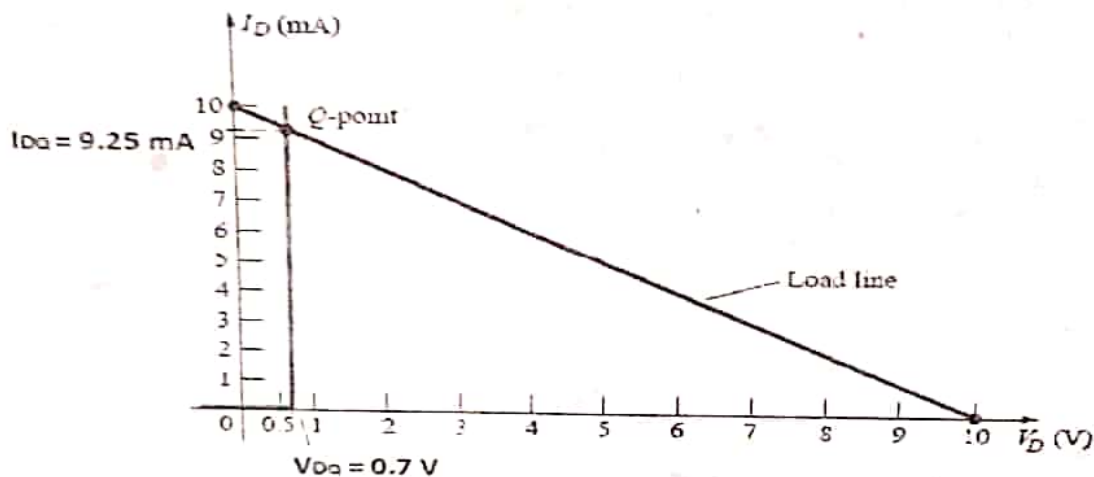


Full Marks: 70

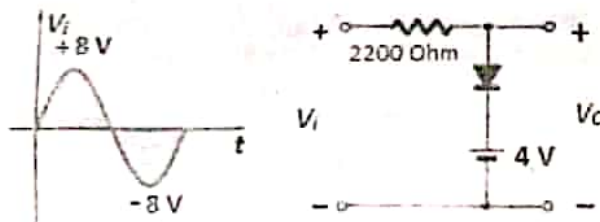
Time: 3 hours

Answer any five questions

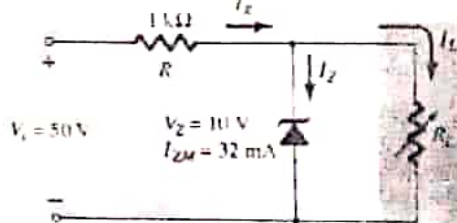
- (a) An intrinsic semiconductor has  $n_i$  number of holes. (i) how many donor ions does it have (ii) how this donor ion number changes when  $n_i$  number of P atom is added to it. 4
- (b) Sketch the atomic structure of silicon doped with n-type and p-type impurity. Draw a basic diagram of pn junction showing all carriers and ions. 5
- (c) Explain depletion layer and barrier potential in a pn junction (no fig. is required). 5
- (a) Determine the diode current at 20°C for a silicon diode with  $I_s = 50$  nA and applied forward bias of 0.6 V. 4
- (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. 5



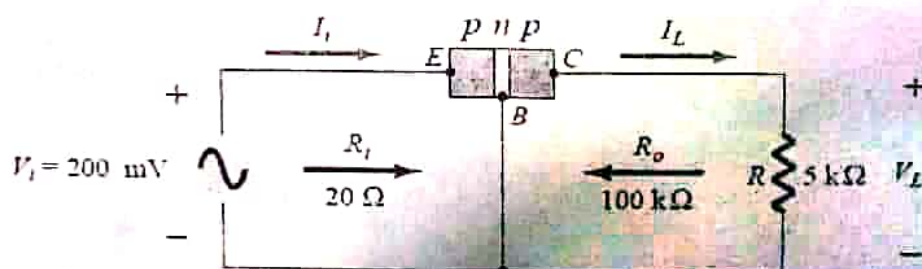
- (c) Draw the input and output voltage graph for the following circuit considering ideal Si diode. 5



- (a) Draw the circuit diagram of a full-wave rectifier circuit. Also draw the rectified output waveform for sinusoidal input. Derive the dc value ( $V_{dc}$ ) of the output voltage. 4
- (b) For the network below, determine the range of  $R_2$  and  $I_L$  that will result in  $V_L$  being maintained at 10V. 5

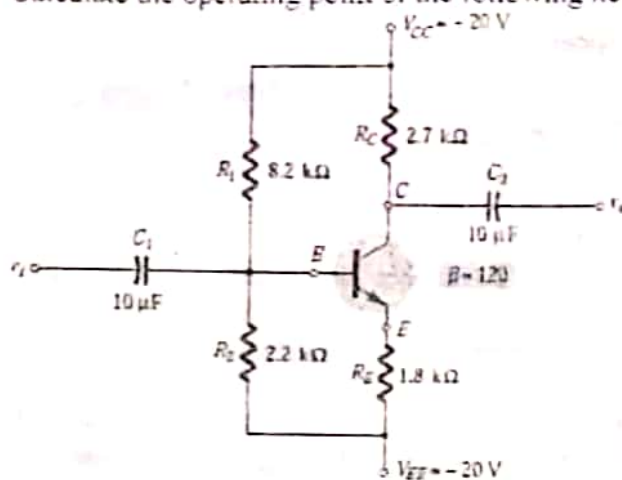


- (c) Calculate the voltage gain ( $A_v$ ) of the following amplifier. 5

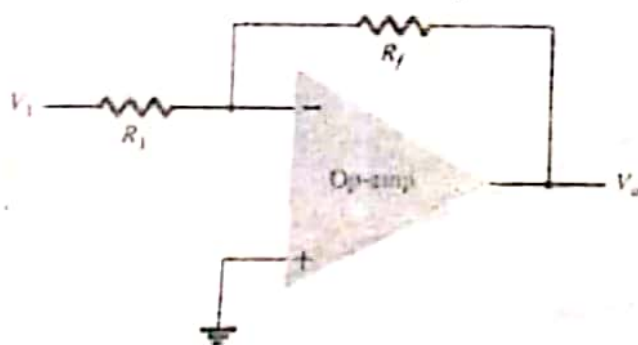




- 4 (a) Why biasing is necessary for a BJT?  
 (b) What is the function of the emitter resistance in a voltage divider bias? How you will determine its value?  
 (c) Calculate the operating point of the following network.



- 5 (a) Draw the basic feedback inverting op-amp circuit and its ac equivalent circuit.  
 (b) Draw an integrator circuit using op amp and derive its output voltage equation.  
 (c) Determine the gain of the following amplifier using virtual ground concept.



- 6 (a) Which FET is best as a switch? Draw the diagram of such a switching circuit and describe its operation.  
 (b) Draw the circuit diagram of a FET amplifier with self-bias and derive the expression for voltage gain.  
 (c) Distinguish between enhancement mode MOSFET and depletion mode MOSFET.

- 7 (a) Explain with diagram the effect of negative feedback on gain and bandwidth.  
 (b) Draw the schematic diagram of a voltage-series feedback amplifier and derive its overall voltage gain equation with feedback,  $A_f$ .  
 (c) Draw the phase-shift oscillator circuit diagram and describe its operation in brief.