Indian Institute of Engineering Science and Technology, Shibpur

B.Tech CST 3rd Semester (Mid Semester) Examination 2019

Data Structures and Algorithms   CS-302

FULL MARKS: 50   **TIME: 2 hrs.**

Answer all the questions. Students are advised to go through the questions carefully before answering. Clearly mention your assumptions, if any, while answering. Credits will be given to precise answer. Two marks are reserved for neatness.

1. (a) Prove that $T(n) = n^3 + 20n$ is $\Omega(n^2)$.

   (b) Suppose algorithms A and B spend exactly $T_A(n) = 0.1n^2 log_{10} n$ and $T_B(n) = 2.5n^2$ microseconds, respectively, for a problem of size n. Choose the algorithm, which is better in the Big-Oh sense, and find out a problem size n_0 such that for any larger size $n > n_0$ the chosen algorithm outperforms the other. If your problems are of the size $n \leq 10^9$, which algorithm will you recommend to use?

   (c) Running time $T(n)$ of processing n data items with a given algorithm is described by the recurrence $T(n) = 2T(\frac{n}{2}) + n$; $T(2) = 1$. Derive a closed form formula for $T(n)$.   [3+6+3]

2. (a) Suggest an efficient implementation of k queues in a single array of size n. It is to be noted that your implementation of k queues should use only one array, i.e., k queues should use the same array for storing elements. Also write down the procedures for inserting an element and deleting an element from a particular queue.

   (b) A Deque or double ended queue is a queue where items are added and removed from either end, either *front* or *rear*. Write down an algorithm using a Deque to check whether a given string is a palindrome or not. Note that, a palindrome is a string that reads the same forward and backward, for example, 'radar', 'toot', and 'madam'.   [6+6]

3. (a) What do you mean by divide and conquer algorithm? Write down an algorithm to find the maximum and minimum elements in an array of n elements using divide and conquer approach and hence estimate the running time of your proposed method.

   (b) Is mergesort an unstable sorting method? Justify your answer with a suitable input instance.

   (c) Write down the quick sort algorithm and provide an estimate of the running time of the algorithm in average case.   [5+3+4]

4. (a) Suggest a suitable data structure that provides efficient access to frequently searched elements i.e. frequently searched elements will be accessed in lesser time than other elements.

   (b) Can you perform binary search on a sorted linked list? If your answer is yes, find out its running time and if your answer is no, explain the reason.

   (c) Suggest a suitable procedure to perform merge sort on a singly linked list containing n elements.   [4+4+4]

INDIAN INSTITUTE OF ENGINEERING SCIENCE AND TECHNOLOGY, SHIBPUR

Dual Degree (B.Tech.-M.Tech.) 3rd Semester Mid Term Examination 2019

Subject: Mathematics-III (MA-301)

(For all Engineering Branches)

Time: 2 hours   Any 4   Full Marks: 100

1. a) What do you mean by the following terms:
       Event space, Mutually exclusive events, Mutually independent events.

    b) State and prove Baye's theorem.

    c) Urn A contains 5 black balls and 6 white balls and urn B contains 8 black balls and 4 white balls. Two balls are transferred from urn B to urn A and then a ball is drawn from the urn A.
    What is the probability that the ball is white ?
    Given that the ball is white . What is the probability that at least one white ball was transferred to urn A ?   **(6 + 10 + 9)**

2. a) Write down the probability mass function of Binomial distribution and Poisson Distribution.

    b) If X has Binomial distribution with parameters n and p, then determine the standard deviation.

    c) Show that variance and mean are same for Poisson distribution.   **(4+ 9 + 12)**

3. a) If the probability of hitting a target is 0.2 and 10shots are fired independently, then what is the probability of the target being shot at least twice ?

    b) Consider the events A and B such that p(A) = ¼, p(B/A) = ½, p(A/B) = ¼.
    Find $p(\overline{A}/\overline{B})$ and $p(A/B) + p(A/\overline{B})$.

4. a) Determine the Laplace transform of $\int_{0}^{t} \frac{\sin u}{u}\, du$.

    b) Compute $L\{t^2 \cos^2 t\ e^t\}$.

c) If f(t) is a periodic function with period T, show that

$$L\{f(t)\} = \frac{1}{1-e^{-sT}} \int_0^T f(t) e^{-st}\, dt,$$ and hence compute $L\{f(t)\}$, where

$$f(t) = 1, \quad 0 < t < \pi$$
$$= \pi - t, \quad \pi < t < 2\pi, \quad \text{and} \quad f(t) = f(t + 2\pi)$$

(9+7+9)

5. a) Find $L\{f(t)\}$, where

$$f(t) = 1, \qquad 0 < t < \pi$$
$$= t^2, \qquad t > \pi$$

b) Compute $L\{t^n\}$, when $n > 0$ and is not a positive integer.

c) Define a convex set and show that set of all convex combinations of a finite number of points is a convex set.

(7+5+13)

6. a) Show that although (2,3,2) is a feasible solution to the system of linear equations : $x + y + 2z = 9$, $3x + 2y + 5z = 22$ yet is not a basic solution. How many basic solutions of the above mentioned system may have ? Find all the basic feasible solution of the given system of linear equations.

b) If there is a feasible solution of the set of m simultaneous linear equations in n unknowns (n>m) $AX = b$, $X \geq 0$, and if rank (A) = m, then show that there is a basic feasible solution to the system.

(11+14)

Indian Institute of Engineering Science and Technology, Shibpur.
5-year Integrated Dual Degree B.Tech/M.Tech (3rd semester,'CST')
Mid-semester Examination, September 2019
Subject: Electrical Machines (EE-304)

Time:- 2 hrs

F.M.:100

Answer all questions

Use **separate answerscript** for Group-A and Group-B

GROUP-A

1.a) How three-phase transformers are arranged in accordance to the phase displacement between the line voltages on its two sides? Describe in detail any two phasor groups pertaining to three-phase transformers. Also draw the phasor diagrams and connection diagrams for the two groups. (2+8)

b) Draw the phasor diagrams and the connection diagrams for following three-phase transformer connections:
   (i) Zy11   (ii) Zd0   (3+3=6)

2. A 3-phase step-down transformer is connected to 6600V mains and draws a line current of 10A from the supply. Each secondary phase has two similar windings. Neglecting losses, calculate the (i) secondary line voltage, (ii) secondary line current and (iii) output for the following transformer connections:
   (i)   Star/ Delta   (ii)   Delta/ Zig-Zag
   (Assume the ratio of primary turns per phase to each secondary winding per phase to be 12)
                                                                    (6+6=12)

3. A 400V 3-phase, 100 kW load at 0.8 p.f. is supplied from 11kV line through three identical single-phase step-down transformers. Determine the voltage, current and kVA ratings of each of the three transformers, if they are connected in:
   (i)   Star/Delta   (ii)   Delta/Star   (6+6=12)

GROUP-B

4. A 24 kW, 250 V, 1600 r.p.m. separately excited d.c. generator has armature circuit resistance of 0.1 Ω. The machine is first run at rated speed and the field current is adjusted to give an open circuit voltage of 260 V. Now, when the generator is loaded to deliver its rated current, the speed of the driving motor is found to be 1500 r.p.m. Compute the terminal voltage of the generator under these conditions. Field flux remains unaltered.   (10)

5. A 6 pole d.c. machine has 300 conductors and each conductor is capable of carrying 80 A without excessive temperature rise. The flux per pole is 0.015 Wb and the machine is driven at 1800 r.p.m. Compute the total current, e.m.f., power developed in the armature and the electromagnetic torque, if the armature conductors are (a) wave connected and (b) lap connected.   (10+10)

6. A 230 V dc shunt machine has armature circuit resistance (including brushes) of 0.5 Ω and field circuit resistance of 115 Ω. If this machine is connected to 230 V supply mains, find the ratio of speed as a generator to the speed as a motor. The line current in each case is 40A.   (10)

7. A 250 V dc series motor has a armature and series-field resistances of 0.25Ω and 0.15 Ω respectively. (a) Calculate the current for developing a torque of 80 Nm at 1200 r.p.m. (b) Calculate the percentage reduction in flux when the motor runs at half the current obtained in part(a).   (10+10)

Time: 2 hours

**Full Marks: 50**

Answer *any five* Questions
(Write all parts of the same question together)

1. a) Express the following system specifications using the propositions p as "The user enters a valid password," q as "Access is granted," and r as "The user has paid the subscription fee", and logical connectives (including negations):

   i. The user has paid the subscription fee, but does not enter a valid password.
   ii. Access is granted whenever the user has paid the subscription fee and enters a valid password.
   iii. Access is denied if the user has not paid the subscription fee.
   iv. If the user has not entered a valid password but has paid the subscription fee, then access is granted.

   b) A Sudoku puzzle is represented by a 9×9 grid made up of nine 3×3 sub-grids, known as blocks. For each puzzle, some of the 81 cells are assigned one of the numbers $1, 2, \dots, 9$, and the other cells are blank. In our case, the puzzle can be solved by assigning a number to each blank cell so that every row, every column, and every one of the nine 3×3 blocks contains each of the nine possible numbers. Construct a compound proposition that asserts the above puzzle. $[(1 \times 4) + 6 = 10]$

2. a) Use quantifiers and predicates with more than one variable to express these statements.

   i. "Every computer science student needs a course in discrete mathematics."
   ii. "There is a student in this class who owns a personal computer."
   iii. "Every student in this class has taken at least one computer science course."
   iv. "There is a student in this class who has taken at least one course in computer science."
   v. "Every student in this class has been in every building on campus."
   vi. "There is a student in this class who has been in every room of at least one building on campus."

   b) You are about to leave for college in the morning and discover that you don't have your glasses. You know the following statements are true:

   i. If I was reading the newspaper in the kitchen, then my glasses are on the kitchen table.
   ii. If my glasses are on the kitchen table, then I saw them at breakfast.
   iii. I did not see my glasses at breakfast.
   iv. I was reading the newspaper in the living room or I was reading the newspaper in the kitchen.
   v. If I was reading the newspaper in the living room then my glasses are on the coffee table.
   Use rules of inferences to determine where are your glasses. $[(1 \times 6) + 4 = 10]$

3. a) Prove that if n is an integer and $3n + 2$ is even, then n is even using
     i. a proof by contraposition.
     ii. a proof by contradiction
   b) Prove or disprove that you can use dominoes to tile a 5×5 checkerboard with three corners removed.
                                                                    [(3 + 3) + 4 = 10]

4. a) Find $\bigcup_{i=1}^{\infty} A_i$ and $\bigcap_{i=1}^{\infty} A_i$ if for every positive integer i,
     i. $A_i = \{i, i + 1, i + 2, \ldots\}$.
     ii. $A_i = \{0, i\}$.
     iii. $A_i = (0, i)$, the set of real numbers x with $0 < x < i$.
     iv. $A_i = (i, \infty)$, the set of real numbers x with $x > i$.
   b) Given a set $A = \{0, 2, 4, 6\ldots\}$. Determine if A is countable or not.
   c) Use *Cantor's diagonal argument* to prove that the set of real numbers is uncountable.
                                                                    [4 + 3 + 3 = 10]

5. a) Define one-to-one and onto functions with examples.
   b) Give an explicit formula for a function from the set of integers to the set of positive integers that is:
     i.   one-to-one, but not onto.
     ii. onto, but not one-to-one.
     iii. one-to-one and onto.
     iv. neither one-to-one nor onto.
   c) Prove the following properties in relation to floor and ceiling functions:
     i. $\lceil -x \rceil = -\lfloor x \rfloor$
     ii. $\lfloor -x \rfloor = -\lceil x \rceil$
                                                                    [2 + 4 + (2 + 2) = 10]

6. a) Find out the numbers of reflexive, symmetric, and anti-symmetric relations in a set of n-elements.
   b) How many equivalence relations are possible in a set of 5 elements?
   c) Determine whether the relations represented by the directed graphs shown below are reflexive, symmetric, antisymmetric, and/or transitive (give reasons).
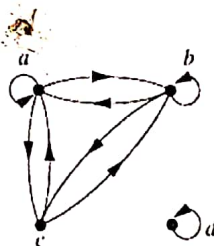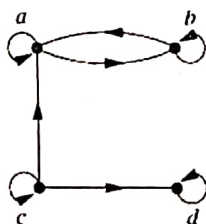
                                                                    [(1 X 3) + 1 + (3 + 3) = 10]

Indian Institute of Engineering Science & Technology, Shibpur

B.Tech (3rd Semester CST) Mid-Semester Examination, 2019
Digital Logic (CS 301)

F.M. 50   Time: 2 hrs

1. (a) If x and y are Boolean variables then, find the equivalent minimize expression of the $x \oplus y \oplus xy$.

(b) Draw the logic diagram of an exclusive NOR gate (two inputs) using NOR gates.

(c) A two-way switch has three terminals a, b, and c. In ON position (logic value 1), a is connected to b, and in OFF position, a is connected to c. Two of these two-way switches S_1 and S_2 are connected to bulb as below. Find the logic expression, if true, will always result in lighting of the bulb.
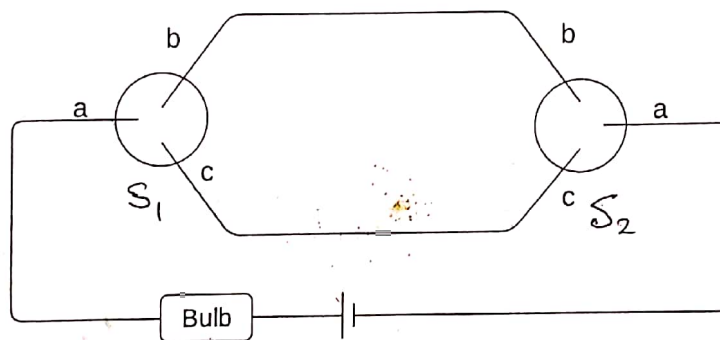

Figure 1: A typical connection of two two-way switches

• (d) What is maximum number of different Boolean functions involving in 'n' Boolean variables?   [3 + 3 + 3 + 1]

2. (a) Using four XOR gates and minimum number of full-adders, construct a 4-bit parallel adder/subtractor circuit. Use an input select variable S so that when S = 0, the circuit adds and when S = 1, the circuit subtracts.

(b) Design a four (three message bits and one parity bit) bit even parity-generator-cum-checker circuit and also draw the logic diagram of the circuit.   [4 + 6]

3. (a) Why wired-logic connection is not allowed with totem-pole (TTL) output circuit?

(b) Which logic level limits the fan-out of DTL gates and why?

• (c) Draw the circuit diagram of a tri-state TTL inverter. [3 + 3 + 4]

4. (a) Design a combinational circuit that will act as 4-bit binary to gray code converter.

(b) An 8×1 multiplexer has inputs A, B, and C connected to the selection inputs S_2, S_1 and S_0 respectively. The data inputs I_0 through I_7 are as follows: $I_1 = I_2 = I_7 = 0$; $I_3 = I_5 = 1$; $I_0 = I_4 = D$ and $I_6 = \overline{D}$. Determine the Boolean function that the multiplexer implements . [5 + 5]

5. (a) Minized the following function using Quine-McCluskey method. [10]

$$f(a, b, c, d) = \sum m(1, 4, 6, 7, 8, 9, 10, 11, 15)$$