

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

MID-SEMESTER EXAMINATION
DURATION: 1 HOUR 30 MINUTES

WINTER SEMESTER, 2021-2022
FULL MARKS: 75

CSE 4303: Data Structures

Programmable calculators are not allowed. Do not write anything on the question paper.
Answer all 3 (three) questions. Marks of each question and corresponding CO and PO are written in the right margin.

1. a) Analyze the following block of code and find out the tightest bound for the time complexity showing detailed steps:

7
(CO1)
(PO2)

```
void complexity () {
    int n, val;
    for (int j=4; j<n; j=j+2) {
        val = 0;
        for (int i=0; i<j; ++i) {
            val = val + i*j;
            for (int k=0; k<n; ++k) {
                val++;
            }
        }
    }
}
```

Figure 1: Code snippet for Question 1. (a)

- b) Given the following XHTML fragment, show the state of the stack (recording the opening tags that have not yet been matched) at the end of parsing.

8
(CO1)
(PO1)

```
<xhtml>
<body>
<p>1b. if  $\lg(\langle i \rangle n \langle /i \rangle) = \log_{\langle sub \rangle 2 \langle /sub \rangle}(\langle i \rangle n \langle /i \rangle) = \langle i \rangle x \langle /i \rangle$  then what is  $\log_{\langle sub \rangle 16 \langle /sub \rangle}(\langle i \rangle n \langle /i \rangle)$  in terms of  $\langle b \rangle x \langle /b \rangle$ ? </p>
<p>1c. Show that  $\lg(2 \langle i \rangle n \langle /i \rangle) = 1 + \lg(\langle i \rangle n \langle /i \rangle)$  and that  $\ln(2 \langle i \rangle n \langle /i \rangle) = \ln(2) + \ln(\langle i \rangle n \langle /i \rangle)$ 
```

Figure 2: Code snippet for Question 1. (b)

- c) Show the step-by-step process to sort the following set of number in descending order using Heap Sort algorithm: {22, 55, 36, 44, 100, 45, 12, 63, 1, 89}
2. a) Showing necessary mathematical arguments, prove that, "A max-heap can be formed from an arbitrary set of numbers in linear time".
- b) Argue on the Space Complexity of the Level-order traversal on a binary tree.
- c) Answer the following questions:
- Argue on storing a binary tree using array-based vs pointer-based approach.
 - A perfect binary tree has 2^k nodes at depth k for $k = 0, 1, \dots, h$. Use this to prove that a perfect binary tree of height h has $2^{h+1} - 1$ nodes.
 - With a perfect binary tree of height h , if a node is randomly selected within the tree, what is the average length of the path from the root to that node?

10
(CO1)
(PO1)
8
(CO3)
(PO2)
5
(CO1)
(PO1)
4×3
(CO3)
(PO2)

3. a) Show that, "If a node in a binary search tree has two children, then its successor has no left child and its predecessor has no right child". Argue on the statement again considering the condition of having two children being withdrawn. 10 (CO3) (PO2)
- b) Under what conditions would a pre-order and breadth-first traversal of a binary tree be the same? Is it possible to produce the same result for in-order and post-order traversal? 5 (CO1) (PO1)
- c) A set of number is stored in a Binary Search Tree. Design functions with least possible time complexity to satisfy the following requirements: 10 (CO2) (PO2)
- i. Print the numbers in descending order.
 - ii. Given a number, return how many numbers are smaller than its value.

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MID SEMESTER EXAMINATION

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DURATION: 1 HOUR 30 MINUTES

FULL MARKS: 75

CSE 4301: Object Oriented Programming

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all **3 (three)** questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

1. a) LFR group is manufacturing toy car for children. Each car has a *model name*, *batch number* (production batch), and *color*. They want to give a serial number (e.g. first car will get serial number 1, second one will get 2 and so on) to each car in order to track them. After quality checking of a car, the company may reject it from selling, if found faulty. (CO2)
 Your task is to create a "Car" class, which includes the above-mentioned attributes and following behaviors: (PO2)
 - At the time of creation, the Car object should be initialized.
 - One can set or change only model name, batch number and color using a Car object.
 - One can return the value of above-mentioned attributes as well as serial number using a Car object.
 - There should be a method that returns the total number of car objects currently present.
- In `main()`, create 5 Car objects using dynamic memory allocation and delete any 2 objects.
- b) In C++, you can use reference variable while passing value to and returning from a user defined function. Generally, to pass an object to a function, pass by reference method is preferred over pass by value method. Do you agree with this statement? Justify your answer with example. (CO1)
 c) In Question 1. (a), the value of the attribute "color" can only be Red, Green, or Blue. Choose a data type to accommodate this restriction. Justify your choice comparing with other data type(s). (PO1)
 (CO1) (PO1)
2. a) Rational numbers can be expressed as a fraction p/q where p (numerator) and q (denominator) are each whole numbers and q does not equal to 0. Create a class named "RationalNumber". (CO2)
 Your implementation must maintain the following properties: (PO2)
 - A new object should be initialized with decimal value zero (0).
 - It should have a *set (int numerator, int denominator)* function.
 - The *get ()* function should return the decimal value of the fraction. Individual numerator and denominator getter function is not public or absent.
 - Member variables must be private
- Overload the addition (+), subtraction (-), multiplication (×), and division (/) operators. These overloading functions should return a RationalNumber object. Both operands can be of RationalNumber type or one of the operands (first or second) can be of `int` data type.
- b) Create a class named "Account" that represents a bank account. You need to store the information about the *account number*, *account title* and *balance*. Now add *deposit(double)* and *withdraw(double)* public member functions. The balance should be checked at the time of withdrawal. (CO2)
 (PO2)

Create a class named "StudentAccount" that has similar attributes and behaviors of Account. In addition to that, it needs to store the information of *GuardianName*. It should be noted that with an object of StudentAccount class, you cannot call *deposit()*, or *withdraw()*.

- c) Object Oriented Programming is popular in developing medium to large scale software. On the other hand, Procedural Paradigm is normally used in small scale software and developing system level software. 5
(CO1)
(PO1)

Identify drawbacks of Procedural Paradigm for which Object-Oriented Programming offers some solutions.

3. a) An approach can be syntax error free but have bad design. Update the following code according to the good design approach of OOP. 13
(CO3)
(PO2)

```
#include <iostream.h>
int totalNoOfCars = 0; // Initially total no of car is 0
class RacingCar{
    ///Constant Acceleration
    void accelerate(double amount, double t){
        distance += speed*t + 0.5*amount*t*t;
        speed += amount * t;
    }
    ///Constant deceleration
    void decelerate(double amount, double t){
        distance -= speed*t - 0.5*amount*t*t;
        speed -= amount * t;
    }
    ///Constant Speed
    void advance(double t){
        distance+=speed*t;
    }
    double getCurrentSpeed(){
        return speed;
    }
    double getCurrentDistance(){
        return distance;
    }
protected:
    double distance;
    double speed;
};

int main(){
    RacingCar r1;
    cout<<"Speed: "<<r1.getCurrentSpeed()<<endl;
    cout<<"Distance: "<<r1.getCurrentDistance()<<endl;
    r1.accelerate(5,10); /// 5 meter/sec for 10 sec
    cout<<"Speed: "<<r1.getCurrentSpeed()<<endl;
    cout<<"Distance: "<<r1.getCurrentDistance()<<endl;
    r1.advance(20);
    cout<<"Speed: "<<r1.getCurrentSpeed()<<endl;
    cout<<"Distance: "<<r1.getCurrentDistance()<<endl;
    r1.decelerate(5,8);
    cout<<"Speed: "<<r1.getCurrentSpeed()<<endl;
    cout<<"Distance: "<<r1.getCurrentDistance()<<endl;
}
```

Figure 1: Code snippet for Question 3. (a)

Use const and static modifier where it is necessary. Correct any logical error found.

- b) Explain the *diamond shape inheritance* problem with a detailed example and show its relationship with multi-level and multiple inheritance. 7
(CO1)
(PO1)
- c) C++ has some useful features like encapsulation, data access restriction, etc. that restricts the developers from making mistakes. In some cases, these normal features lead to restricting the programmer from writing intended code. Therefore, some features (like friend function) are also offered to help the programmer to avoid this kind of situation. 5
(CO1)
(PO1)
- Explain the friend function with an example.

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)**ORGANISATION OF ISLAMIC COOPERATION (OIC)****Department of Computer Science and Engineering (CSE)****MID SEMESTER EXAMINATION****WINTER SEMESTER, 2021-2022****DURATION: 1 HOUR 30 MINUTES****FULL MARKS: 75****CSE 4305: Computer Organization and Architecture****Programmable calculators are not allowed. Do not write anything on the question paper.****Answer all 3 (three) questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.**

-
1. a) Explain the following terms: 5
- i. Deeply embedded system (CO1)
 - ii. System bus (PO1)
 - iii. Core
 - iv. Solid state device
 - v. Data channels
- b) Define "cylinder" with appropriate figure. A bit near the center of a rotating disk is traversed slower than a bit on the outside. Therefore, some approaches are found to compensate for the variation in speed so that the read-write head can access all the bits at the same rate. Briefly explain those approaches with necessary figures. 10
- c) A few fundamental design aspects classify and distinguish cache architectures. "Replacement Policy" and "Write Policy" are crucial elements since they entail writing to cache and main memory, respectively. Provide examples of some of the most troublesome situations for which these approaches are developed. In addition, provide a concise description of these design elements, highlighting the different implementation techniques. 10
2. a) Consider a system with three I/O devices: a printer, a disk, and a communications line, with increasing priorities of 2, 4, and 5, respectively. A user program begins at $t = 0$ taking 20 units time in total for completion. At $t = 10$, a printer interrupt occurs requiring total 10 units time to be completed; at $t = 15$, another communication interrupt raises and takes 10 units time; a disk interrupt occurs at $t = 20$ taking same amount of time. Now answer the following questions: 10
- i. How will the interrupting device be recognized when an interruption occurs? (CO1)
 - ii. How does an interrupt mechanism works? Explain briefly. (PO2)
 - iii. How will a processor manage this multiple interrupt situation through a single interrupt pin serving all ISRs belonging to their respective priorities? Briefly describe your proposed solution with the help of a timing diagram how and when the interrupts will be enabled or disabled. Include any necessary consideration if necessary.
- [Note: t represents time of occurrence]
- b) For the hexadecimal main memory addresses 111111, 666666, BBBB, find out the following information, in hexadecimal format considering 64KB cache and 16MB main memory where line size and block size is 4 bytes each: 10
- i. Tag, Line, and Word values for a direct-mapped cache. (CO4)
 - ii. Tag and Word values for an associative cache. (PO2)
 - iii. Tag, Set, and Word values for a two-way set-associative cache.
 - iv. Suppose the byte with address 0001 1010 0001 1010 1011 1101 is stored in the cache. What are the addresses of the other bytes stored along with it?
 - v. Why is the tag also stored in the cache?

- vi. How many total lines and sets could be stored in the cache memory?
- vii. How many total blocks could be stored in the main memory?

- c) In an interrupt driven I/O system, an interrupt has been occurred during the execution of the instruction at location N shown in Figure 1. To serve that interrupt immediately a context switching is performed. Briefly describe the operations of context switching stepwise happened two times to serve this interrupt. 5 (CO4) (PO1)

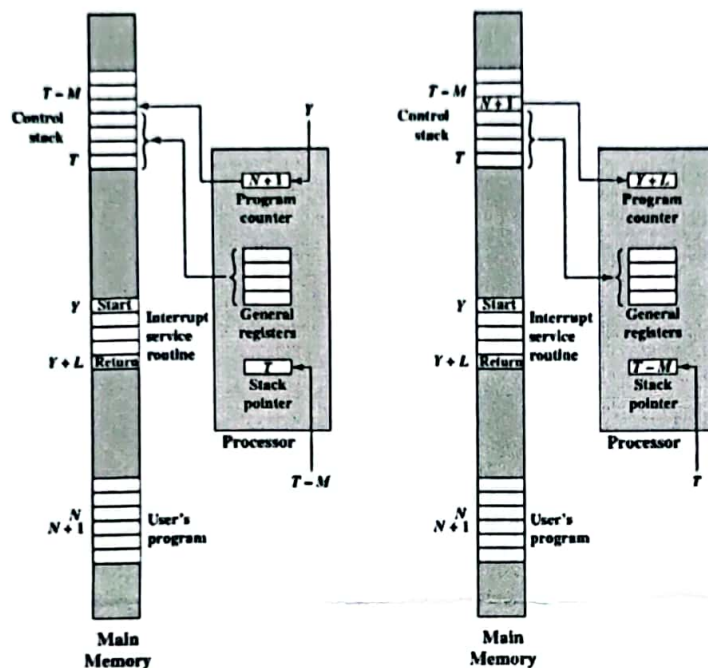


Figure 1: Two times context switching for Question 2.(c)

3. a) The concept of a family of compatible computers was both novel and extremely successful. A customer could start with a relatively inexpensive model and later, if the customer's needs grew, he could upgrade to a faster machine with more memory without sacrificing the investment in already developed software. Which characteristics do you think that a family should follow to accomplish the preceding? 5 (CO2) (PO1)
- b) Using the required diagram, explain how a soft error could be recognized and fixed in a semiconductor memory system. Given the 11-bit data word 00100101010, create the corresponding composite word using the logic you explained above, which corrects single errors and detects double errors. Illustrate intermediary steps in the calculation. 10 (CO4) (PO2)
- c) The raw speed of the microprocessor will not achieve its potential unless it is fed a constant stream of work in the form of computer instructions. Anything that gets in the way of that smooth flow undermines the power of the processor. Accordingly, processor designers must come up with ever more elaborate techniques for feeding more complex instructions to a processor. Briefly describe those techniques utilized in the contemporary processors. 10 (CO2) (PO1)

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WINTER SEMESTER, 2021-2022
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CSE 4307: Database Management Systems

Answer all 3 (three) questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

1. a) "In a traditional file processing system it is hard to provide user access to some, but not all, data." 10
 Explain using suitable example. (CO1)
- b) Is there any difference between schema and instance in relational database area? Explain. 4 + 6
 Consider the following records: (CO1)
(PO1)

Table 1: Employees data for Question No. 1(b)

Name	Address	DOB
m	a	1-1-87
n	b	2-4-82
q	a	1-12-80
r	f	3-4-79

Now, deduce its super keys, candidate keys, and primary key for the given records. Present suitable arguments for finalizing the primary key.

- c) What is domain of attribute? How can you ensure it in implementation phase? Explain with example. 5
(CO1)
(PO1)
2. a) Consider the following SQL statement to list all employees name, address and their total salary where total salary is calculated as the sum of his/her basic and bonus amount (if any): 5
(CO1)
(PO1)
- ```
select Name, address, (salary+bonus) Total
from emp;
```
- It was observed that the values for total salary for a number of employees were displayed as 0 but each of employees monthly salary has been found correct.
- Your task is to identify and explain the most probable cause of the above result. At the same time, provide a suitable solution to get rid of such error.
- b) Consider the following entities (note: here pk means primary key, fk(x) means foreign key referencing entity x): 2 × 5  
(CO1)  
(PO1)
- Depts (Name (pk), Location, Budget)
  - Students (SID (pk), Name, CGPA, Dept (fk[Depts]))
  - Teachers (TID (pk), Name, Designation, Dept (fk[Depts]))
  - Supervisors (TID (fk[Teachers]), SID (fk[Students]), ProjectName)

Write SQL statements for the following queries:

- i) List of departments name, location, and total number teachers for each department.
- ii) List of the students with ID, name, their dept name, and dept location only for those departments that are located at "Academic Building 2".

- iii) List of teachers with their name, designation, and the total number of students they are supervising.
- iv) List of teachers with their name and designation who are supervising at least 5 students.
- v) List of top 3 department name, location and the total number of students (ranking is based on total number of students)

c) What is the basic purpose of a materialized view? Consider the following 2 view definitions:

5

```
create or replace view empV
as select id,name, salary/12 as monthlySalary
from emp;
```

(CO2)

```
create or replace view studentV
as select id,name,dob,cgpa
from students;
```

(PO2)

Is it allowed to insert data through these views? Justify your choice. (assume the tables emp and student exist with the mentioned attributes in the view definitions)

3. Read the following user requirement in the context of automation of Bangladesh NID, driving license and treatment history:

*National ID (NID) is an integrated collection of citizens' information such as Name, Date of Birth, Occupation, Blood Group. Each citizen has his/her own NID. In order to investigate the population density, the country has been divided into divisions. Each division has its name, size (in square kilometer) and a brief description. Again each division has a number of districts with similar attributes. Citizen information must be connected to its corresponding division and district.*

*Each citizen may have exactly one driving license where information such as type of license, issue date, and expiration date are maintained. Whenever any accident occurs, it is logged in the central system. The system stores relevant information such as date and time of accident, location of accident, and the number of deaths (if any).*

*There are a number of hospitals in the country having names and contact information. Each hospital may have more than one contact number. Citizens may avail treatment in any hospitals they prefer. Whenever any patient (i.e. citizen) is admitted, the system keeps the record of his/her date of admission, a brief description, and release date.*

a) Draw the Entity Relationship Diagram (ER-D) using conventional method.

10

(CO3)

b) Write appropriate DDL statements to implement above ER-D.

(PO3)

10

(CO1)

c) Write standard SQL for the followings:

(PO1)

5 × 2

- i Find the list of Districts along with its total population.
- ii Find the list of Districts having at least 20000 people living there.
- iii Find the number of accidents occurred (if any) by a citizen whose NID is 210.
- iv Find the list of top 5 hospitals based on the number of patients admitted so far.
- v Find the list of Divisions along with its total number of Districts for each Division.

(CO1)

(PO1)



## ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

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MID SEMESTER EXAMINATION

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DURATION: 1 HOUR 30 MINUTES

FULL MARKS: 75

**Math 4341: Linear Algebra****Programmable calculators are not allowed. Do not write anything on the question paper.**Answer all **3 (three)** questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

1. a) Consider the following three matrices

18+2

(CO1)

(PO1)

$$A = \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix} \quad B = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix} \quad C = \begin{bmatrix} a & 1 & 1 \\ 0 & a & 1 \\ 0 & 0 & a \end{bmatrix}$$

- i. Determine if the matrices  $A$ ,  $B$  and  $C$  are invertible. If any of the matrices is invertible, find its inverse by Gauss-Jordan elimination. For matrix  $C$ , find the inverse in terms of  $a$ , if it exists.
- ii. For what values of  $a$  is  $C$  invertible? How does your formula for  $C^{-1}$  breakdown for values of  $a$  for which  $C$  is not invertible?

- b) Consider the following matrix
- $A$
- ,

5

(CO1)

(PO1)

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

Find three values of  $a$ , for which the elimination process will fail to give three pivots for this matrix. In other words, for which three values of  $a$  is this matrix singular?

2. a) Assume that
- $S$
- and
- $T$
- are lines in
- $\mathbb{R}^4$
- (4-dimensional space) that pass through
- $(0, 0, 0, 0)$
- . So,
- $S$
- and
- $T$
- both can be considered as subspaces of
- $\mathbb{R}^4$
- .

2+3+3

(CO3)

(PO1)

- i. When is the union  $S \cup T$  of the two lines also a subspace?
- ii. If  $S \cup T$  is not a subspace, describe the smallest possible subspace that contains both lines  $S$  and  $T$ .
- iii. If  $S$  and  $T$  are ANY type of subspaces of  $\mathbb{R}^4$ , not necessarily lines, how would you construct the smallest subspace that contains both  $S$  and  $T$ ?

- b) Find the complete solution of the following:

10

(CO2)

(PO1)

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

Show all necessary steps.

- c) Does there exist a matrix
- $B$
- whose column space is spanned by
- $(1, 2, 3)$
- and
- $(1, 0, 1)$
- and whose nullspace is spanned by
- $(1, 2, 3, 6)$
- ? If so, construct
- $B$
- . If not, explain why not.

7

(CO3)

(PO3)

3. a) Forward elimination changes  $Ax = b$  to a row-reduced form  $Rx = d$ , and the complete solution for  $Ax = b$  is:

10+10  
(CO2)  
(PO1)

$$x = \begin{bmatrix} 4 \\ 0 \\ 0 \end{bmatrix} + c \begin{bmatrix} 2 \\ 1 \\ 0 \end{bmatrix} + d \begin{bmatrix} 5 \\ 0 \\ 1 \end{bmatrix}$$

- i. What is the 3 by 3 reduced row echelon matrix  $R$ ? What is  $d$ ?
  - ii. If the process of elimination subtracted 3 times row 1 from row 2 and then 5 times row 1 from row 3, what matrix connects  $R$  and  $d$  to the original  $A$  and  $b$ ? Use this matrix to find  $A$  and  $b$ . Remember, no upward elimination was involved in the process.
- b) Suppose  $A$  and  $B$  are 3 by 3 matrices.
- i. If a vector  $v$  is in the column space of  $AB$ , why is  $v$  also in the column space of  $A$ ? [Hint:  $b$  is in the column space of  $A$  means there is some  $x$  for which  $Ax = b$  is true.]
  - ii. Give an example for both  $A$  and  $B$  so that  $C(AB)$  is smaller than  $C(A)$ .

2+3  
(CO3)  
(PO1)



**ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)**  
**ORGANISATION OF ISLAMIC COOPERATION (OIC)**  
**DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING**

Mid-Semester Examination  
Course Number: EEE 4383  
Course Title: Electronic Devices and Circuits

Winter Semester: 2021 - 2022  
Full Marks: 75  
Time: 90 Minutes

There are 03 (three) questions. Answer all 03 (three) questions. The symbols have their usual meanings. Marks of each question and corresponding CO and PO are written in brackets.

1. (a) Illustrate the effect of lower values of  $V_{cc}$  on the load line and the Q point in output characteristics curve of BJT. (05)  
(CO1)  
(PO1)
- (b) Analyze the circuit using small signal  $r_e$  model for the common emitter transistor configuration given in Fig. 1(b) and find the following parameters. (20)  
(CO2)  
(PO2)
- Determine  $r_e$ .
  - Calculate  $Z_i$  and  $Z_o$ .
  - Find  $A_v$ .
  - Repeat parts (ii) and (iii) with  $r_o = 25 \text{ k}$ .

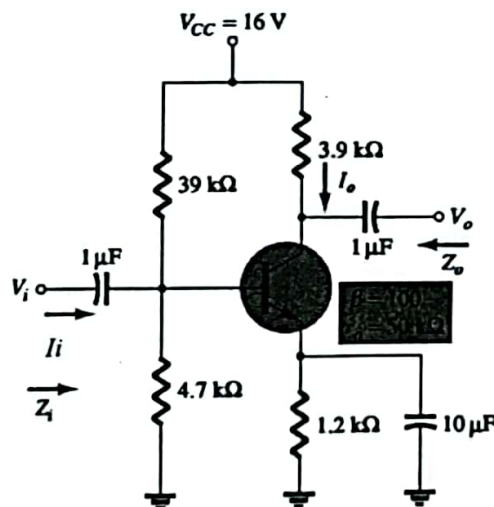


Fig. 1(b)

2. (a) The transistor in the circuit shown in Fig. 2(a) has  $\beta=100$  and exhibits a  $V_{BE}$  of 0.7 at  $i_c = 1$  mA. Design the circuit so that a current of 2 mA flows through the collector and a voltage of +5 V appears at the collector. (15)  
(CO3)  
(PO3)

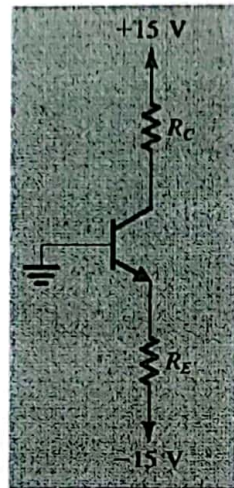


Fig. 2(a)

- (b) Write down the working principle of BJT for Common emitter configuration. (10)  
(CO1)  
(PO1)

3. (a) Sketch Output Voltage ( $V_o$ ) for the given network shown in the Fig. 3(a2). (15)  
Also, show the necessary calculation. (CO1)  
(PO1)

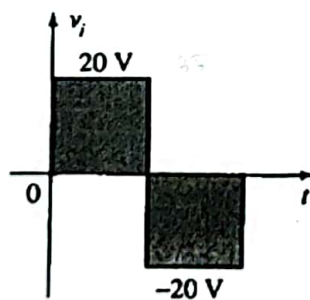


Fig. 3(a1)

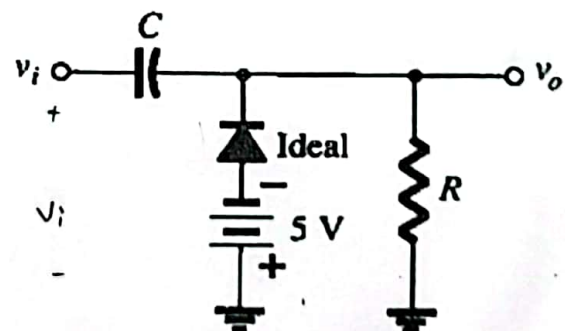


Fig. 3(a2)

- (b) Explain three types of equivalent circuits of diode and sketch their corresponding characteristics. (10)  
(CO1)  
(PO1)