L-2/T-2/CSE **Date : 01/04/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2017-2018

Sub : **CSE 215** (Database)

Full Marks : 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

1. (a) Viru Sahastrabudhhe has taught different RAID levels to Farhan. To check whether Farhan has understood RAID levels or not, Viru Sahastrabudhhe has given a system with six data disks numbered from 1 to 6 to Farhan and asked him to answer the following questions: **(10+3+3**

   (i) Design a RAID level 6 scheme for the given data disks using minimum number of redundant disks possible. You are not allowed to use any data disk as redundant disk for the design.

   (ii) Describe the recovery process of your designed system if Disk 1 and Disk 3 fail simultaneously.

   (iii) Describe the recovery process of your designed system if the disks 1, 3, and 6 fail simultaneously.

   Now, write down the correct and complete answer that Farhan should provide in reply to Viru Sahastrabudhhe's tricky (!) question.

   (b) Consider a dictionary where each page contains only a single word along with its description. If we take the word from each page and form indexing based on the taken words, then what type of indexing (Dense/Sparse) would it be? Explain your answer. **(5)**

   (c) Write the steps of a one-pass algorithm for finding $S - R$, where number of records in relation R is smaller than the number of records in relation S. **(6)**

   (d) Calculate average time (with explanation) to read one block of data from a **Megatron 747 disk**. Megatron 747 disk has 8192 tracks and maximum and minimum time to read one block of data is given below: **(8)**

	Seek time (ms)	Rotational latency (ms)	Transfer time (ms)	Total time (ms)
Minimum	0	0	0.5	0.5
Maximum	17.4	15.6	0.5	33.5

2. (a) The highly anticipated Marvel movie "Avenger: Endgame" has been released recently and theatres are flooded with movie-lovers. Three superhero enthusiasts Leonard, Howard, and Raj are dying to watch the movie in any first-day show, but they failed to manage tickets. Out of desperation, they decided to hack the database managing seat reservation system of a nearby theatre concurrently. At first, Leonard hacked into the system. He read all the reservations for the matinee show. After making changes, he saved the reservations.

Contd P/2

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Contd ... Q. No. 2(a)

Then Howard read the reservations for the same show and did the same as Leonard. Next, Leonard read the reservations for night show on the same date and after making changes saved those. Subsequently, Raj changed the reservations for a morning show and saved it in the database. Finally, Howard repeated the same process for the same night show as Leonard did. [Note that, there are different relations for morning, matinee and night show.]

Based on this context, answer the following questions: **(7+7+7=21)**

(i) Construct the schedule of actions using standard notations

(ii) What is a conflict serializable schedule? Show whether the schedule of previous question is conflict serializable or not without using Precedence graph.

(iii) Show whether the schedule is conflict serializable or not using Precedence graph. If it is not conflict serializable, then briefly describe the reason. If it is conflict seriablizable, then determine the serializability order using topological sort.

(b) Express following query using relational algebra and draw equivalent logical query tree: **(6+3=9)**

```
SELECT title
FROM StarsIn
WHERE starsName IN
(
SELECT name
FROM MovieStar
Where name LIKE "%Khan" and birthdate > "18-MAR-1990"
);
```

(c) Give an example where the Bit-map index is preferred over other indexing techniques. **(5)**

3. (a) Astronomer Neil has landed up in unknown BNARY planet instead of moon due to rocket malfunction and abducted by the people of BNARY. The will only let Neil go if he can solve some hashing problems. **(9+12=21)**

In the game of life or death, Neil has been given the following DBMS table:

Product Id	Quantity	Price per Quantity
03	10	5
05	5	90
09	10	1200
11	12	50
13	11	89
18	2	65

Neil has been asked by BNARY people to use the hash function $h(x) = x \ mod \ 1024$ for answering the following questions. Now considering yourself in the place of Neil, write down the correct answer of each of the following questions:

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Contd ... Q. No. 3(a)

(i) Insert all the given data incrementally using the Product Id of the table in an initially empty extensible hashing system. Show the state on the system after each insertion.

(ii) Insert all the given data incrementally using the Product Id of the table in an initially empty liner hashing system. Show the state of the system after each insertion.

(b) Consider the following cylinder requests: **(9)**

Cylinder of Request	Request Arrival Time (*ms*)
2000	0
5000	10
1000	15
8000	25
9000	35
4000	50

Schedule these requests according to the elevator algorithm showing the total time needed for serving. Use data from Question 1(d) and assume moving the head assembly requires 1 ms (to start and stop) + 1ms for every 500 cylinders and head assembly is initially on the 1st cylinder.

(c) What is deadlock in database transaction? Explain with example. **(5)**

4. (a) The following is a sequence of undo log records found in the disk after a crash: **(3+9=12)**

```
< START T1 >
< T1, A, 10 >
< START T2 >
< T2, B, 5 >
< T1, C, 7 >
< START T3 >
< T3, D, 12 >
< COMMIT T1 >
< START CKPT ? >
< START T4 >
< T2, E, 5 >
< COMMIT T2 >
< T3, F, 1 >
< T4, G, 15 >
< END CKPT >
< COMMIT T3 >
< START T5 >
< T5, H, 3 >
< START CKPT ? >
< COMMIT T5 >
```

Now Answer the following questions:

(i) What are the correct values of the two "?" –s in the log record?

(ii) Describe the action of recovery manager, showing changes to both the disk and the log.

Contd P/4

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Contd ... Q. No. 4

(b) "Two-phase locking is efficient for B+ tree index structure" – Justify this statement using illustrative examples. **(7)**

(c) Consider the B+ tree given in the figure for Question 4(c). Now change the B+ tree incrementally according to the following instructions. For each instruction, draw the final modified state of the B+ tree. **(4×4=16)**

(i) Insert keys 8, 9

(ii) Insert keys 24, 27

(iii) Remove Keys 8, 9

(v) Remove Keys 24, 27

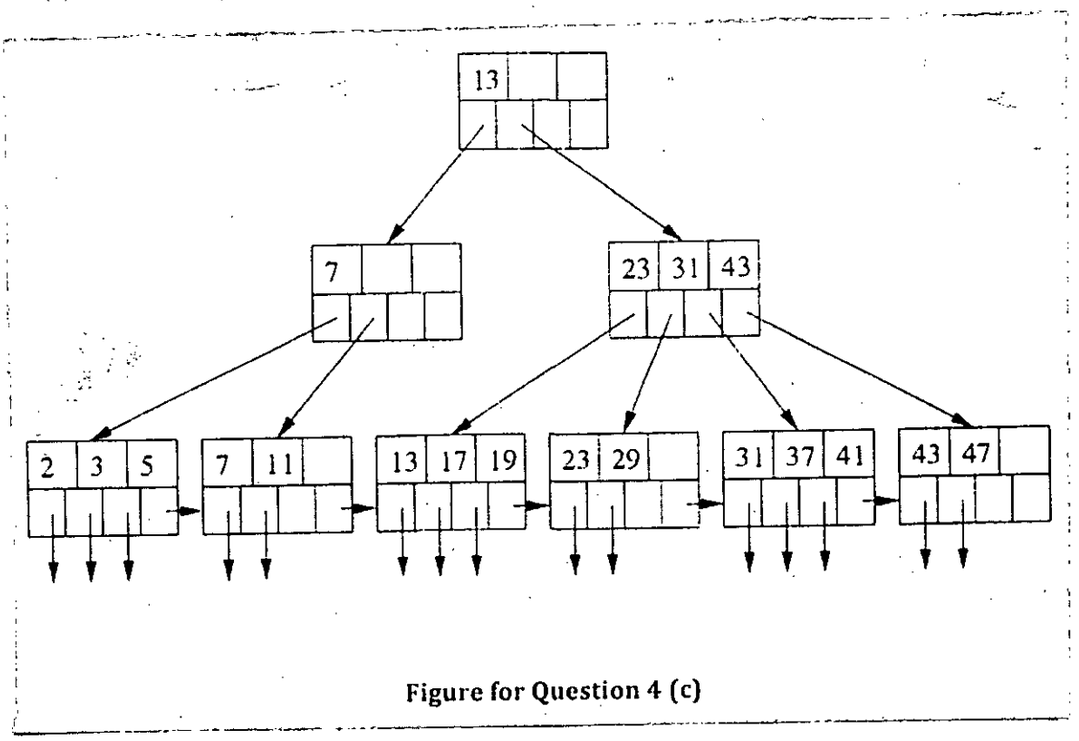

Figure for Question 4 (c)

SECTION – B

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

5. (a) Assume that you are designing a database for a university. Consider the following in your design. **(5+15=20)**

- Each student has a student id, name, address and contact name.
- Each course has a course number, name of the course, credit hour per term, and the minimum level and term of the students for whom the course is offered.
- Each student enrolls in several courses.
- Now, university employee can be divided into two parts. The can be either faculty members or they can be office staff.

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Contd ... Q. No. 5(a)

- Each faculty member has a name, designation, address, contact number and room number associated with them. On the other hand, each office staff has a name, contact and address, hourly payment rate associated with them.
- In each semester, every faculty member conducts several courses. At the same time, a single course can have many course teachers. Moreover, if a course is conducted by several teachers, then one of them is assigned as the coordinator. Assume that each semester is identified by a label such as "January 2019"

(i) Write down the list of entity sets. With each entity set, mention its attributes.

(ii) Draw the E/R diagram of your design. Use appropriate arrows to indicate multiplicity of each relation. There is no need to show the attributes of the entity sets. However, if there is an attribute on a relation then you must mention it.

(b) Convert the isa-hierarchies of the diagram in the following figure into schemas using three principal conversation strategies. **(10)**

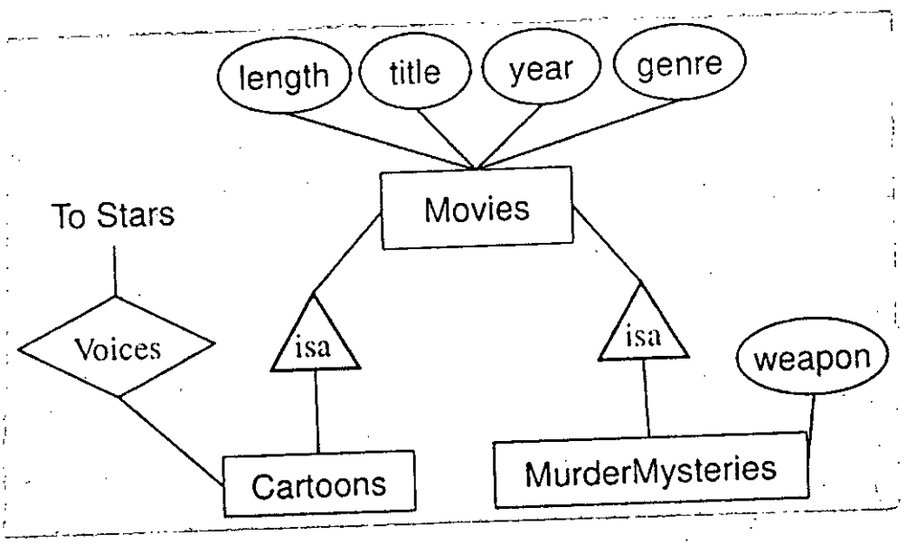

Figure for Question. 5(b) Partial E/R diagram of movie database

(c) Define weak entity set. Also give an example of weak entity set. **(5)**

(5×5=25)

6. (a) Consider the following schemas:
    - Books(<u>isbn</u>, title, publisher_id, publish_year, price_per_copy, copies_sold)
    - Author(<u>author_id</u>, name, contact)
    - Publisher(<u>publisher_id</u>, name, address)
    - AuthorOfBook(<u>book_id</u>, <u>author_id</u>)

Now answer the following queries.

(i) Find all the books authored by "Ernest Hemingway".

(ii) Find the revenue earned by each publisher between 1980 and 1990 by selling books.

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Contd ... Q. No. 6(a)

(iii) Find the name of the authors who have published at least 5 books since 1995.

(iv) Find the publisher which published books of most of the authors.

(v) Find the name of all the books, which are sold more copies than any other books published before 1990 by the same publisher.

(b) Consider the following schemas. **(5×2=10)**

- Manufacturer(man_id, name, address)
- Laptop(model, man_id, speed, ram, hd, screen, price)
- Printer(model, man_id, is_color, type, price)

Write expressions of relational algebra to answer the following queries.

(i) Find the model and speeds of each laptop manufactured by "Dell".

(ii) Find the sorted list of names of the manufacturers that produce at least three different models of laptops.

7. (a) Write the steps to compute the closure of a set of attributes with respect to a set of functional dependencies (FD). Let us consider a relation with attributes A, B, C, D, E, F. Suppose that this relation has the FD's **(5+5=10)**

$AB \rightarrow C$

$BC \rightarrow AD$

$D \rightarrow E$

$CF \rightarrow B$

Find the closure of {A, B}, that is {A, B}+.

(b) The following schema has been designed for an address book application: **(5+5+5=15)**

R (SSN, Name, PhoneType, PhoneNumber)

A person can have different types of phone numbers (e.g. Mobile, Home or Office). The following set F of functional dependencies hold on R:

SSN →Name

SSN, PhoneType →PhoneNumber

SSN, PhoneType →Name

PhoneNumber →SSN, Name, PhoneType

(i) What are the keys for R?

(ii) Is R in BCNF? Why or why not?

(iii) Decompose R into BCNF (if it is already not in BCNF).

(c) Give an example of a relation which is in 3NF but not in BCNF. Define Multivalued Dependency. **(5+5=10)**

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8. (a) Consider the following schema. **(10)**

MovieExec(name, address, cert#, netWorth)

Suppose that we want to prevent the average net worth of movie executive from dropping below 50,000$. This constraint could be violated by insertion, update and deletion to the netWorth column. Write a trigger that checks this constraint before each update to the networth column and if the constraint is violated then sets the value of networth equal to the minimum amount required to satisfy the constraint.

(b) Consider the following schema. **(10)**

Movie(title, year, filmType, inColor, studioId)

Studio(studioId, name, address)

Write a stored procedure that takes as input the name of a studio and a year. It then counts and prints the number of black and white movies produced by that studio in the specified year.

(c) From the Document Type Definition (DTD) given below describe the structure of the data in XML. Write a sample XML file using this DTD. **(10)**

```
<!DOCTYPE STARS [
      <!ELEMENT STARS (STAR*)>
      <!ELEMENT STAR (NAME, ADDRESS+, MOVIES)>
      <!ELEMENT NAME (#PCDATA)>
      <!ELEMENT ADDRESS (STREET, CITY)>
      <!ELEMENT STREET (#PCDATA)>
      <!ELEMENT CITY (#PCDATA)>
      <!ELEMENT MOVIES (MOVIE*)>
      <!ELEMENT MOVIE (TITLE, YEAR)>
      <!ELEMENT TITLE (#PCDATA)>
      <!ELEMENT YEAR (#PCDATA)>
]>
```

(d) Briefly describe Map-Reduce framework **(5)**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2017-2018

Sub : **CSE 211** (Theory of Computation)

Full Marks : 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

1. (a) Define the Boolean Satisfiability Problem with necessary examples. **(6)**

   (b) With the knowledge that 3-SAT problem is NP, prove that graph 3-colorability is NP-Complete. **(20)**

   (c) Using the graph framework in Question (b), show how the final 3-color graph for a 3-SAT problem of,

   $$(x_1 \vee \overline{x_2} \vee \overline{x_3}) \wedge (x_1 \vee x_3 \vee x_4),$$ will look like. **(9)**

2. (a) Let us say that we have a DFA D for a certain language L for an alphabet Σ. How can you readily find the DFA from D for the language, $\Sigma^* - L$? Explain why your proposed method works. Is there any scenario for which this will not work?

   Does your proposed method work for NFA's as well? Explain. **(10)**

   (b) Give DFA's (draw state diagrams only) accepting the following languages over the alphabet {0, 1}: **(10+7)**

   (i) The set of all strings beginning with a 1 that, when interpreted as a binary integer, is a multiple of 5. For example, strings 101, 1010, and 1111 are in the language; 0, 100, 0101, and 111 are not.

   (ii) The set of all strings beginning with a 1 that, when interpreted as a binary integer, is a power of 2.

   (c) Using the techniques of proving closure properties of regular languages, draw the NFA for the regular expression, $(a \cup b)^* aba$. **(8)**

3. (a) Design an NFA which accepts all and only the set of strings over the alphabet {0, 1} such that there are at least two 0's with nonzero number of characters between these two 0's and that (number of characters) is a multiple of 4. In addition to these pairs of 0's, there may be other 0's in the string. Some of the strings accepted by this NFA are, 00000, 101111010, 01000010111011. And some of the strings *not* accepted by this NFA are, 00, 10101010.

   Show the NFA using state diagram as well as transition table. **(18)**

   (b) After learning the pumping lemma (difficult to understand, easy to go astray when applying it), Surcharged Skye got very excited and came up with very personal opinions regarding a number of languages as follows: **(17)**

Contd P/2

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Contd ... Q. No. 3(b)

(i) For $L_1 = \{ww \mid w \in \{0, 1\}^*\}$, we choose the string $0^P 0^P$, take $x = \epsilon$, $y = (00)^k$, $k \leq \frac{p}{2}$.

Now, since $\forall i \geq 0, xy^i z \in L_1$, L_1 is regular.

(ii) For $\Sigma = \{0, 1\}$, $L_2 = \{w \in \Sigma^* \mid n_0(w) = 2n_1(w)\}$ ($n_a(w)$ denote the number of a's in w), we choose the string $0^{2p}1^p$, take $y = 01$. Since $\forall i \geq 0, xy^i z \in L_2$, we have failed to demonstrate that L_2 contradicts pumping lemma.

(iii) For $L_3 = \{0^n1^n0^n \mid n \geq 0\}$, we chose the string $0^k1^k0^k$, where $k = \left\lfloor \frac{p}{3} \right\rfloor$. Now, since $\forall i \geq 0, xy^i z \notin L_3$, for all possible y's, L_3 is not regular.

Explain clearly whether you find anything wrong in each of the opinion expressed by Skye. Symbols used have got their usual meanings used in class.

4. (a) Consider the NFA given below: **(15)**

	a	b	c	ϵ
$\rightarrow p$	$\{p\}$	$\{q\}$	$\{r\}$	$\emptyset$
q	$\{q\}$	$\{r\}$	$\emptyset$	$\{p\}$
$*r$	$\{r\}$	$\emptyset$	$\{p\}$	$\{q\}$

(i) Give, with necessary explanations, general forms of all the strings of length three or less accepted by the automaton.

(ii) Convert the automaton to an equivalent DFA. Showing the detailed computations is optional.

(b) Find regular expressions for each of the following languages: **(20)**

i. $\Sigma = \{a, b, c\}$, $L = \{w \in \Sigma^* \mid w \text{ contains at least one occurrence of each symbol in } \Sigma\}$,

ii. $\Sigma = \{a, b\}$, $L = \{a^n b^m \mid n \geq 3, m \text{ is odd}\}$,

iii. $\Sigma = \{a, b\}$, $L = \{a^n b^m \mid (n + m) \text{ is odd}\}$,

iv. $\Sigma = \{a, b\}$, $L = \{vwv \mid v, w \in \Sigma^*, |v| = 2\}$,

v. $\Sigma = \{a, b\}$, $L = \{w \mid w \in \Sigma^*, n_a(w) \mod 3 = 0\}$, where $n_a(w)$ denotes the number of a's in w.

Contd P/3

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SECTION – B

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

5. Provide context-free grammars that generate the following languages (the alphabet Σ is { 0, 1 }): **(7+8)**

   (a) The set of all strings with equal number of 0s and 1s

   (b) {w|w contains at least three 1s}

6. (a) Show that the following grammar is ambiguous by giving two different parse trees for some string. **(7+8)**

$$E \rightarrow E+E$$
$$E \rightarrow E \times E$$
$$E \rightarrow (E)$$
$$E \rightarrow a$$

   (b) Remove ambiguity from the grammar given above.

7. (a) Convert the following context-free grammar into an equivalent grammar in *Chomsky normal form*. Show the steps of your conversion. Here, 0 and 1 are the terminals. **(8+7)**

$$S \rightarrow A1A|B$$
$$A \rightarrow 0A|1A|\mathcal{E}$$
$$D \rightarrow 00$$

   (b) Determine whether 01101 is in the language of the grammar thus found using the CYK algorithm.

8. (a) Design a PDA that recognizes the language **(15)**

$$L = \{a^n b^n c^m d^m | n \geq 1,\ m \geq 1\}$$

   Draw its transition diagram.

9. Design a Turing machine (TM) that takes as input two numbers N_1 and N_2 of equal length in binary and computes the logical OR of the two numbers. The tape initially contains $N_1\#N_2\#$, where '#' is a tape symbol that is used as the separator. Your TM should terminate with the OR of the two numbers in binary after the second #. (You can use multiple tracks, storage in the state if you wish). **(15)**

10. Briefly explain whether the following statements are true or false: **(15)**

    (i) A one-tape Turing machine with multiple tracks can simulate a Multi-tape Turing machine.

Contd P/4

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Contd ... Q. No. 10

(ii) A deterministic Turing machine can simulate n moves of a non-deterministic Turing machine in $P(n)$ moves, where $P(n)$ is some polynomial in n.

(iii) A deterministic Turing machine can simulate n moves of a conventional computer in $P(n)$ moves, where $P(n)$ is some polynomial in n.

11. Define the following: **(9+6)**

(i) Diagonalization language

(ii) Universal language

(iii) Halting problem

Show that one of the above is *not recursively enumerable* (*RE*).

12. The *subgraph isomorphism problem* is, given graphs G_1 and G_2, does G_1 contain a copy of G_2 as a subgraph? That is, can we find a subset of the nodes of G_1 that, together with the edges among them in G_1 forms an exact copy of G_2, when we choose the one to one correspondence between nodes of G_2 and nodes of the subgraph of G_1 properly? Prove that the *subgraph isomorphism problem* is NP-complete. **(15)**

13. (a) Define the following classes of langulages: **(6+9)**

(i) P

(ii) NP

(iii) PSPACE

(iv) NPSPACE

(b) For each of the following pairs of classes of languages, what is the widely believed relationship between the classes (whether they are equal or which one is a subset of the other)? Briefly justify your answer.

(i) P and NP

(ii) PSPACE and NPSPACE

(iii) NP and PSPACE

L-2/T-2/CSE **Date: 11/04/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2017-2018

Sub: **CSE 207** (Data Structures and Algorithms II)

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) What is a spanning tree of a graph? Write Kruskal's algorithm for finding a minimum spanning tree of an edge-weighted graph. Analyze the time complexity of the algorithm by suggesting data structures for efficient implementation of the algorithm. **(3+5+7)**

(b) Find a minimum spanning tree of the graph in Figure 1 using Prim's algorithm showing every step of the algorithm. **(10)**

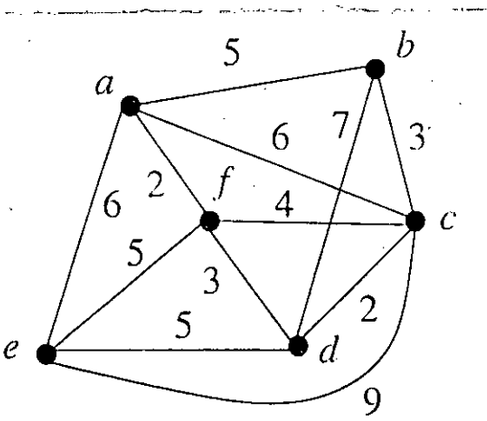

Figure 1: The graph for Question Number 1(b).

(c) Let G be a weighted connected graph and let V_1 and V_2 be a partition of the vertices of G into two disjoint non-empty sets. Let e be an edge in G with minimum weight among those edges with one endpoint in V_1 and the other in V_2. Then show that there is a minimum spanning tree T of G containing e. **(10)**

2. (a) Define a flow network. What is an augmenting path in a flow network? Explain with illustrative examples. **(3+3)**

(b) Find the maximum flow and the minimum cut in the flow network given in Figure 2 using Ford-Fulkerson algorithm. The vertex s is the source and the vertex t is the sink of the flow network. Integers represent the flow capacities of the edges. **(10)**

Contd P/2

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Contd... Q. No. 2(b)

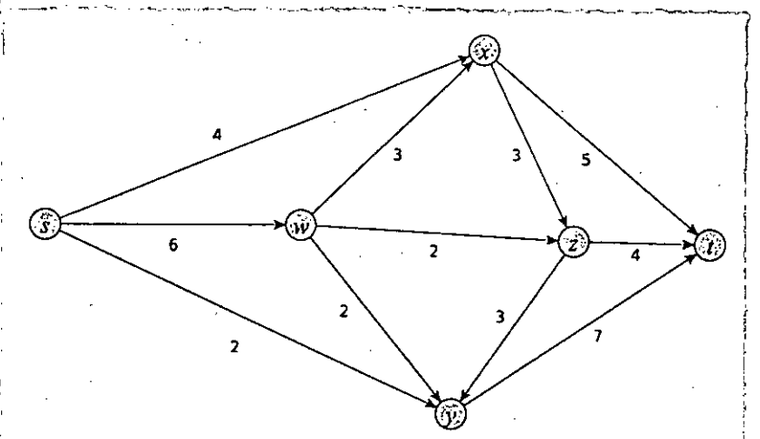

Figure 2: Figure for Question Number 2(b).

(c) Describe the minimum path length augmentation method of Edmonds and Karp and explain how this method improves the time complexity of Ford-Fulkerson algorithm. **(10)**

(d) The *strength of a path* in an edge-weighted graph G is defined as the minimum weight in the edges that make up the path. The *all pair strongest path problem* asks to find the strongest path between every pair of vertices in the graph G. Design an algorithm to solve the all pair strongest path problem. **(9)**

3. (a) How do we cope with hard problems? Discuss. **(5)**

(b) Solve the following instance of the 0-1 knapsack problem by a branch-and-bound algorithm using a state-space tree. **(10)**

Item	Weight (kg)	Profit (Taka)
1	3	18
2	5	35
3	4	44
4	7	56
5	2	18

Capacity = 10kg

(c) Apply backtracking to the problem of finding a Hamiltonian circuit in the graph in Figure 3. Show the corresponding state-space tree. **(10)**

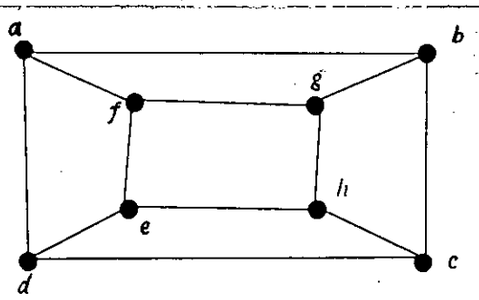

Figure 3: The graph for Question Number 3(c).

(d) Discuss the approximability of the general Traveling Salesperson Problem (TSP). Give an approximation algorithm for the Euclidean TSP problem and compute the approximation ratio of your algorithm. **(2+3+5)**

Contd P/3

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4. (a) What do you mean by $X \leq_P Y$?

Show that vertex cover problem $\leq_P$ set cover problem. **(3+7)**

(b) Define the satisfiability problem. Show that the independent set problem in NP-hard by reducing the 3-SAT problem to the independent set problem. **(3+7)**

(c) Give an approximation algorithm of the set cover problem and compute the approximation ratio of your algorithm. **(3+7)**

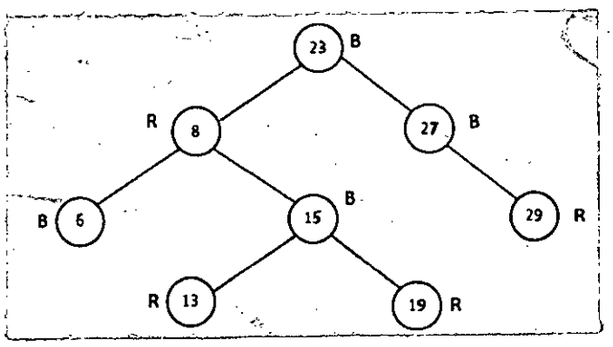
(d) Your friend claims that he has developed a polynomial time algorithm to solve the set-packing problem. What will happen if his claim is proved to be true? **(5)**

SECTION – B

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

5. (a) Prove that a tree with n nodes and the property that the heights of the two children of any node differ by at most 1 has $O(\log n)$ height. **(12)**

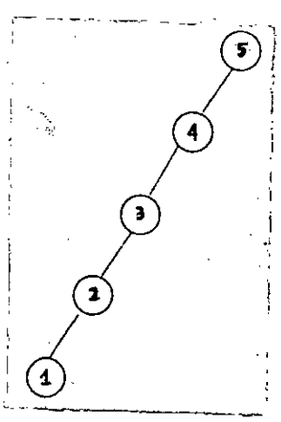
(b) Insert 11 into the Red-Black tree shown below. You have to show each operation. (The red and black nodes are indicated by 'R' and 'B', respectively.) **(15)**



(c) Mention one advantage of AVL trees over red-black trees, and one advantage of red-black trees over the AVL trees. **(4)**

(d) If i-th and (i+2)-th Fibonacci numbers are x and y, respectively (where i>0), what would be the minimum number of nodes in an AVL tree with height (i-1)? **(4)**

6. (a) Consider the following binary search tree. Perform *splay* (1) (that means splay the node with value 1). You have to show the intermediate steps, and mention which operations you are performing at various nodes. **(10)**



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Contd... Q. No. 6

(b) Mention the running times of the following operations for both Binomial heap and Fibonacci heap. **(6+6)**

(i) Insert key

(ii) Find min

(iii) Extract min

(iv) Union of two heaps

(v) Decrease key

One of your friends claims to have designed a mergeable heap which takes O(1) time for each of the operation mentioned above. Would you believe it? Justify your answer.

(c) Write down the algorithm for extracting the minimum key from a Fibonacci heap. **(8)**

(d) What is the main objective of splay trees? Do splay trees explicitly try to balance the height? **(5)**

7. (a) What is meant by a "maximally damaged tree" in the context of Fibonacci heaps? Draw the maximally damaged tree of order 5 (that means the degree of the root is 5). **(4+6)**

(b) Prove that there are ${}^{k}C_{i}$ nodes at depth i in a binomial tree B_k. **(5)**

(c) Under simple uniform hashing, what is the expected number of items that may collide with an element x in a hash table with separate chaining? Assume that there are m separate chains (lists) and n items in the hash table. **(10)**

(d) (i) "Quadratic probing does not necessarily probe all locations in the hash table" — prove or disprove this statement.

(ii) Briefly discuss the concept of perfect hashing. **(5+5)**

8. (a) How can BFS be adapted to solve single source shortest path problem in an edge-weighted graph with unequal weights? Explain. **(5)**

(b) Explain the intuitive idea behind Bellman-Ford algorithm. How will you detect a negative cycle using Bellman-Ford algorithm? **(6+2)**

(c) Write Dijkstra's algorithm for single source shortest path problem. Prove its correctness. Analyze the time complexity of the algorithm. What would be the running time of Dijkstra's algorithm if a Fibonacci heap is used instead of a binary heap. **(5+5+7+5)**

L-2/T-2/CSE **Date : 27/03/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2017-2018

Sub : **EEE 269** (Electrical drives and Instrumentation)

Full Marks : 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

1. (a) For an input signal shown in fig. no. 1(a)(i), design a system using op-amps, which will give the output as shown in fig. 1(a)(ii). No other voltage source is available except dc voltage sources for the biasing of the op-amps. Consider ideal cases. **(23)**

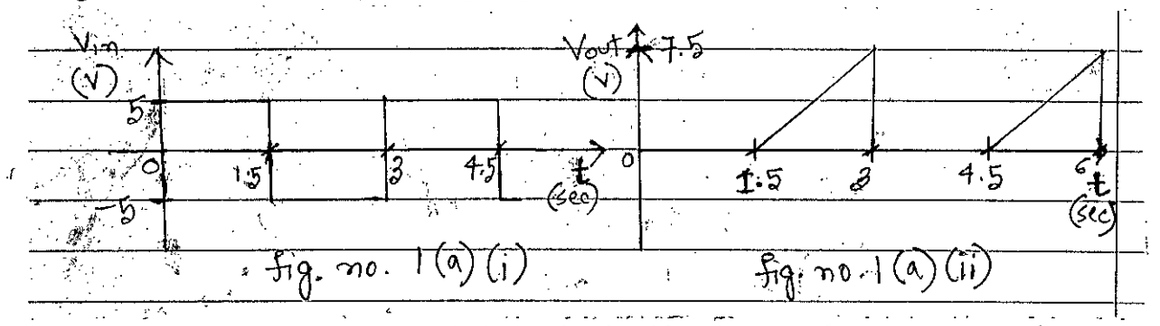

fig. no. 1(a)(i) fig. no. 1(a)(ii)

(b) For any 3 input voltages: x, y, z; design a circuit with op-amps to have an output voltage, v, as, $v = k_1x + k_2y - k_3z$ where, k_1, k_2, k_3 are constants. **(12)**

2. (a) For an analog signal shown in fig. no. 2(a), design a Flash ADC with 4 bit output. Show the analog and the corresponding digital values in a table. What are the shortcomings of your design? Give reasons behind those shortcomings. **(25)**

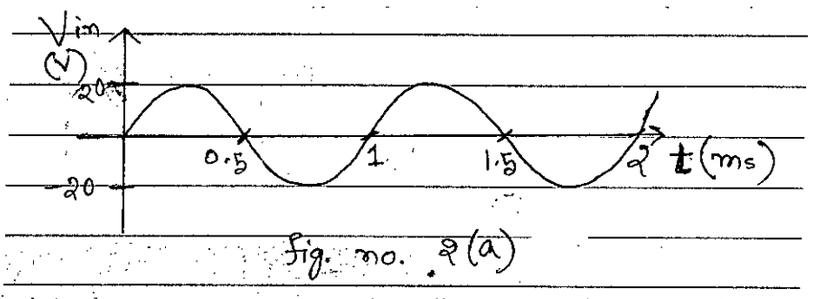

fig. no. 2(a)

(b) Describe any two elements of the 'Signal Conditioning System' with examples. **(10)**

3. (a) Describe how the 'Electrical Interference Noises' can couple into a measurement system. Also give at least one solution to reduce each coupling. **(25)**

(b) For a strain gauge, show that, $G_f = 1 + 2\nu + \dfrac{\Delta\rho/\rho}{\Delta L/L}$ **(10)**

where, all the symbols have their usual meanings.

Contd P/2

EEE 269(CSE)

4. (a) Fig No. 4(a) shows a system, where 2 metal plates are moving in x direction simultaneously. There are 3 different materials with dielectric constants ϵ_1, ϵ_2, and ϵ_3 respectively between these metal plates. Derive the expression for the capacitance C across the metal plates. Also, draw the graph of C vs. x. Consider that, $\epsilon_3 > \epsilon_2 > \epsilon_1$. **(25)**

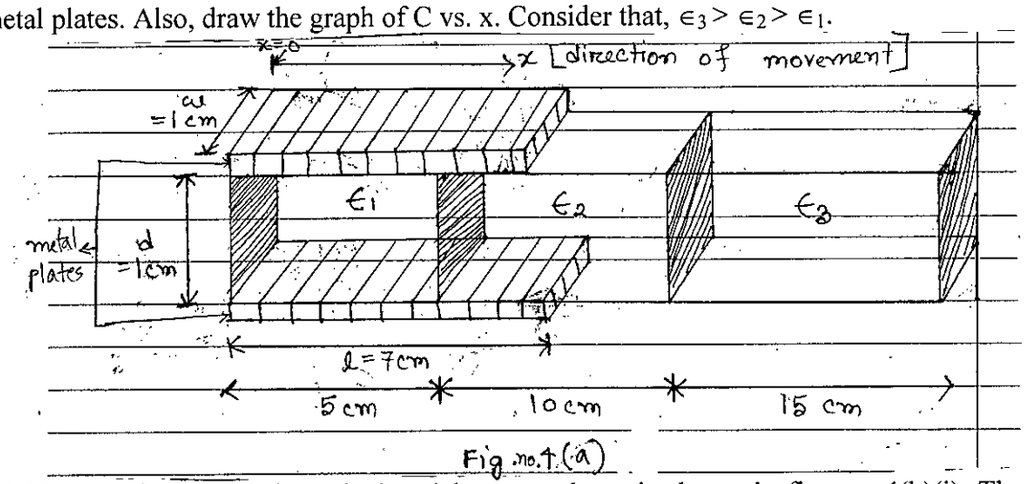

Fig no.4.(a)

(b) A variable capacitance angular velocity pickup transducer is shown in fig. no. 4(b)(i). The equivalent circuit of the transducer is shown in fig. no. 4(b) (ii) . Prove that the current, i, is directly proportional to the angular velocity dθ/dt, where E_b is the voltage applied across the transducer. **(10)**

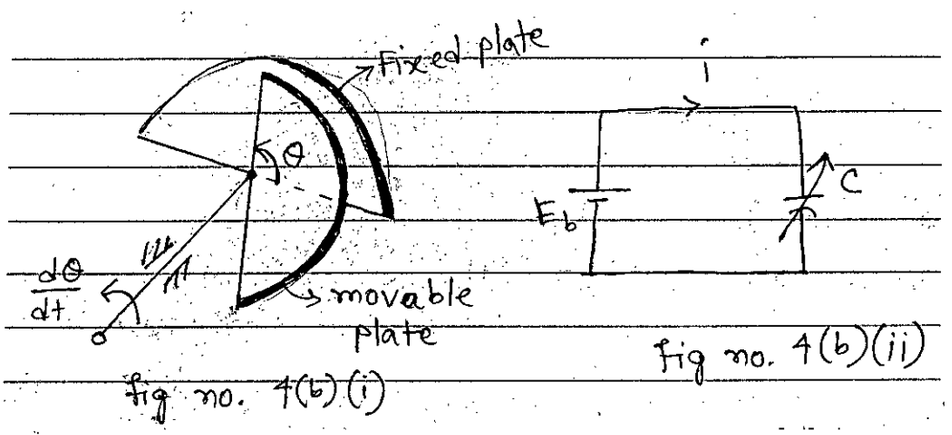

fig no. 4(b)(i)

fig no. 4(b)(ii)

SECTION – B

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

5. (a) What is voltage regulation? Explain with phasor diagram, why voltage regulation is positive for inductive loads. **(5)**

(b) Explain why open circuit test is usually performed in low side and short circuit test is performed in high side. **(10)**

(c) A 30kVA, 8000V/230V distribution transformer has an impedance referred to primary of 20 + j 100 Ω. The components of the excitation branch referred to the primary side are R_{h+e} = 100 k Ω and X_m = 20 k Ω.

Contd P/3

EEE 269(CSE)

Contd ... Q. No. 5(c)

(i) If the primary voltage is 7967V and the load impedance is $z_L = 2 + j0.7\ \Omega$, what is the secondary voltage of the transformer? What is the voltage regulation? **(5+5=10)**

(ii) What is the core loss and efficiency of the transformer if same is connected as mentioned in part (i)? **(5+5=10)**

6. (a) A 460 V, 25 hp, 60 Hz, four pole, Y-connected wound rotor induction motor has the following impedances in ohms per phase referred to the stator circuit: **(18)**

$R_1 = 0.641\ \Omega$ $R_2 = 0.332\ \Omega$ $X_m = 26.3\ \Omega$

$X_1 = 1.106\ \Omega$ $X_2 = 0.464\ \Omega$

(i) What is the break down torque of this motor? At what speed and slip does it occur?

(ii) What is the starting torque of this motor?

(iii) If the rotor resistance is doubled, at what speed the maximum torque will occur? What will be the new starting torque of the motor?

(b) (i) Explain why a single-phase induction motor is unable to start itself. Name three major starting techniques of single phase induction motor. **(7+3=10)**

(ii) How is starting torque produced in a shaded – pole motor? **(7)**

7. (a) The internal generated voltage E_A of a 2 pole Δ connected, 50 Hz, three phase synchronous generator is 14.4 kV, and the terminal voltage V_T is 12.8 kV. The synchronous reactance of this machine is 4 Ω and armature resistance can be ignored. **(20)**

(i) If the torque angle of the generator $\delta = 18°$, how much power is being supplied by this generator?

(ii) What is the power factor of the generator at this condition?

(iii) Sketch the phasor diagram under these circumstances.

(iv) Ignoring the losses in this generator, what torque must be applied to its shaft by the prime mover at these conditions?

(b) Explain, using phasor diagrams, what happens to a synchronous motor as its field current is varied. Derive a synchronous motor V curve from phasor diagram. **(10)**

(c) What is a synchronous capacitor? Why it is used? **(5)**

8. (a) What is armature reaction? How the problems associated with armature reaction can be solved? Give brief description of any two methods. **(18)**

(b) How the speed of a shunt dc motor can be controlled? Explain any two methods. Provide the change in torque-speed characteristic curve due to the methods. **(17)**

L-2/T-2/CSE **Date: 16/03/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2017-2018

Sub: **MATH 247** (Linear Algebra, Laplace Transform and Fourier Analysis)

Full Marks: 280 Time: 3 Hours

The figures in the margin indicate full marks

Symbols have their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Solve the following system of linear equation by Gaussian elimination **(20)**

$$3x_1 + 2x_2 - x_3 = -15$$
$$5x_1 + 3x_2 + 2x_3 = 0$$
$$3x_1 + x_2 + 3x_3 = 11$$
$$-6x_1 - 4x_2 + 2x_3 = 30$$

(b) Let, V be a vector space of all 2 × 2 matrices over the real field $\mathbb{R}$. Determine whether W is a subspace of V. Where: **(10)**

(i) W consists of all non singular matrices of V.

(ii) W consists of all matrices A of V for which $A^2 = A$.

(c) Determine a basis and dimension of the solution space for the following homogeneous system of linear equations: **(16⅔)**

$$2x_1 + 2x_2 - x_3 + x_5 = 0$$
$$-x_1 - x_2 + 2x_3 - 3x_4 + x_5 = 0$$
$$x_1 + x_2 - 2x_3 - x_5 = 0$$
$$x_3 + x_4 + x_5 = 0$$

What is the null space of its coefficient matrix?

2. (a) Let, $\underline{v_1} = \begin{bmatrix} 1 \\ 3 \end{bmatrix}$ and $\underline{v_2} = \begin{bmatrix} -1 \\ 4 \end{bmatrix}$, and let $A = \begin{bmatrix} 1 & 3 \\ -2 & 5 \end{bmatrix}$ be the matrix for $T: \mathbb{R}^2 \to \mathbb{R}^2$ with respect to the basis $B = \{\underline{v_1}, \underline{v_2}\}$. **(20)**

(i) Find $[T(\underline{v_1})]_B$ and $[T(\underline{v_2})]_B$.

(ii) Find $T(\underline{v_1})$ and $T(\underline{v_2})$.

(iii) Find a formula for $T\left(\begin{bmatrix} x_1 \\ x_2 \end{bmatrix}\right)$.

(iv) Use the formula obtained in (c) to compute $T\left(\begin{bmatrix} 1 \\ 1 \end{bmatrix}\right)$.

(b) If $T: V \to W$ is a linear transformation, then prove that **(16⅔)**

(i) The kernel of T is a subspace of V.

(ii) The range of T is a subspace of W.

(c) Let, $T: \mathbb{R}^3 \to \mathbb{R}^3$ be the linear operator defined by **(10)**

$T(x, y, z) = (x + 2y - z, 2x + y + z, y + z)$. Find the rank and nullity of T.

Contd P/2

MATH 247/CSE

3. (a) Determine whether the following matrix A is diagonalizable or not. If so, find a matrix P that diagonalizes the matrix **(23⅔)**

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

and find $P^{-1}AP$. Also compute A^{21}.

(b) Apply the Gram-Schmidt process to transform the basis vectors $\underline{u_1}=(1,1,1)$, $\underline{u_2}=(0,1,1)$, $\underline{u_3}=(0,0,1)$ into an orthogonal basis $\{\underline{v_1},\underline{v_2},\underline{v_3}\}$; then normalize the orthogonal basis vectors to obtain an orthonormal basis $\{\underline{q_1},\underline{q_2},\underline{q_3}\}$. **(23)**

4. (a) Show that $L\{\ln t\}=\dfrac{\Gamma'(1)-\ln s}{s}=-\left(\dfrac{\gamma+\ln s}{s}\right)$ where, γ = Euler's constant. **(13)**

(b) Let, $F(t)=\begin{cases}3t & ;0<t<2\\ 6 & ;2<t<4\end{cases}$, where $F(t)$ has period 4. Then draw $F(t)$ and find $L\{F(t)\}$. **(13)**

(c) Find $L^{-1}\left\{\dfrac{e^{-\sqrt{s}}}{s}\right\}$. **(20⅔)**

SECTION – B

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

5. (a) Using Laplace Transform, evaluate $\int_0^\infty \dfrac{e^{-xt}}{(1+x)\sqrt{x}}dx$. **(15)**

(b) Find **(16)**

(i) $L^{-1}\left\{\dfrac{(s+10)e^{-5s}}{s^2+s+1}\right\}$ (ii) $L^{-1}\left\{\dfrac{(2s^3+10s^2+8s+40)}{s^2(s^2+9)}\right\}$

(c) State and prove Heaviside expansion formula, and using this formula find **(15⅔)**

$$L^{-1}\left\{\frac{3s+1}{(s-1)(s^2+1)}\right\}$$

6. (a) Evaluate the integral (using Laplace Transform): $\int_0^\infty \cos x^2 dx$. **(15)**

(b) Solve (using Laplace Transform): $y''(t)-ty'(t)+y(t)=1$ when $y(0)=1,\ y'(0)=2$. **(20⅔)**

(c) Show that $Si(\infty)=\dfrac{\pi}{2}$. **(11)**

Contd P/3

MATH 247/CSE

7. (a) (i) Find the Fourier coefficients corresponding to function defined as: **(24⅔)**

$$f(x)=\begin{cases}0, & -5<x<0\\ 3, & 0<x<5\end{cases}$$

with period = 10.

(ii) Also write the above function in corresponding Fourier series.

(iii) How should $f(x)$ be defined at $x=-5, 0, 5$ in order that the Fourier series will converges to $f(x)$ for $-5\le x\le 5$?

(b) State and prove Parseval's identity. Write the Parseval's identity corresponding to the half-range Fourier cosine series of $f(x)=x, 0<x<2$ and also determine the sum,

$$S=\frac{1}{1^4}+\frac{1}{2^4}+\frac{1}{3^4}+\cdots+\frac{1}{n^4}+\cdots$$ **(22)**

8. (a) Discuss about Fourier integral for even and odd function. Also find the Fourier integral of the function $f(x)=\begin{cases}0, & x<0\\ \frac{1}{2}, & x=0\\ e^{-x}, & x>0\end{cases}$ **(22)**

(b) Use finite Fourier transform to solve: **(24⅔)**

$$\frac{\partial U}{\partial t}=\frac{\partial^2 U}{\partial x^2}, U(0,t)=0, U(6,t)=0, U(x,0)=\begin{cases}1, & 0<x<3\\ 0, & 3<x<6\end{cases}$$

where $0<x<6$, $t>0$ and interpret physically.
