

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2010-2011

Sub : **CSE 307** (Software Engineering and Information System Design)

Full Marks : 280

Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

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**SECTION – A**

There are **FOUR** questions in this Section. Answer any **THREE**.

1. (a) Read the following Use Case Carefully.

(24 <sup>2</sup>/<sub>3</sub>)

**Use Case : Check Out Books**

**Primary Actor:** Worker

Stakeholders and Interests:

-Worker: wants fast, and easy check out of books.

-Patron: wants fast check out, and does not want to be charged for books they did not check out.

-Library: wants fast check out of books, and wants to make sure that all books that leave the library have been checked out. Wants to allocate books fairly.

-Government: wants to protect investment in books and keep costs down.

Wants to promote learning and citizen happiness.

**Preconditions:** The Worker has been authenticated.

**Success Guarantee (Post conditions):** The System remembers that the Patron has checked out the books.

**Main Success Scenario (or Basic Flow):**

1. The Worker tells the System the identity of a patron who wishes to check out books.
2. The System confirms that the patron is allowed to check out books, and remembers the patron's identity.
3. The Worker tells the system the identity of a book this patron is checking out.
4. The System confirms that the book can circulate, calculates the due date based on whether the patron is a faculty member or a student, and records that the patron has checked out this book, which is due on the calculated due date, and makes that information available from the library catalog.
5. The System tells the Worker the due date (which also confirms that the book has been checked out).

The Worker repeats steps 3-5 until indicates done.

**Extensions (or Alternative Flows):**

- 2a. if the patron is not allowed to check out books because they have violated some library policy (for example, if the patron has not paid their university bill or library fines):

Contd ..... P/2

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### **Contd ... Q. No. 1(a)**

1. The System tells the Worker that the patron is not allowed to check out books and the reason for this prohibition.
2. The use case ends.
- 4a. If the book that is being checked out is non-circulating;
  1. The System tells the Worker why the book is non-circulating.
  2. The use case continues from step 3 in the main success scenario.

#### **Special Requirements**

- There are different due dates depending on the kind of patron one is dealing with. For example, faculty can take out books for the whole academic year, whereas students can only take them out for a limited time.
- The System must respond to the Worker, at least giving some progress indication, within 3 seconds, 95% of the time.
- Workers are experts, because they use the system continuously, so the interface should have minimal interaction and should minimize the physical effort involved; for example, workers should not have to be prompted.
- Displays for the worker should be visible from one meter away.
- The system should be quiet.

#### **Technology and Data Variations List:**

- 3a. Barcode scanners are normally used to identify books.
- 3b. Books without barcodes have to be entered manually.

**Frequency of Occurrence:** nearly continuous.

**Open Issues:** How to deal with failures and recovery?

How to deal with overnight check out of reserve items.

How to deal with library books that are unknown to the circulation system.

Now draw a **Collaboration** and **Class diagram**, which should be relatively complete for the use case given. It should include associations also.

(b) List all behavioral UML diagrams and describe the purpose of each of them. (8)

(c) Draw an **Activity diagram** that represents the making of a cup of tea. The initial three activities are Fill kettle with water, Find cup and Find tea bag and they may be performed in parallel. When the Find cup and Find tea bag are completed the activity Place tea bag in cup can start. The kettle must have boiled and the tea bag must have been placed in the cup before the activity Add water to cup can begin. If milk is required then activity Add milk should be performed. (10)

(d) Assume that A, B, C and Boolean variables, X, Y, Z are outcomes. Propose a decision table for the following procedure: (4)

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**Contd ... Q. No. 1(d)**

```
If A then if B then X
else if C then Y else Z endIf endIf
else if C then X else Z endIf
endIf
```

Make sure your final table is in simplified form, i.e., does not have redundant rows or columns.

- 2. (a) To buy a book electronically from chapters.com, a customer needs to select the book from a list provided by Chapter's eCommerce system, provide credit card information to the system, then the system gets authorization from the bank for the payment, and --if positive -- confirms the sale. The order is then sent to the orders department and when the book becomes available, it is shipped to the customer. Also, the order department charges the customer's credit card by informing the bank of the amount.

Draw a **Sequence diagram** that models this process. Make sure to model all relevant actors and the interactions between them. Do show explicitly the time intervals when different actors actively participate in the process you are modeling.

(12)

- (b) Give a **State Chart diagram** that describes the lifetime of a video tape in a video store. You can assume that a video tape is purchased, packaged properly (plastic case with identification information on the outside), put in the video store database, and is then put up for rental. Customer who choose to rent it, check it out and return it in 3 days. If a customer fails to return it, the store calls him/her the next day. The call is repeated a second time after 2 more days, and if the tape is not returned within 2 more days, the store delegates the matter to a collection agency and removes the video tape from its collection. If the tape is damaged on return, it is removed from the collection database also. Finally, if the tape is missing during the annual store inventory, it is removed from the collection database as well.

(12 2/3)

Make sure to define **events, conditions, actions** for transitions in your diagram, where appropriate.

- (c) A book is written by an author, published by a publisher, sold by a book store, and read by a reader. Moreover, for a reader to read a book, she must buy it from a book store that is selling it.

(8)

Draw a **Use Case diagram** for this scenario, showing relationships between different use cases.

- (d) (i) What is the present value of \$ 1,000 one year from now, assuming a 10% discount rate?

(4+10)

- (ii) Explain the difference between **return on investment** and **payback period**. Why might you need to know both in order to decide which of two different development alternatives represents a better investment for a particular organization?

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3. (a) **The Blood Bank Testing Unit.** This is one unit within the College Street Red Cross Blood Donor Centre. On the day following a blood donation, the Blood Bank unit tests all blood for blood type and potential viral agents. They send the results of these tests to the Processing Office (another unit of the Centre). For each tested blood unit, they fill out a form which lists the blood unit number, the blood type, the date and the results of the test. If the tests indicate that the blood may be contaminated with a viral agent, the blood unit is destroyed. This is indicated on the test form.

(12<sup>2</sup>/<sub>3</sub>)

Blood units have a limited shelf life. The Blood Bank receives a list every day of those units which have exceeded their shelf life. These are discarded and the list sent back to the Processing Office with a signed indication of the disposal of the units.

The Blood Bank also distributes blood to various hospitals requesting blood. Requests usually come in for specific blood types. The Blood Bank prepares refrigerated containers of these units and distributes them to the hospital vans when they arrive to pick up their supply. The Blood Bank receives a listing for each hospital and the specific units of blood to supply to the hospital from the Processing Office. The order is printed in triplicate. When the order is filled, the lab technician signs the order and returns a copy to the Processing Office. A copy of it travels with the blood to the requesting hospital. The final copy is kept in the Blood Bank records but discarded after one year.

Draw a **data flow diagram** for the Blood Bank Testing Unit System.

- (b) Define each of the following with suitable examples:

(24)

- (i) Detailed Report
- (ii) Summary Report
- (iii) Exception Report
- (iv) Turnaround Document
- (v) Two-Tier Architecture
- (vi) Three-Tier Architecture
- (vii) File-Server Architecture
- (viii) Agile Method

(c) The ordinary way to extend a software system is to find a suitable superclass, and to subclass it, You can also "inherit" behavior from more than one class by copying some of the operations of the second class and delegating calls to an instance of that class. Both of these extension techniques, however, require that you know at compile time what behavior you want to add. Name these two techniques that we just described. Should one of these techniques require a preferential treatment?

(5)

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**Contd ... Q. No. 3**

(d) Does the following code fragment implement the **Factory design pattern**? Explain in brief. (5)

```
public class XMLReaderFactory {
    // This method returns an instance of a class
    // that implements the XMLReader interface.
    // the specific class it creates and returns is
    // based on a system property.
    public static XMLReader createXMLReader ();
}
public interface XMLReader {
    public void setContentHandler (ContentHandler handler) ;
    public void parse (InputStream is) ;
}
```

4. (a) Which of the following (i) and (ii) is a valid implementation of **Singleton Pattern**? Give specific reason for each of the following implementation. (5)

(i)

```
public class Singleton {
    private static Singleton s_singleton = new Singleton ();
    private Singleton () {}
    private static Singleton getInstance() {
        return s_singleton;
    }
}
```

(ii)

```
public class Singleton {
    private Singleton () {}

    private static class SingletonHolder {
        private static final Singleton instance = new Singleton ();
    }

    public static Singleton getInstance () {
        return SingletonHolder. instance;
    }
}
```

(b) Write down the guideline for input design and output design of a system. (5+5)

(c) In principle a social network service focuses on building online communities of people who share interests and/or activities, or who are interested in exploring the interests and activities of others. Facebook support groups that people can join. Each group has a title, administrative members, a group type (open/ closed), and a list of related groups. Otherwise, a group operates just like an ordinary page. If somebody writes on the wall page of the group, the information is broadcasted to all the members and it is visualized in the news feeds of the members.

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**Contd ... Q. No. 4.(c)**

Which design pattern is the most appropriate to handle this basic functionality of such a Facebook group? Users should be able to join a group as well as leave a group if they get bored. Once a user has joined a group it will automatically receive any updates that are published on the wall. Give a short explanation. In particular, show a complete class diagram(s) and enough code fragments to illustrate your use of the pattern to solve the problem.

**(12)**

(d) Now let's suppose that you would like to extend the functionality of Facebook group that you have created in **Question. 4(c)** by adding the possibility that besides normal users a group page can also be a member of another group. As an example it should be possible that the group page of the "CSE BUET 08" joins the "BUETIANS" group. As a consequence all the members of the "CSE BUET 08" group become automatically members of the "BUETIANS" group.

**(12<sup>2/3</sup>)**

Which design pattern is most appropriate to accommodate this change? How the solution proposed in the previous example shall be extended. Please give a short explanation why. Show a complete class diagram(s) and enough code fragments to illustrate your use of the pattern to solve the problem.

(e) Suppose Alice told you the following story

**(7)**

"At the company for which I work we are facing this problem: We have a large amount of application software written using a particular library. Let's call this library LibX. The provider of this library was XIndustries AB. We wanted to extend the functionality of our application and for this reason we tried to contact XIndustries AB to implement the necessary library functionality. To our surprise we found out that XIndustries AB has gone out of business. Fortunately we found out that there is another company called YEnterprise AB is producing LibY that provides the same functionality as LibX but many of the classes have different interfaces. We don't have access to the source code of the old library LibX and neither to the source code of LibY. What should we do?"

Which design pattern is most appropriate to accommodate this change? In particular, show an appropriate class diagram to solve the problem.

**SECTION – B**

There are **FOUR** questions in this Section. Answer any **THREE**.

5. (a) What do you know about COCOMO model? Describe the basic COCOMO model with its limitations. How COCOMO II model for cost estimation can be used at various stages of a project lifecycle?

**(5+10+15)**

(b) How Ishikawa diagram is used to identify, explore and depict problems, and the causes and the effects of those problems? Describe with an appropriate example.

**(16<sup>2/3</sup>)**

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6. (a) Discuss about waterfall model and iterative model of software development. **(3+3)**  
(b) What are the challenges that arise in quality management of a software development process? Suppose your team is developing customized hospital management software. Identify the quality criteria for such a project. **(4+8)**  
(c) What is the difference between verification and validation? What input/output faults you may check while designing a banking transaction module. **(2+5)**  
(d) Describe the communication practices a software engineer should adopt. **(6<sup>2</sup>/<sub>3</sub>)**  
(e) Suppose you are writing a 'Queue' class. Design some test cases to verify your code. **(15)**
7. (a) Discuss about professional and ethical responsibilities of a software engineer. **(6<sup>2</sup>/<sub>3</sub>)**  
(b) As a part of ensuring eGovernance goal, the Government is going to computerize its land management process that keeps records about land ownership and transfers of ownerships. It is your responsibility to do the requirement analysis for such a project. What fact finding techniques you may use and how? **(25)**  
(c) Your company has previously made the very successful game BUET Premier League 2011 (BPL 2011). But new 3D technology has arrived and the introduction of Kinect sensor requires you to upgrade the game to a newer version. Now, the overall market condition is not good due to economic recession, and this game may be a key to success for your company over the other game developing firms in the market. Identify the associated risks in this project and describe how you plan to cope up with these. **(15)**
8. (a) What is the difference between software engineering and system engineering? **(5)**  
(b) Suppose you are the project manager of a newly founded software firm and you are estimating the cost of a customized VOIP software to quote in a tender process. The market is very competitive, but you have the advantage of having some skilled persons in your firm. What pricing factors you should consider while making that cost estimation and why? **(15<sup>2</sup>/<sub>3</sub>)**  
(c) Describe the following software cost estimation techniques: **(3+3)**  
(i) Parkinson's Law.  
(ii) Pricing to win.  
(d) Find the critical path of a project using PERT chart base on the following table describing task dependencies and the expected duration of each task. **(20)**

Task	Prerequisite	Duration
A	-	2
B	-	3

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**Contd ... Q. No. 8(d)**

C	A	3
D	B,C	5
E	C	1
F	D	4
G	E,F	3
H	G	2
I	G	3
J	H,I	5
K	J	6

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**SECTION – A**

There are **NINE** questions in this Section. Answer any **SEVEN**.

1. (a) Define and explain the terms compiler, assembler and linker. For C/C++ programs, elaborate the relationship of these with (i) header files, (ii) libraries. (15)
  
2. Two main types of errors that can occur in the lexical analyzer are (a) no regular expression matches the current input; and (b) a start comment character inside a comment. Explain these errors with necessary examples. How do you want to deal with these errors in a lexical analyzer? (15)
  
3. Explain clearly the difference among the following regular expressions in the context of Lex lexical analyzer generator. (15)
  - (i) {mytoken}
  - (ii) [mytoken]
  - (iii) mytoken
  - (iv) (mytoken) +
  - (v) mytoken+
  
4. a\*b     printf( "1" );  
 (a|b)\*b   printf( "2" );  
 c\*        printf( "3" );  
 We have the above snippet, with patterns and their associated actions, from a Lex code. Show the output, with detailed explanations, that is produced when this scanner is run over the following strings: (15)
  - (a) aaabccabbb
  - (b) cbbbbabc
  - (c) cbabc

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5. (a) Left-factor this grammar, (15)

$$S \rightarrow T; S \mid \epsilon$$

$$T \rightarrow UR$$

$$R \rightarrow *T \mid \epsilon$$

$$U \rightarrow x \mid y \mid [S]$$

Hence find FIRST and FOLLOW sets for each non-terminal in the grammar obtained.

6. (a) For the left-factored grammar in Question 5, construct an LL parsing table. Now show in detail what will happen if the string  $[x;y]^*[];$  is parsed. (15)

7. Eliminate left recursion from the grammar, (15)

$$A \rightarrow B \mid a \mid CBD$$

$$B \rightarrow C \mid b$$

$$C \rightarrow A \mid c$$

$$D \rightarrow d$$

If you encounter a production like  $X \rightarrow X$  at some point of elimination, you can drop it since it does not affect the language.

8. Identify whether each of the following grammar is LL(1) or not. State the reason(s) in each case. (15)

(a)  $A \rightarrow C \mid \epsilon, C \rightarrow CE, C \rightarrow \epsilon, E \rightarrow \epsilon$

(b)  $S \rightarrow A \mid B, A \rightarrow aaA \mid aa, B \rightarrow aaB \mid a$

(c)  $S \rightarrow AaAb \mid BbBa, A \rightarrow \epsilon, B \rightarrow \epsilon$

(d)  $A \rightarrow abc \mid B, B \rightarrow acb$

(e)  $A \rightarrow bcd \mid B, B \rightarrow \epsilon, C \rightarrow DAbd, B \rightarrow b, C \rightarrow c, D \rightarrow d$

9. (a) Write a Yacc plus Lex program which calculates the value of an arithmetic expression which involves single line inputs only. The arithmetic expression comprises of numbers with decimal points, addition, subtraction, multiplication and division operators. Parentheses can be used in the expression. The expressions may also contain the sin, cos and tan trigonometric functions. (15)

**SECTION – B**

There are **FOUR** questions in this Section. Answer any **THREE**.

10. (a) Differentiate with example between - (4×6)

(i) Syntax-directed definition and syntax-directed translation.

(ii) Static and dynamic storage allocation in run-time environment.

(iii) Syntax tree and directed acyclic graph (DAG)

(iv) S-attributed definitions and L-attributed definitions.

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**Contd ... Q. No. 10**

(b) We have the following three address code sequence where we have two procedures m, and p. Our target machine is byte addressable with 8 bytes to a word. Codes for the procedures start at addresses 100, and 400 respectively and stack starts at address 1000. Activation record sizes are 128, and 256 bytes respectively. Each action requires 80 bytes. Find out the target code for the given three address code sequence when stack allocation is used. Target code must contain appropriate comments. (11)

```
/* code for m */
action 1
call p
action 2
halt
/* code for p */
action 3
return
```

11. (a) The following grammar generates binary numbers with a decimal point.

```
A → L . L
    | L
L → L B
    | B
B → 0
    | 1
```

(i) Design an SDT (**Syntax-directed translation scheme**) that computes the value of binary numbers generated from the above grammar. (12)

(ii) The translation of string 110.101 should be the decimal number 6.625. Draw the annotated parse tree for this translation and clearly show the dependency graph. (7+6)

(b) Construct DAG for the following assignment statement (10)

```
b[i] = a + (a + a + (a + a + a + (a + a + a + a)))
```

12. (a) For the following assignment statement write down an equivalent three address code sequence. (10)

```
y[i][j] = a[k] * b + c (3, d, 2.5)
```

Here, y is an array of type **array (10, array (15, float))**, a is an array of type **array (10, integer)** and c is a function of type **integer × float × float → float**. Assume that width of an integer is 4 and that of a float is 8.

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**Contd ... Q. No. 12**

(b) The following C code computes Fibonacci numbers recursively.

```
int f ( int n) {  
    int t, s;  
    if ( n < 2 ) return 1;  
    s = f(n - 1);  
    t = f(n - 2);  
    return s + t;  
}
```

(i) Show the complete activation tree for it. (8)

(ii) What does the control stack look like when the fourth call of f (1) is about to return. Show only argument and return value in an activation record. (Assume that the initial call is f(6)). (7)

(c) Write down the names and purposes of the fields that might appear in a general activation record of a function. (10)

13. (a) Consider the following grammar for declaration statement.

```
D → T id;  
T → B C  
B → int | float  
C → P A  
P → * P | ∈  
A → [num] A | ∈
```

(i) Construct parse trees for the following declaration statements according to the above grammar. (4+5+6)

- (1) int x;
- (2) float \* y;
- (3) int \* [10] z;

(ii) Design and SDD for the above grammar that computes the type and width of a declared identifier. Assume, the width of an integer is 4 and that of a float is 8. (13)

(b) Draw the code structure layout for the following control - flow construct. (7)

```
S → for (S1 ; B ; S2) S3
```

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**SECTION – A**

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Explain the factors by which an indexing technique can be evaluated. (5)
- (b) Construct a B+ tree for the set of key values {2, 4, 6, 8, 12, 18, 20, 24, 30, 32} with  $n = 4$ . Assume that the tree is initially empty and values are added as per given order. (10)
- (c) Describe static hash file organization with an example. How can bucket overflows be handled? (10)
- (d) The relation account is given in Figure 1. Construct bitmap indices on type, branchname and location attribute. Explain how can you find balance for branchname = 'B2' and location = 'L1' and type = 'D'. (10)
  
2. (a) Explain block level stripping with an example of storing 1, 2, ..... n logical blocks into a disk subsystem consisting of 8 disks. (5)
- (b) Explain the data dictionary schema for DBMS. List the advantages and disadvantages for storing a relational database as follows: (10)
  - (i) Store each relation in one file.
  - (ii) Store multiple relations in one file.
- (c) Consider the E-R diagram in Figure 2 which contains composite, multivalued and derive attributes. (10)
  - (i) Give an SQL: 2003 schema definition corresponding to the E-R diagram.
  - (ii) Give constructors for each of the structured types defined above.
- (d) Describe with an example, the object identity and reference types in SQL. How can you process queries using reference type? (10)
  
3. (a) Explain the transaction states with the state diagram. (5)
- (b) A concurrent schedule of three transactions T1, T2 and T3 is given in Figure 3. Show the steps to transform the above schedule into an equivalent conflict serial schedule. (10)
- (c) Explain with examples, the testing of serializability by using precedence graph. Show the cases of both conflict and non-conflict schedules. (10)
- (d) Given relations  $R_1$  (A, B, C, D) and  $R_2$  (C, D, E) stored in sites  $S_1$  and  $S_2$ . Describe the join operation of  $R_1$  and  $R_2$  using semi-join strategy. Give an example of parallel join. (10)

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4. (a) Explain two phase locking protocol. (5)
- (b) Describe the implementation of lock manager using a lock table data structure and show the following locks: (10)
- (i) T1 has granted locks for data items 10, 22, 35 and waiting for data item 44.
  - (ii) T2 has granted locks for data items 44 and 22.
  - (iii) T3 has been waiting for data item 22.
  - (iv) T4 has been granted locks for data items 8, 10, 22 and waiting for data item 35.
- T1, T2, T3 and T4 are the transactions. Also explain how the lock manager process a lock request using the structure.
- (c) Explain the rules of performing read and write operations in time-stamp ordering protocol. What are the advantages and disadvantages of this protocol? How is the protocol improved in Thomas Write Rule? (10)
- (d) Describe log-based recovery methodology. For the given transactions <T1, T2, T3>, write the log records. (10)

T1: Read (A)	T2: Read (B)	T3: Read (A)
A = A-50	Read (A)	DISPLAY (A)
Write (A)	B = B+50	
	Write (B)	
	DISPLAY (A+B)	

**SECTION – B**

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Describe the key properties that give a DBMS edge over a file system. (14)
- (b) Show the block diagram of database management system components. (14)
- (c) Discuss 'Schema versus Data' and 'DDL versus DML'. (7)
6. Consider the following scenario of a hospital:
- Patients are treated in a single ward by the doctors assigned to them. Usually each patient will be assigned a single doctor, but in rare cases he/she will be assigned two doctors.
  - Healthcare assistants also attend to the patients; a number of these are associated with each ward.
  - Initially the system will be concerned solely with drug treatment. Each patient is required to take a variety of drugs a certain number of times per day and for varying lengths of time.
  - The system must record details concerning patient treatment and staff payment. Some staffs are paid on a part time basis and doctors and care assistants work varying amounts of overtime at varying rates. (subject to grade).

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**Contd ... Q. No. 6**

- The system will also need to track what treatments are required for which patients and when and it should be capable of calculating the cost of treatment per week for each patient (though it is currently unclear to what use this information will be put).
  - (a) Define entities and their attributes for the hospital management system described above. (10)
  - (b) Draw ER diagrams to show the relationships among entities of the above system. (25)
7. (a) Define BCNF, 3NF, and 4NF. Describe relationships among these normal forms. (9+8)
- (b) Describe the BCNF decomposition algorithm. (10)
- (c) Consider a relation with schema  $R(A, B, C, D)$  and FD's  $AB \rightarrow C$ ,  $C \rightarrow D$ , and  $D \rightarrow A$ . What are the non-trivial FD's that follow from the given FD's? (8)
8. Consider the following schema:
- Product (pid, name, price, category, year, maker-cid)
  - Purchase (buyer-ssn, seller-ssn, store, pid)
  - Company (cid, name, stock price, country)
  - Person (ssn, name, phone number, city)
- Note:
- in Purchase: buyer-ssn, seller-ssn are **foreign keys** in Person, pid is **foreign key** in Product;
  - in Product maker-cid is a foreign key in Company
- (a) Write SQL statements to answer the following queries: (20)
- Find names of people buying telephony products.
  - Find products (and their manufacturers) that are more expensive than all products made by the same manufacturer before 1972.
  - Find names of people who bought Bangladeshi products and did not buy Indian products.
  - Find names of products (and their manufacturers) whose prices are less than the average product price of that company.
- (b) Express the following queries using relational algebra: (8)
- Find names of people who bought Indian products and live in Gulshan.
  - Find people who bought stuff from Alam or bought products from a company whose stock prices is more than BDT 2500.
- (c) Define natural joins and outer joins. (7)
-

A-Id	Type	Branchname	Location	Balance
1	D	B1	L1	2000
2	C	B1	L1	2000
3	D	B2	L1	2000
4	D	B2	L2	5000
5	D	B2	L1	5000
6	C	B3	L2	3000
7	L	B3	L2	2000

Figure 1: Account relation for Question No. 1

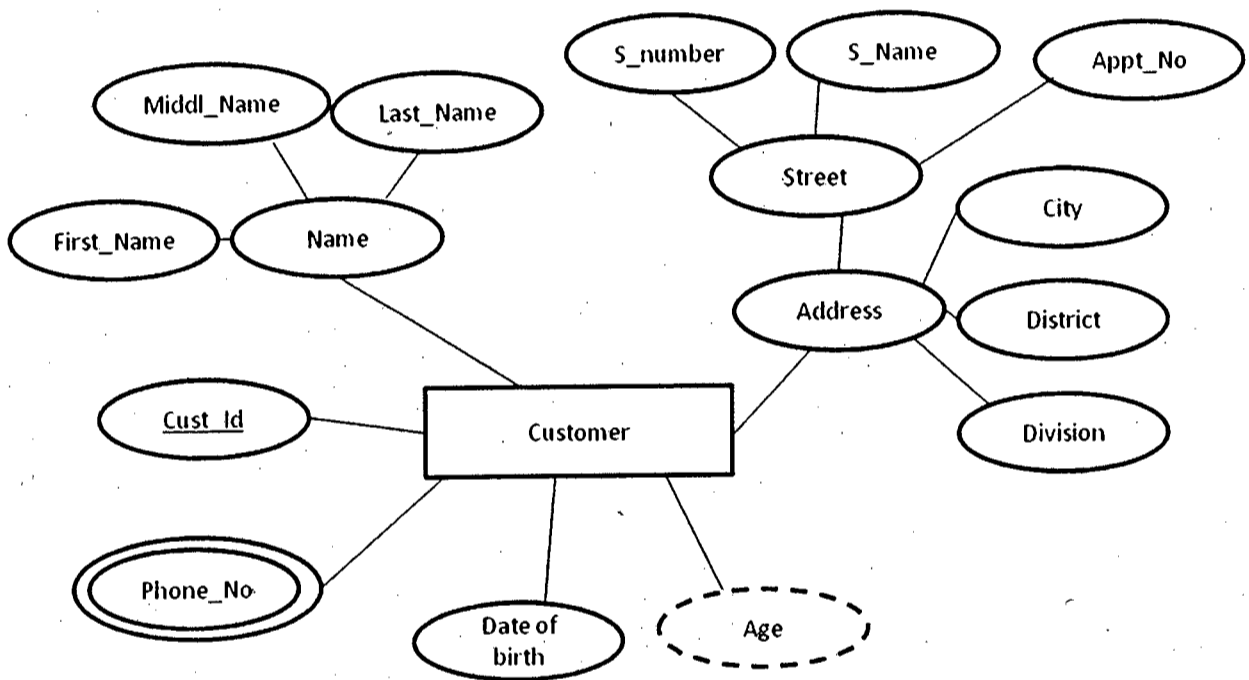


Figure 2: E-R diagram for Question No. 2

T1	T2	T3
Read (A)		
Write (A)		
	Read (A)	
		Read (A)
	Write (A)	
Read (B)		
Write (B)		
	Read (B)	
	Write (B)	

Figure 3: Concurrent schedule for Question No. 3

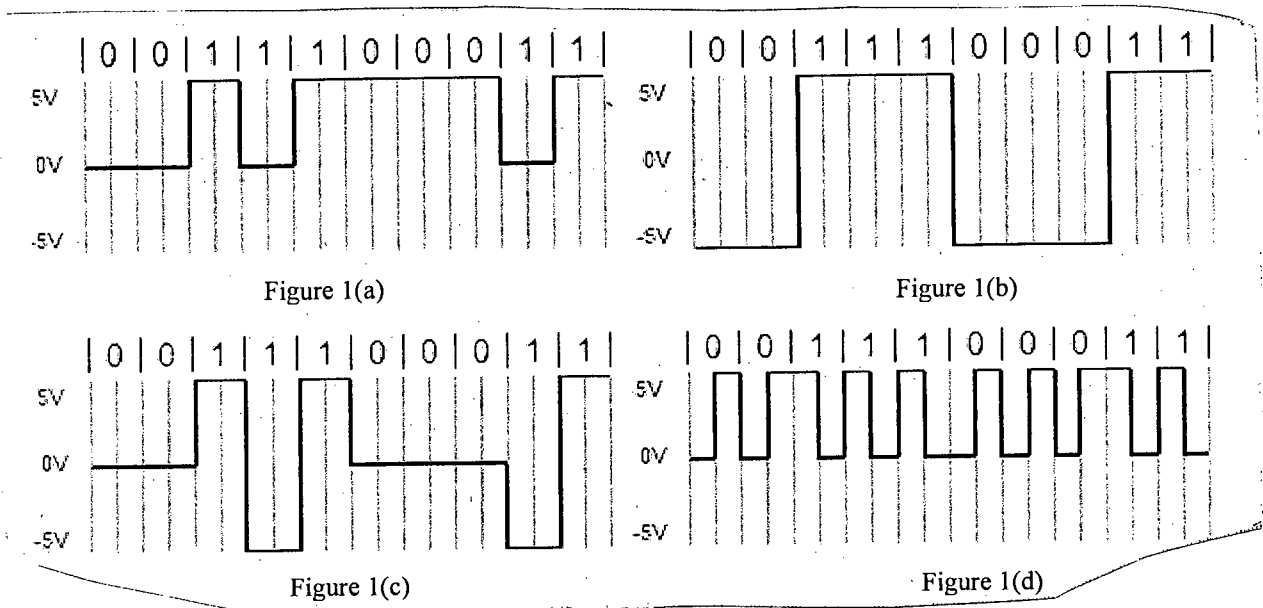


**SECTION – A**

There are **FOUR** questions in this Section. Answer any **THREE**.

1. (a) Consider the four signals in Figure 1(a), 1(b), 1(c) and 1(d) that are generated by encoding the bit-stream '0011100011' using four different digital line coding techniques. For each of these four line coding techniques identify and write the bit encoding rules (i.e., how 0 and 1 are represented). Compare the four techniques with respect to the following characteristics. (4+16=20)

- (i) Bandwidth requirement                      (ii) Synchronization capability  
 (iii) DC value suppression                      (iv) Error detection capability



- (b) Three signals, each covering the range 10-15 KHz are to be transmitted simultaneously using Frequency Division Multiplexing (FDM). The resultant signal should cover the range 80-95 KHz. Describe how to generate the desired frequency multiplexed signal. (8)

- (c) FSK transmission is used to transmit 1200-bit/s digital signals over a telephone channel. The FSK signals are to fit into the range 500 to 2900 Hz. The carrier frequencies are 1200 and 2200 Hz respectively. Find the baseband bandwidth required for the binary signals. Assuming sinusoidal roll-off shaping, what roll-off factor is required? (7)

2. (a) Explain with an example the difference between bit rate and pulse rate and thus show the advantage of using multisymbol signaling. Describe how multi-symbol signal can be generated using QPSK. Also draw the block diagram of a QPSK signal generator. (8+8+4=20)

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(b) How do Frequency Modulation (FM) and phase modulation (PM) differ? Show that the bandwidth of narrowband FM signal is  $2B$  Hz when baseband bandwidth of the modulating signal is  $B$  Hz. **(5+10=15)**

3. (a) Show that for a real time signal  $f(t)$ , the signal  $f_{SSB}(t) = f(t)\cos\omega_c t + f_h(t)\sin\omega_c t$  represents a lower sideband SSB-SC signal where  $f_h(t)$  represents the Hilbert Transform of  $f(t)$ . **(15)**

(b) There are two methods for generating SSB-SC signal: (i) Passing a DSB-SC signal through a band-pass filter; (ii) Using a circuit according to the expression for  $f_{SSB}(t)$  as mentioned in Question 3(a). Now identify the practical difficulties involved in both the methods. Give example of a signal which is suitable for SSB-SC modulation using the first method. **(8+5=13)**

(c) Why Vestigial-sideband (VSB) signal is called so? Describe how VSB signal is generated. **(3+4=7)**

4. (a) What is the maximum number of pulses that can be transmitted over a bandwidth of  $B$  Hz? Explain your answer. **(15)**

(b) The amplitude spectrum for a sinusoidal roll-off filter is given as follows: **(6+6+8=20)**

$$\begin{aligned} |H(\Delta\omega)| &= \frac{1}{2} (1 - \sin(\pi/2)(\Delta\omega/\omega_x)) & |\Delta\omega| < \omega_x \\ &= 0 & |\Delta\omega| > \omega_x \\ &= 1 & -\omega_c < \Delta\omega < -\omega_x \end{aligned}$$

Sketch the amplitude spectrum. Does this filter satisfy the Nyquist Criterion of odd symmetry for generating wave-shape with zero intersymbol interference (ISI)? Explain your answer. Show that for the given sinusoidal roll-off filter  $B = (1 + r)/2T$ , where the symbols carry their usual meanings in the given context.

**SECTION – B**

There are **FOUR** questions in this Section. Answer any **THREE**.

5. (a) How is the bandwidth of a real time signal calculated? Let  $f'(t)$  be the derivative of a real time signal  $f(t)$ . Which of  $f(t)$  and  $f'(t)$  has higher bandwidth? Explain your answer. **(6+8=14)**

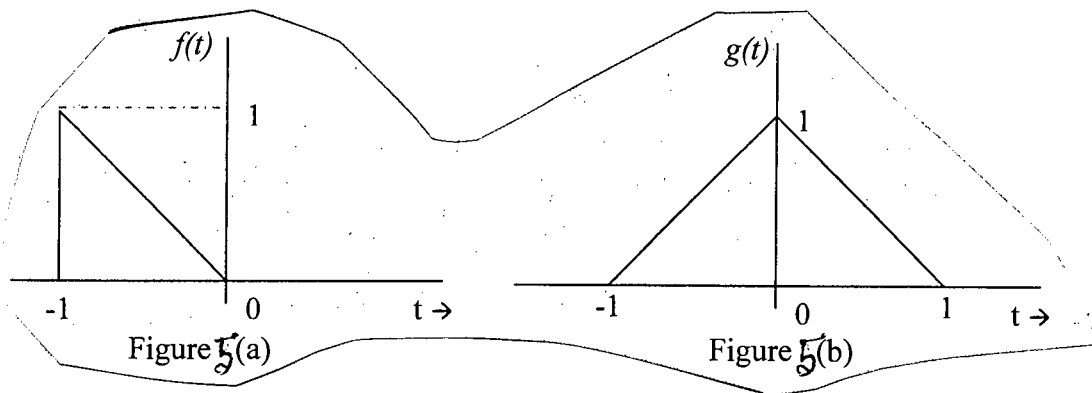
(b) The Fourier Transform of the triangular pulse  $f(t)$  in Figure 5(a) is given as- **(15+6=21)**

$$F(\omega) = 1/\omega^2 (e^{j\omega} - j\omega e^{j\omega} - 1)$$

Using this information, and the time-shifting and time-scaling properties, find the Fourier Transforms of the signal  $g(t)$  shown in Figure 5(b). Does the inverse-time bandwidth relation hold for this signal?

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6. (a) Find out and sketch the impulse response of an ideal low-pass filter with linear phase characteristic. Using the result explain why such an ideal filter is physically unrealizable. **(10+5=15)**
- (b) Let the signal  $g(t)$  as shown in Figure 5(b) be input to a linear time invariant system with transfer function,  $H(\omega) = j\omega$ . Find out and sketch the output (in time domain) of the system. **(8)**
- (c) Let  $f(t)$  be a real time signal band-limited to B Hz. Let  $f_s(t)$  be the signal obtained by periodically sampling  $f(t)$  at a rate of  $2B$  samples per second. Show that if  $f_s(t)$  is passed through an ideal low pass filter of bandwidth B Hz, then the output will be proportional to  $f(t)$ . **(12)**
7. (a) How does a Quantizer with uniform spacing of levels work in a PCM system? When does quantization with non-uniform spacing result in better signal-to-quantization noise ratio than quantization with uniform spacing? Explain with an example. **(5+10=15)**
- (b) Explain how step size  $k'$  affects 'quantization noise' and 'overload noise' in a Delta Modulation (DM) system. How does adaptive delta modulation adjust  $k'$  to reduce both 'quantization noise' and 'overload noise'? **(14+6=20)**
8. (a) What is Time Division Multiplexing (TDM)? What is the advantage of using TDM hierarchy? Explain why the output data rate of a multiplexer at any level in a TDM hierarchy is usually kept higher than the total of data rates of all its incoming channels. **(6+6+6=18)**
- (b) What is the advantage of using Differential Pulse Code Modulation (DPCM) system over Pulse Code Modulation (PCM) System? Discuss briefly on designing the predictor of a DPCM system. **(5+12=17)**

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