



Indian Institute of Information Technology Vadodara

Gandhinagar + ICD

Course ID: CS 201
Full Marks: 30

Course name: Object Oriented Design and Programming
Date: 07.11.2023 **Exam Duration:** 120 minutes

Instructions:

- Attempt All Questions Sequentially
- 5 Marks would be deducted if the answers are not in sequential order
- Follow the "Remarks" mentioned in the last page. Evaluation would be done based upon the maximum permitted lines only
- Precise and to-the-point answers are encouraged
- Scan and Upload in Google Classroom for ICD campus students only.

1. What are the challenges for software engineering. → See slides [2]

2. Mention four points on why object-oriented approach is suitable for a software development → See slides [4]

3. Differentiate between the following: → See slides
i. Dynamic and Static Polymorphism
ii. Is-A and Has-A relationship [4]

4. Draw a use-case diagram for the below mentioned scenario,
Try to draw in the link provided by the sir in WhatsApp group
i. Students
a) Registers for a Course
b) Students must provide name, roll, email, and batch as mandatory information
c) After registration,
a. A password would be mailed to the email address
d) Members should login to Moodle account
e) Students who forgot their password for Moodle would re-emailed.

ii. Employees
a) May use the features of the system
b) May view the Course Registration details [4]

5. Choose any Complex system of your choice and answer the following
i. Describe the system (underline the name of the complex system)
ii. Mention three factors on why you consider the chosen system as a complex system
iii. Elaborate on any one factor (as per your answer in 2.ii), and mention how would you address the selected factor using object orientation approaches
iv. Mention any two non-functional requirements related to the complex system



Indian Institute of Information Technology Vadodara Gandhinagar + ICD

- v. Mention any two ways in which illusion of simplicity can be achieved in your chosen complex system
- vi. How can you ensure Canonical form of the chosen complex system?
- vii. What do you mean by the object model of the chosen complex system?
- viii. Would you consider the complex system as,
 - a) Discrete or Random. Justify the same.
 - b) Development process or Construction process. Justify the same.

[$1 + 3 + 2 + 2 + 2 + 2 + 2 + 2 = 16$]

Remarks:

Q1: Use one sentence maximum for each challenge

Q2: Use one sentence maximum for each of the four points

Q3: Each difference carries 1 point. Write maximum two differences using one sentence

Q4: A single use-case diagram is to be drawn. Rough work if required can be done at the end

Q5: (i) Use one sentence maximum.

(ii) Use one sentence maximum for each of the three factors

(iii) Use three sentences maximum for justification

(iv) Use maximum one sentence for each of the two points

(v) Use two sentences maximum for each of the two methodologies

(vi) Write only the name of factors which are to be considered for canonical form

(vii) Use one sentence maximum

(viii) Use one sentence for justifying your answer.

~~Mid semester Exam 2023~~

~~SC201~~

~~Total Time: As per the institute norms~~

~~Total Marks: 80~~

~~All questions are compulsory.~~

Q1: Explain the contribution of one Indian environmental scientist and one Indian environmental activist. 10

Q2. Explain what type of natural resource (renewable or non renewable) is water? 5

Q3. Environmental Science is a multidisciplinary subject. Elaborate. 5

Q4. What are some unique features of Indian environmentalism? 5

Q5. Write short notes: 5 marks each

1. Bio accumulation and bio magnification
2. Ecosystem people and biosphere people
3. Bio-piracy

Q6. One word answer: (if option is provided pick the right one. Only write the correct answers) 5 marks each

1. Who is the present Environmental Minister of India? *Bhupender Yadav*
2. World Environmental Day is celebrated on.....(July 5, June 5, January 10, July 10)
3. Total biodiversity hotspots in the world are.....of which.....are in India. (36/2, 1000/15, 32/3)
4. A simple food chain haslinks. (3-5, 0, 2-5)
5.is an example of primary succession. (glacier retreat, landslide)
6. Plants are autotrophies. True or false
7. The Biodiversity Act 2002 strictly aims at preventing usage of biological resources for any commercial or scientific usage. True or false.
8. Country which has been pioneer in drip irrigation practice is..... Israel, US, China, Egypt

~~Indian Institute of Information Technology – Vadodara~~
 Mid-Semester Examination Autumn 2023-24
 B. Tech. (IT & CSE)
 EC-201: Digital Logic Design

Time: 2:0 hrs.

Max. Marks: 50

❖ Attempt all questions

❖ Calculator is not allowed

Q. 1 Do the followings

(a) $(1110010110)_2 = (?)_{10}$

(b) $(761.12)_8 = (?)_{10}$

(c) Prove

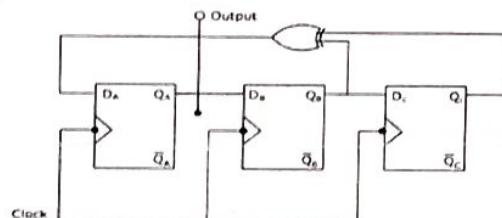
$$(A+B+C)(A+B'+C)(A+B+C') = (A+BC)\cdot(A+B)(A+B') \Rightarrow A+BC$$

(d) How many AND, OR and EXOR gates are required for the configuration of full adder? 2 AND, 1 OR, 2 XOR

(e) The minimum number of 2-input NAND gates required to implement a 2-input XOR gate is 4

Q. 2

- a) What is the output pattern observed at QA in the first four clock cycles? Assume the flip flops are in reset condition initially. (Please give the answer in the format: output in clock cycle 1(initial value), output in clock cycle 2, output in clock cycle 3, output in clock cycle 4)



2

2

2

2

2

5

- b) What is the minimum number of 2-input NAND gates required to implement a 4-variable function, function expressed in sum-of-minterms form as $f = \Sigma(0, 2, 5, 7, 8, 10, 13, 15)$? Assume that all the inputs and their complements are available.

5

Q. 3

- (a) Minimize the function using K-Map $f(A, B, C, D) = \Sigma m(0, 1, 2, 3, 5, 7, 9, 10, 11, 13, 15)$

5

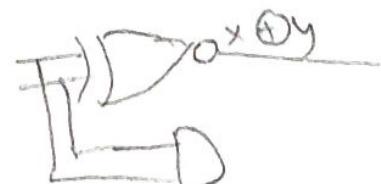
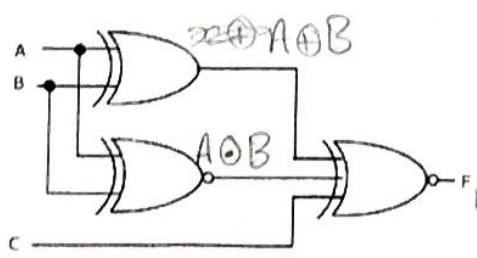
- (b) Convert SR flip-flop to JK flip-flop and draw the state diagram of SR flip-flop and JK flip-flop.

5

Q. 4

- a) For the output F to be 1 in the logic circuit shown, all possible input combination should be.

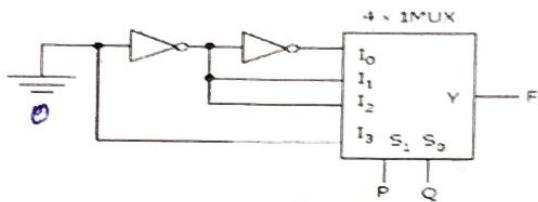
5



$A \oplus B = 0$	$A \oplus B = 1$	$= 0$	$= 1 = 0$	$= 1$
$A \oplus B = 1$	$A \oplus B = 0$	$= 1$	$= 1 = 0$	$= 0$
$C = 1$	$C = 1$	$= 0$	$= 0 = 1$	$= 0$
				P.T.O

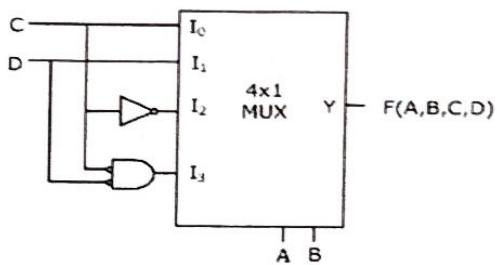
5

- b) The logic function implemented by the circuit below is (ground implies logic 0)



Q. 5

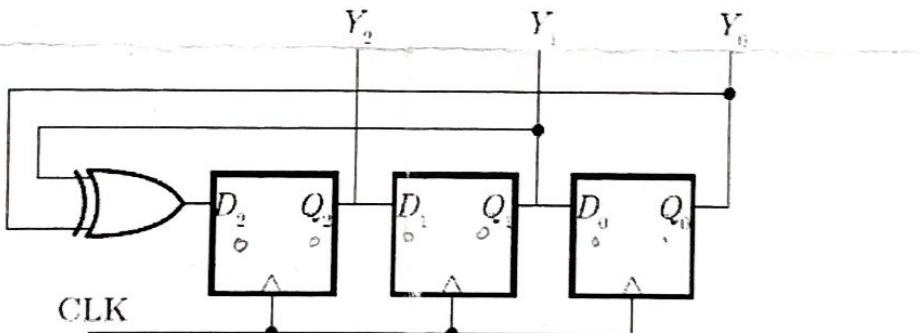
- a) The Boolean function realized by the logic circuit shown is



5

- b) A three-bit pseudo random number generator is as shown in the figure. Initially, the value of output $Y = Y_2 Y_1 Y_0$ is set to 111. The value of output Y after three & 10 clock cycles is

5



~~20252306~~

IIIT Vadodara
CS203: Design and Analysis of Algorithms

Midterm

Marks: 30

Course Instructor: Dr. Dibyendu Roy

Instructions: Clearly write your name and roll number. Question paper is of 2 pages. Solutions must be argued properly for getting credits. Scientific calculator is allowed.

(Q1)

[5 marks]

What do you mean by maximum-subarray of an array $A[1 \dots n]$. Describe an algorithm to find the maximum-subarray of A in $\Theta(n \log_2 n)$. → From notes

(Q2)

[10 marks]

You are given a sequence of positive real numbers $a[1 \dots n]$. You can now add “+” (addition) and “ \times ” (multiplication) signs between these numbers, and your goal is to generate an expression that has the largest value. As an example, if $a = \{2, 3, 0.5, 2\}$, then you should output the expression $2 \times 3 + 0.5 + 2 = 8.5$. This is larger than any other expression (e.g. $2 \times 3 \times 0.5 \times 2 = 6$, $2 + 3 + 0.5 + 2 = 7.5$, $2 + 3 \times 0.5 + 2 = 5.5 \dots$). You must add either a “+” or a “ \times ” between two consecutive numbers, and you are not allowed to change the ordering of the numbers or add brackets. As usual the expression is evaluated to first compute the products and then the sum. Design an algorithm that runs in time $O(n^2)$ and outputs the largest possible value of the expression. For this problem you can assume all additions, multiplications and comparisons of real numbers can be done in $O(1)$ time.

1. Write the recurrence equation and specify the base cases.
2. Design an algorithm (runs in time $O(n^2)$) for achieving the maximum value of the expression. Prove the correctness of the algorithm and derive its time complexity.

(Q3)

[5 marks]

Alice is playing a game where she controls a character to walk on a $m \times n$ table. The character starts at the bottom-left corner (coordinate $(1, 1)$) and wants to go to the top-right corner (coordinate (m, n)) (for better understanding see Table 1). The character can only move to the right (from (i, j) to $(i, j + 1)$) or up (from (i, j) to $(i + 1, j)$). Each square of the table has a non-negative value $v[i, j]$. The goal is to find a path from the starting point to the end point that maximizes the sum of $v[i, j]$ for all the squares (i, j) on the path.

			(3, 4)
	→	→	↑
(1, 1) →	↑		

Table 1: Table of size 3×4

1. Define the recurrence equation and specify the base cases.
2. Design an algorithm that outputs the desired maximum sum. Discuss its complexity.

(Q4)

[5 marks]

Consider an array $A[1 \dots n]$ that is first decreasing and then increasing. More precisely, there is a coordinate $1 \leq p \leq n$ such that for all $i < p$, $A[i] > A[i + 1]$, and for all $i \geq p$, $A[i] < A[i + 1]$. Your goal is to find the smallest element in this array. Design an algorithm to find the smallest element in $O(\log_2 n)$ time complexity.

(Q5)

[5 marks]

State the Rod-cutting problem. Using dynamic programming design an efficient algorithm to find the optimal rod cutting.



Indian Institute of Information Technology, Vadodara

Subject: Probability and Statistics
Branch: CSE/IT
Timing: 10:00 AM to 12:00 PM
Session: Autumn 2022-23

Subject Code: MA201
Semester: 3
Date: 17th October 2022
Total Marks: 30

Mid Semester Examination

General Guidelines :

1. All questions are compulsory.
2. Scientific calculator is allowed.

1. Two numbers x and y are selected at random between zero and one. Let the events A, B, C be defined as follows. $A = \{x > 0.5\}$, $B = \{y > 0.5\}$ and $C = \{x > y\}$.
 - (a) Find $P[AB]$, $P[BC]$ and $P[CA]$. (2)
 - (b) Find $P[A|B]$, $P[B|C]$ and $P[C|A]$. (2)
 - (c) Discuss dependency of all events with each other based on calculations. (1)
2. A service provider who has leased 30 satellite channels and expects that 10% of channels would be ideal signs a contract with 33 users. He can access additional satellite channels at 50% extra cost at short notice if more than 30 users demand channels simultaneously.
 - (a) What is the probability that exactly 30 users request satellite channels? (1)
 - (b) What is the probability that all users making a request is served? (2)
 - (c) Justify that the service provider make profit/loss from the arrangement. (2)
3. A coin is tossed two times. Probability of head is $\frac{1}{3}$. X is random variable that shows number of heads. Y is random variable that shows number of tails.
 - (a) Calculate and Draw PMF of X and Y . (2)
 - (b) Calculate and Draw PMF of $Z = X + Y$ using Convolution. (3)
4. An urn consists of 2 black and 2 white balls. A person picks 2 balls randomly. X_1 is number of black balls. X_2 is number of black balls. X_3 is number of colours present in selected balls.
$$X_1 - \text{black} \quad X_2 - \text{white} \quad X_3 - \text{all}$$
 - (a) Calculate PMF of X_1, X_2 and X_3 . (2)
 - (b) Derive covariance matrix for X_1, X_2 and X_3 . (2)
 - (c) Derive correlation matrix for X_1, X_2 and X_3 . (1)
5. X and Y are random variables with joint density given by (5)
$$f_{X,Y}(x,y) = \begin{cases} x^2 + \frac{xy}{3}, & 0 \leq x \leq 1, 0 \leq y \leq 2 \\ 0, & \text{otherwise} \end{cases}$$

Find Covariance $COV(X, Y)$.

6. For any two independent random variables X and Y , $Z = \min(X, Y)$.
 - (a) Find $f_Z(z)$. (3)
 - (b) If X and Y are uniform random variables between 0 and 1, find $f_Z(z)$. (2)

Best wishes



Indian Institute of Information Technology Vadodara

Course ID: CS 201
Full Marks: 30

Course name: Object Oriented Design and Programming
Date: 18.10.2022 **Exam Duration:** 120 minutes

Instructions: Attempt All Questions Sequentially.

1. Differentiate between Composition and Aggregation in class diagram with examples. [2]
2. Software engineering considers both technical matters and non-technical matters. List two technical matters and two non-technical matters that are within the domain of software engineering. [2]
3. What are the different strategies followed for eliminating code duplication within a single class. Write a program code in Java or C++ where a single class performs multiple tasks without code duplication. [2+4]
 - 4. Choose the correct answer among the below two options and answer the associated questions accordingly:
 - All methods and attributes in the Superclass are by default available to all the Subclasses. Draw and mention how your class diagram depicts such a scenario.
 - All methods and attributes in the Superclass are not by default available to all the Subclasses. Draw and mention how your class diagram depicts such a scenario.
5. Which of the following is more appropriate for representing a system. Explain your choice with appropriate justification;
 - Use-case diagram
 - Sequence diagram
 - Class diagram[4]
6. Mention with explanation and sample diagrams related to all the different types of relationships that multiple classes can have in a class diagram. [6]
7. Explain the following with the help of diagrams:
 - Extend relationship in use-case diagram
 - Include relationship in use-case diagram
 - Sloping line in sequence diagram[6]

CS203 Design and Analysis of Algorithm

Autumn Semester 2022-23
Mid Semester Examination - Set B
Dr. Ashish Phophalia

Oct 19, 2022

1. [3+3 = 6 Marks] Consider a recurrence relation $T(n) = \sqrt{n}T(\sqrt{n}) + n$. Prove that $\Theta(n\log n)$ and $\Theta(n)$ are NOT suitable bounds as per definition of Θ bound [Hint: You can use substitution method].

2. [3+3 = 6 Marks] Use a recursion tree to determine a good asymptotic upper bound on the recurrence $T(n) = T(n-1) + T(\frac{n}{2}) + n$. Use the substitution method to verify your answer.

3. [6 Marks] Write an algorithm for 3-way Merge Sort algorithm as discussed in the class. Also, specify complexity of your approach.

4. [6 Marks] Attempt any one from the two choices.

(a) Write an optimal algorithm (using any technique) for maximum product subarray problem where you are given any array having positive and negative numbers and maximum product subarray. Justify your solution.

OR

(b) Given n pairs of parentheses, write an efficient algorithm (using recursion technique) to generate all combinations of well-formed parentheses.

Input: $n = 3$

Output: ["((0))", "(00)", "(00)", "0(0)", "000"]

Input: $n = 1$

Output: ["0"]

5. [6 Marks] Attempt any one from the two choices.

(a) What is the best way to multiply a chain of matrices with dimension that are $10 \times 5.5 \times 3.3 \times 20, 20 \times 12, 12 \times 4$, and 4×40 . Show your work. No need to write algorithm.

OR

(b) Let $S = \{a, b, c, d, e, f, g\}$ be a collection of objects with benefit-weight values as follows: a:(12,4), b:(10,6), c:(8,5), d:(11,7), e:(14,3), f:(7,1), and g:(9,6). What is the optimal solution to the fractional knapsack for S assuming we have sack (bag) that can hold objects with total weight 22? Show your work.

6. [5+5=10 Marks] Attempt any one from the two choices.

(a) You are given with n files having records and you are asked to merge those files in optimal way. The good news is all records are sorted in the file and when you merge them then don't worry about sorting part. However, you have to create always a new file to merge two files at a time. Write an algorithm to find an optimal merging way to merge n files. Use your optimal binary merge pattern for ten files whose length are 26, 32, 15, 5, 74, 53, 95, 35, 3

~~SC 201 MID SEMESTER EXAM IIIT Vadodara~~

B tech III sem

Total Marks: 60

Time: 10 am to 12:15 pm (or as per the institute rules)

All questions are compulsory.

Q1: Write short notes on: (10)

1. Food chain and food web
2. Forest ecosystem
3. Bio-magnification
4. Environmentalism

Q2: Environmental studies is an interdisciplinary area of inquiry. Elaborate. (10)

Q3: Environmental risks are a product of the modern society. (10)

Q4: Elaborate on the natural resource scenario in India with the example of at least one renewable and one non-renewable resource. (10)

Q5: Should ethics, values and moral judgements of scientists have place in environmental studies. (10)

Q6: Explain the contributions of one environmental scientist and one environmental activist. (10)

End Semester Exam: SC201: Environmental Sciences (B tech 3rd Sem)

Time: As per the institute rules

You are required to submit handwritten copies.

Total Marks: 80

ecological succession
food web
food chain
big & small ecosystem
Second hit
after calamity

Question paper

Q1: Does sustainable development leads to win-win situation? (10)

Q2: Write short notes on: (20 Marks: 5 marks each)

1. In situ conservation
2. Endangered species in India
3. Renewable and non-renewable energy sources
4. Any environmental movement

Q3: Elaborate on the role of an individual in environmental problems. (10)

Q4: What is the difference between a national park and reserve forest? (10)

Q5: Explain the Biodiversity Act and the related issues. (10) 2002

Q6: Explain the concept of ecosystem. (10)

Q7: Explain some of the values, ideologies and philosophies that are associated with environment. (10)

End Semester Exam: SC201: Environmental Sciences (B tech 3rd Sem)

Time: As per the institute rules

You are required to submit handwritten copies.

Total Marks: 80

Question paper

Q1: Does sustainable development leads to win-win situation? (10)

Q2: Write short notes on: (20 Marks; 5 marks each)

1. In situ conservation
2. Endangered species in India
3. Renewable and non-renewable energy sources
4. Any environmental movement

Q3: Elaborate on the role of an individual in environmental problems. (10)

Q4: What is the difference between a national park and reserve forest? (10)

Q5: Explain the Biodiversity Act and the related issues. (10) 20%

Q6: Explain the concept of ecosystem. (10)

Q7: Explain some of the values, ideologies and philosophies that are associated with environment. (10)

ecological succession
food web
food chain
tertiary & small ecosystem
Second hit
after calamity

Time: 3:0 hrs

Max. Marks: 75

Attempt all questions

Q.1

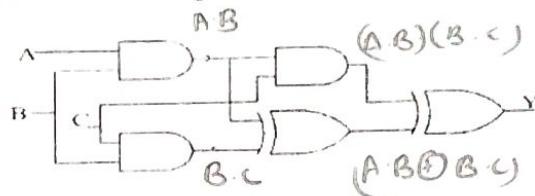
Do the followings

(a) $(110110001)_2 = (?)_{10}$

2

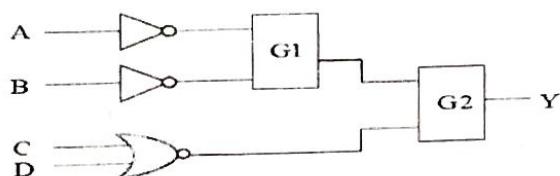
(b) The output of the combinational circuit given below is:

3



(c) In the figure shown, the output is required to be $Y = AB + CD$. The gates G1 and G2 must be, respectively,

2



(d) Simplify the Boolean function F together with the don't-care conditions in (1) sum-of-products form and (2) product-of-sums form.

3

$$F(w, x, y, z) = \sum m(0, 1, 2, 3, 7, 8, 10) + \sum d(5, 6, 11, 15)$$

Q. 2

(a) A sequential circuit has two D flip-flops A and B, two inputs x and y, and one output z. The flip-flop input equations and the circuit output are as follows:

5

$$D_1 = x'y + xA$$

$$f(C_1 = ?)$$

$$D_2 = x'B + xA$$

$$z = B$$

a. Draw the logic diagram of the circuit

b. Tabulate the state table

(b) The content of a 4-bit register is initially 1101. The register is shifted six times to the right with the serial input being 101101. What is the content of the register after each shift?

5

Q. 3

(a) Minimize the function using K-Map $F(A, B, C) = \sum m(1, 2, 5, 7) + \sum d(0, 4, 6)$ and what are the limitations of K-map?

5

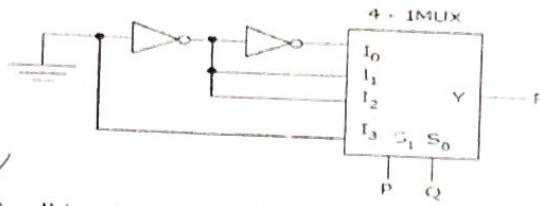
(b) What is the minimum number of 2-input NOR gates required to implement a 4-variable function expressed in sum-of-minterms form as $f = \sum(0, 2, 5, 7, 8, 10, 13, 15)$? Assume that all the inputs and their complements are available.

5

Q. 4

(a) The logic function implemented by the circuit below is (ground implies logic 0)?

5



- (b) Conditionals in a continuous assignment are specified through the “?:” operator. Conditionals get inferred into a multiplexer. For example, the following is the code for a simple multiplexer 5

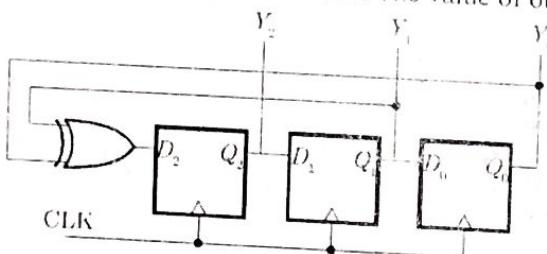
`assign wire1 = (sel==1'b1) ? a : b;`

What is the meaning of above statement and also draw the circuit diagram and output waveform?

- (c) A serial in/parallel out, 4-bit shift register initially contains all 1s. The data nibble 0111 is waiting to enter. After four clock pulses, what is the content of the register after each shift? 5

Q. 5

A three bit pseudo random number generator is as shown in the figure. Initially, the value of output $Y(Y_2 Y_1 Y_0)$ is set to 111. The value of output Y after 8th clock cycles is ? 5



Q. 6

- (a) How to design Synchronous Counter? Give its necessary steps.

UP 1
2 5
3 2
4 1
5 1

- (b) Design a 3-bit Asynchronous up Counter. Draw the output diagram/Timing Diagram. 5

- (c) Convert SR flip-flop to JK flip-flop and draw the state diagram of SR flip-flop and JK flip-flop. 5

- (d) Define Ring counter and Johnson counter and find usable state and no usable state. 5

- (e) A 4-bit Modulo-6 ripple counter uses J-K flip-flop. If the propagation delay of each FF is 50 ns, the maximum clock frequency that can be used is equal to ___ MHz. 5

*****END*****



$$P(|X - \mu| > \epsilon) \leq \frac{(\text{Var})^2}{\epsilon^2}$$

Indian Institute of Information Technology, Vadodara

$$\frac{1-1}{k^2}$$

Subject: Probability and Statistics
Branch: CSE/IT
Timing: 02:00 PM to 05:00 PM
Session: Autumn 2022-23

Subject Code: MA201
Semester: 3
Date: 19th December 2022
Total Marks: 45

End Semester Examination

Instructions :

1. All questions are compulsory.
2. Scientific calculator is allowed.
3. \dagger Some distribution table values:

- Standard Normal distribution : $\Phi(3.33) = 0.9996, \Phi(2.22) = 0.9868$.
- t distribution with degree of freedom 3: $t_{0.025} = 3.182, t_{0.05} = 2.353$.
- χ^2 distribution with degree of freedom 3: $\chi^2_{0.025} = 9.21, \chi^2_{0.05} = 7.81$.

\dagger You can consider this as Hint for the some questions.

1. Give Proof of weak law of large numbers using Chebyshev inequality. (5)
2. Is $\frac{1}{n} \sum_{i=1}^n (X_i - \bar{X})^2$ is biased estimator for sample Variance S^2 ? Prove. (5)

3. Estimate mean and variance for Gaussian Random variable using Maximum likelihood estimation (MLE). (7)

4. A coin is flipped a total of 200 times, in 4 batches of 50 flips each. The number of heads in each of the batches is as follows: (7)

24, 27, 22, 24

$$\begin{aligned} & 19.579 \\ & 29.321 \quad 1 - \left(\frac{2}{5}\right) \\ & w = \frac{3}{5} \end{aligned}$$

find the 95% confidence interval for probability of head.

5. An urn containing two black and three white balls. If 100 times, two balls are chosen from urn with a replacement. What is the probability that a black ball appears more than 100 times? (7)

6. In one experiment, person toss a coin till he get head but he toss it maximum 3 times. (2)

- (a) What is the probability that he not get head till 3 trials if coin is *fair*? (2)
(b) Person repeated an experiment 50 times. His observations after 50 times performing experiments are, (5)

Number of trials to get head	1	2	3	Not got head in 3 trials
Number of Experiments	22	13	8	7
	50	50	50	50

At the 5% significance level, do these data provide significant evidence that the used coin is *fair*? Prove.

7. A certain part of a machine can be in two states: working or undergoing repair. A working part fails during the course of a day with a probability of 0.2. A part undergoing repair is put into working order during the course of a day with a probability of 0.8. If Monday a part went for repair then what is the probability that it is working on Thursday? (7)

$$T_w = 0.8$$

$$T_R = 0.2$$

$$W_R = T_R W_w + T_w$$

$$W_R = (0.2)(0.8) + (0.8)(0.2) = 0.16 + 0.16 = 0.32$$

$$P_R = W_R T_w + W_w T_R$$

$$P_R = (0.32)(0.8) + (0.68)(0.2) = 0.256 + 0.136 = 0.392$$

NETY
94+1

CS203 Design and Analysis of Algorithm

Autumn Semester 2022-23
End Semester Examination
Dr. Ashish Phophalia

December 21, 2022

1. [3+2 = 5 Marks] Prove the following

- (a) $O(\max\{f(n), g(n)\}) = O(f(n) + g(n))$
- (b) If $d(n)$ is $O(f(n))$ and $e(n)$ is $O(g(n))$, then the product $d(n).e(n)$ is $O(f(n).g(n))$

2. [3+2 = 5 Marks] Justify your answer

- (a) What is the running time of Quick Sort when all elements of array A have same value?
- (b) The running time of Quick Sort is $\Theta(n^2)$ when the array A contains distinct elements and is sorted in decreasing order.

3. [7+3 = 10 Marks] Write an algorithm to find the number of connected components in the directed graph. How to modify your approach if the given graph is strongly connected graph.

Kruskal
Prin
BFS

4. [10 Marks] Suppose you are given a connected graph G, with edge costs that you may assume are all distinct. G has n vertices and m edges. A particular edge e of G is specified. Give an algorithm with running time $O(m + n)$ to decide whether e is contained in a minimum spanning tree of G.

5. [10 Marks] The sets A and B have m and n elements respectively from a linear order. These sets are not necessarily sorted. Also assume that $m \leq n$. Show how to compute $A \cup B$ and $A \cap B$ in $O(n \log(m))$ time.

6. [3+7 = 10 Marks] Define the 0/1/2 knapsack problem for n objects to be $\text{Max} \sum_{i=1}^n p_i x_i$ subject to the constraints

$$\sum_{i=1}^n w_i x_i \leq c \text{ and } x_i \in \{0, 1, 2\}, 1 \leq i \leq n$$

Here you can have an 0, 1 or 2 copies of any object x_i .

- (a) Define dynamic programming functional equation to solve 0/1/2 Knapsack problem.
- (b) Give an algorithm with complexity to solve the 0/1/2 Knapsack problem.

7. [6+4 Marks] We have studied KMP String matching algorithms. The algorithms work on the idea that whenever there will be mismatch for a character in the given pattern P (length = m) and text T (length = n), where $m \leq n$, we shift the pattern accordingly to find another match. Now, consider a Wildcard Character (represented as ? symbol) which appears at only one position in the pattern P and can be matched with any character in the text. The idea of wildcard character is to let matching process to continue and we can tolerate the mismatch of one character. Write a modified KMP algorithm to take care the wildcard character in the matching process. Also show the steps of your modified algorithm on example: T: ABABAC~~B~~DCDA and P: B?C. Here P can be matched in T at index 7.

0 1 2 3 4 5 6 7 8 9
1 2 3 4 5 6 7 8 9 10 11

8. [10 Marks] Apply Rabin-Karp Algorithm on text T: ABABACBDCBAC and pattern P: BAC using $m = 21$. (Use ASCII values for the characters like $66*100+65*10+67$ for BAC)

Key = $\frac{\text{sum}}{\% m}$

1

AB~~A~~BA~~A~~: BD CBA <
7316 } 7225

A = 65
B = 66
C = 67

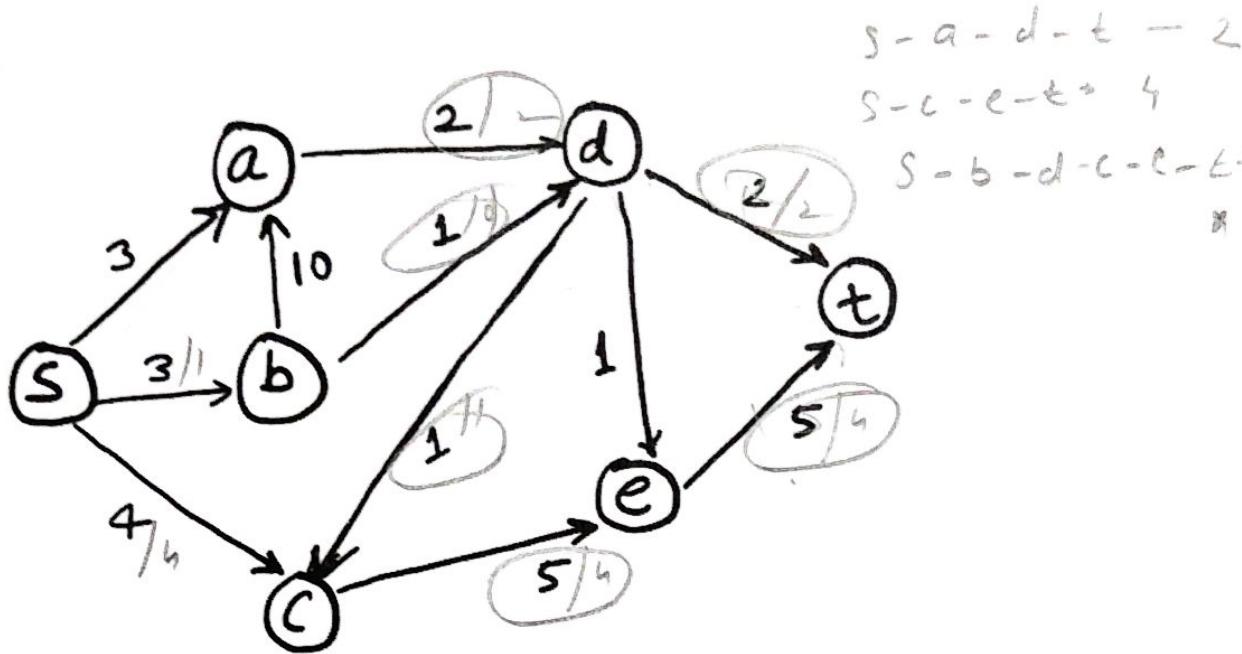


Figure 1: Graph for Ford-Fulkerson algorithm

9. [8+2 Marks] Apply Ford-Fulkerson algorithm on the Graph shown in Figure 1 where maximum capacity mentioned on edges. Show all your steps clearly. Also give the minimum cut of the graph.
10. [4+6 Marks] Write down the Floyd-Warshall algorithm and hence apply on the Graph shown in Figure 2. Also, show the predecessor matrix.

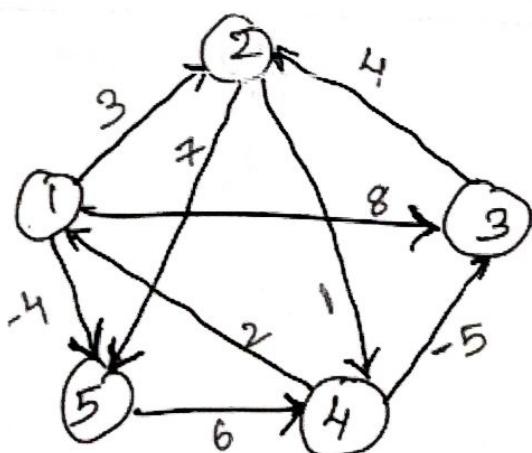


Figure 2: Graph for Flyod-Warshall algorithm

End Semester Exam: SC201 Environmental Sciences (B tech 3rd Sem)

Time: As per the institute rules

You are required to submit handwritten copies.

Total Marks: 70

Question paper

Q1: What are some of the contentions related to the concept of sustainable development? (10)

Q2: Explain some of the values, ideologies and philosophies that are associated with environment. (10)

Q3: Elaborate on the role of an individual in environmental problems. (10)

Q4: Explain two environmental protection legislations in India? (10)

Q5: What are common pool resources and elaborate on the management of commons.(10)

Q6: Write short notes on: (20 Marks: 5 marks each)

1. In situ conservation
2. Endangered species in India
3. Renewable and non-renewable energy sources
4. Any environmental movement

Endterm

Marks: 45

Course Instructor: Dr. Dibyendu Roy

Instructions: Clearly write your name and roll number. Solutions must be argued properly for getting credits. Scientific calculator is allowed.

(Q1)

[9 marks]

Describe Insertion sort algorithm. Prove its correctness. Finally derive its complexity for worst case and best case.

(Q2)

[9 marks]

State and prove Master theorem for solving recurrences.

(Q3)

[9 marks]

(a) (4 marks) Let $X = \langle x_1, x_2, \dots, x_m \rangle$ and $Y = \langle y_1, y_2, \dots, y_n \rangle$ be sequences and let $Z = \langle z_1, z_2, \dots, z_k \rangle$ be any longest common subsequence (LCS) of X, Y . Then prove the followings.

1. If $x_m = y_n$ then $z_k = x_m = y_n$ and $\langle z_1, z_2, \dots, z_{k-1} \rangle$ is an LCS of $\langle x_1, x_2, \dots, x_{m-1} \rangle$ and $\langle y_1, y_2, \dots, y_{n-1} \rangle$.
2. If $x_m \neq y_n$ then $z_k \neq x_m$ implies $\langle z_1, z_2, \dots, z_k \rangle$ is an LCS of $\langle x_1, x_2, \dots, x_{m-1} \rangle$ and $\langle y_1, y_2, \dots, y_n \rangle$.
3. If $x_m \neq y_n$ then $z_k \neq y_n$ implies $\langle z_1, z_2, \dots, z_k \rangle$ is an LCS of $\langle x_1, x_2, \dots, x_m \rangle$ and $\langle y_1, y_2, \dots, y_{n-1} \rangle$.

(b) (5 marks) Using the above result derive a recursive solution to find the length of LCS of X, Y . Finally describe an efficient algorithm to find the length of LCS of X, Y .

(Q4)

[9 marks]

(a) (5 marks) Write down the Huffman algorithm for finding optimal code. Prove its correctness.

(b) (4 marks) What is an optimal Huffman code for the following set of frequencies, based on the first 8 Fibonacci numbers a:1 b:1 c:2 d:3 e:5 f:8 g:13 h:21? Can you generalize your answer for any general n Fibonacci numbers?

(Q5)

[9 marks]

Describe the BFS algorithm. Prove that upon termination of BFS on a graph $G = (V, E)$ with a source vertex $s \in V$ it will produce the minimum distance of every vertex $v \in V$ from s if it is reachable.





to know what priority is
value & given by set priority to get the priority of the thread which helps it to decide the order of execution

Indian Institute of Information Technology Vadodara

7. Identify classes and their attributes for each of the requirements (F1 to F4). Use proper notations for representing classes. Need to present the class diagram with explanation. Class diagram (along with necessary attributes, multiplicity, methods, etc.) should depict only the below facts.

A point-of-sale application needs to record all purchases. Here are a few facts:

- F1: Customers make purchases.
- F2: Customers have names.
- F3: Purchases have dates.
- F4: Purchases have amounts equal to the sum of the prices of the items sold.

[3 + 3 = 6]

8. Given the code fragment,

```
interface Readable {  
    public void readBook();  
    public void setBook();  
}
```

yes no

```
abstract class Book implements Readable {  
    public void readBook() {}  
}
```

throw new name Exception

```
class EBook extends Book {  
    public void readBook() {}  
}
```

class I throws ArithmeticException

```
public class Test_Main {  
    public static void main (String args[]){  
        System.out.println("IIIT-Vadodara");  
    }  
}
```

add / not add

What needs to be added in the above program so that it prints "IIIT-Vadodara". Explain the problem and why the addition solves the problem.

[2 + 2 + 2 = 6]

9. What are the different conditions when a Thread gets interrupted? How the conditions interrupt the execution of the Threads? Write a single program to depict the above-mentioned conditions. The program output should be able to show how the Thread behaves as per the conditions.

[2 + 2 + 5 + 2 = 11]



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Course ID: CS 201
Full Marks: 45

Course name: Object Oriented Design and Programming
Date: 20.10.2022 **Exam Duration:** 180 minutes

Instructions: Attempt All Questions Sequentially.
Mention SET Number at the Top of Answer Sheet.

SET - A

1. What do you mean by an Industrial use Software? *→ See notes or slides* [2]

2. Differentiate between Sequence diagram and Activity diagram. *→ See slides* [2]

3. Constructors can be Static in Java. State yes or no, and justify accordingly. *No [1 + 3 = 4]*

*Static keyword belongs to a class rather than the object of a class.
A constructor is called when an object of a class is created, so no use of the static keyword.*

4. Can we use UML for user interface (UI) design? Give a short explanation for justifying your answer. *[1 + 3 = 4]*

5. Consider the following code snippet,

```
class Test_Main {  
    public static void main(String args[]) {  
        try {  
            System.out.println("IIT");  
        }  
        finally {  
            System.out.println("Vadodara");  
        }  
    }  
}
```

Will the code Compile? Explain your choice with proper justification. *[1 + 3 = 4]*

6. When and why a software development process would choose the following program language for implementation;

- C
- Java

Explain with a simple example of a scenario (when) and subsequently justifying it (why). *[3 + 3 = 6]*

~~Indian Institute of Information Technology – Vadodara~~
 End-Semester Examination Autumn 2023-24
 B. Tech. (IT & CSE)
 EC-201: Digital Logic Design

Time: 3:0 hrs.

Attempt all questions

Max. Marks: 75

Q. 1 Do the followings

(a) $(AC)_{16} = (?)_8$ $(1012)_{16} (10101100)_{16} = 2548$ 2

(b) $(IEF)_{16} = (?)_8$ $(11101111)_{16} = 6757$ 2

- (c) Simplify the Boolean Function F together with the don't-care conditions in (1) sum-of-products form and (2) product-of-sums form

$$F(w, x, y, z) = \sum m(0, 1, 2, 3, 7, 8, 10) + \sum d(5, 6, 11, 15)$$

- (d) The minimum number of 2-input NAND gates required to implement a Half Adder is ~~false~~ 5

(e) $(1245)_8 = (?)_{16}$ and $(?)_{10}$

$$60101010010 = (2A5)_{16}$$

$$\begin{array}{r} 1245 \rightarrow 5 \\ 155 \rightarrow 3 \\ 123 \rightarrow 2 \\ \hline 2335 \end{array}$$

Q. 2 (a) A sequential circuit has two D flip-flops A and B, two inputs x and y, and one output z. The flip-flop input equations and the circuit output are as follows:

$$D1 = x'y + xA$$

$$D2 = x'B + xA$$

$$z = B$$

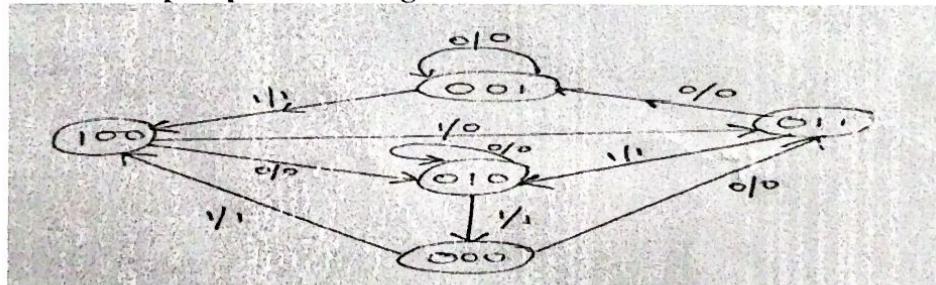
- 1) Draw the logic diagram of the circuit

- 2) Tabulate the state table

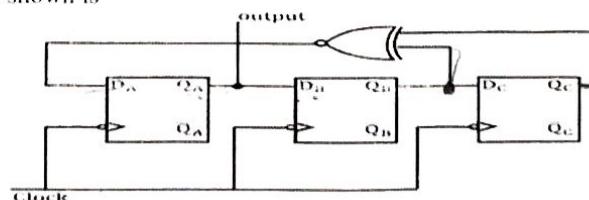
- (b) The content of a 4-bit register is initially 1101. The register is shifted six times to the right with the serial input being 101101. What is the content of the register after each shift? 5

Q. 3 (a) A sequential circuit has three flip-flops A, B, C, one input x, and one output, y. The state diagram is shown in below Figure. The circuit is to be designed by treating the unused states as don't-care conditions. Analyze the circuit obtained from the design to determine the effect of the unused states 15

- 1) Use D flip-flops in the design
 2) Use J-K flip-flops in the design



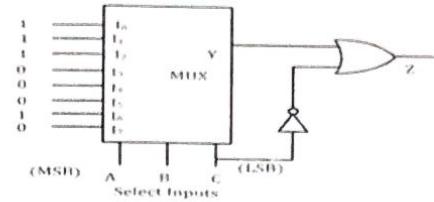
- (b) Assuming that all flip-flops are in reset condition initially, the count sequence observed at QA in the circuit shown is 5



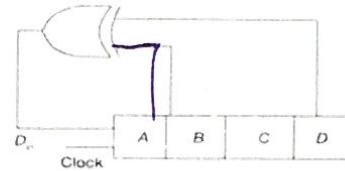
Q. 4

- (a) A combinational circuit using a 8-to-1 multiplexer is shown in the following 5

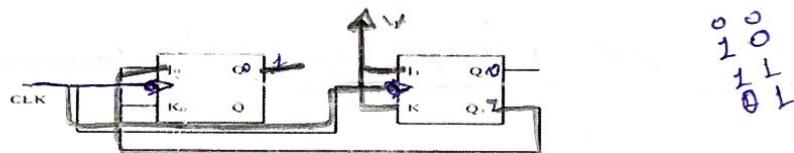
figure. The minimized expression for the output (Z)



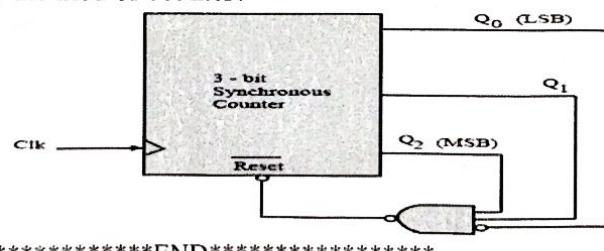
- (b) A 4-bit shift register circuit configured for right-shift operation, i.e., $Din \rightarrow A$, $A \rightarrow B$, $B \rightarrow C$, $C \rightarrow D$ is shown. If the present state of the shift register is ABCD = 1101, the number of clock cycles required to reach the state ABCD = 1111 is 5



- Q. 5** (a) The content of a 4-bit register is initially 1101. The register is shifted six times to the right with the serial input being 101101. What is the content of the register after each shift? 5
- (b) Given that the initial state (Q_1Q_0) is 00, the counting sequence of the counter after six clock is? 5



- Q. 6** (a) Design: SR latch using NAND Gate and NOR Gates & SR flip-flop Using NOR Gates. 5
- (b) For the circuit shown in the figure, the delay of the bubbled NAND gates is 2 ns and that of the counter is assumed to be zero. If the clock (Clk) frequency is 1 GHz, then find the mod of counter? 5



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Indian Institute of Information Technology – Vadodara
 Mid-Semester Examination Autumn 2022-23
 B. Tech. (IT & CSE)
 EC-201: Digital Logic Design

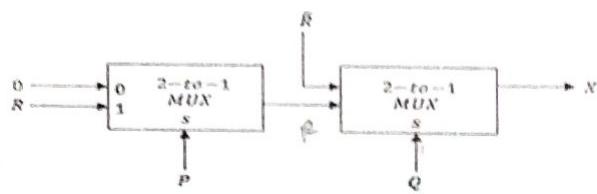
Max. Marks: 60

Time: 2:0 hrs

Attempt all questions

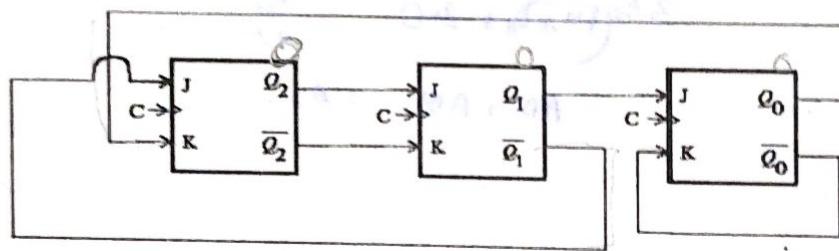
- Q. 1** Do the followings 32 54 20 32 2
- (a) $(110110)_2 = (?)$ 2
- (b) For function $AB + AB'C + AB'C'$, find the minimum no. of NAND Gates? 2
- (c) Minimize the logical expression $(A+B+C)(A+B'+C)(A+B+C')$ using Boolean theorems. 2
- (d) Identify and remove the redundant term from the logical expression $AB + A'C + BC = AB + A'C + BC(A+A) = AB + A'C + ABC + ABC = AB + A'C$ 2
- (e) Minimize the function using K-Map $f(A,B) = \Sigma m(0,2,3)$. 5
- Q. 2** Implement the full subtractor circuit using minimum number of NAND gate only. 5
- (b) Explain carry look ahead adder with suitable diagram and drive the expression for it. 5
- Q. 3** Minimize the function using K-Map $f(A,B,C,D) = \Sigma m(0,1,2,3,5,7,9,10,11,13,15)$ 5
- (b) Take your roll number and write it in the 4-variable SOP function (for eg. If roll no is 201411012 the SOP function will be $f(A,B,C,D) = \Sigma m(2, 0, 1, 4, 1, 1, 0, 1, 2) = \Sigma m(0, 1, 2, 4)$. And also take don't care conditions for 10, 11, 12, 13, 14, 15. Now make its 4-variable K-map. And implement it using basic Gates only. 5
- Q. 4** Find the output f of the following circuit. 5
- (a) Find the output f of the following circuit.
-
- (b) Consider the two cascaded 2-to-1 multiplexers as shown in the figure. 5
- P. T. O**

figure. The minimal sum of products form of the output X is ?



Q. 5

- (a) The below sequential circuit is design using JK flip-flops is initialized with $Q_2 Q_1 Q_0 = 000$. The state sequence for this circuit for the next 5th clock cycle is? 5



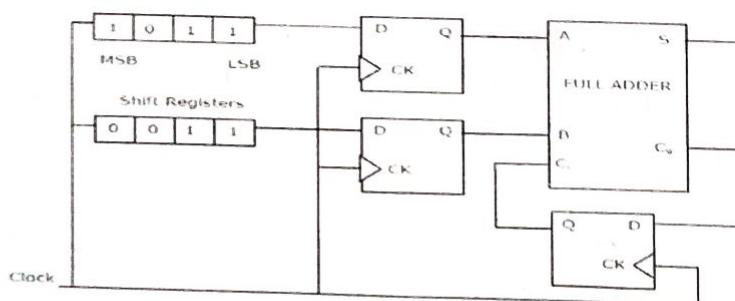
- (b) Convert the S-R flip flop ~~using~~ J-K flip flop. $SP \rightarrow J-K ?$ 5

$$SP \rightarrow J-K ? \\ OP \quad JK \rightarrow SP ?$$

Q. 6

- (a) Design a circuit that accept binary numbers between 1 & 5 and generates an output, equals to the numbers of 1's in the input. Use only 2-input logic gates for implementation. **(5 Marks)**

- (b) The circuit shown in figure below, two 4-bit parallel-in serial-out shift registers loaded with the data shown are used to feed the data to a full adder. Initially, all the flip-flops are in clear state. After applying two clock pulses, find out the outputs of the full-adder S and C0. **(5 Marks)**



*****END*****

$$T(3)=1$$

$$n=2$$

$$T(n) = T(\frac{n}{2}) + n$$

$$T(n) = 2T(\frac{n}{2}) + n$$

$$T(n) = 2^k T(\frac{n}{2^k}) + kn$$

$$T(n) = 2^k T(1) + kn$$

$$T(n) = kn + kn \log_2 n$$

$$T(n) = 2kn + 2 \cdot 2 \cdot n$$

$$T(n) = 2kn + 2n^2$$

CS203 Design and Analysis of Algorithm

Autumn Semester 2022-23
Mid Semester Examination - Set A
Dr. Ashish Phophalia

Oct 19, 2022

1. [3+3 = 6 Marks] Consider a recurrence relation $T(n) = \sqrt{n}T(\sqrt{n}) + n$. Prove that $\Theta(n \log n)$ and $\Theta(n)$ are NOT suitable bounds as per definition of Θ bound [Hint: You can use substitution method].
2. [3+3 = 6 Marks] Use a recursion tree to determine a good asymptotic upper bound on the recurrence $T(n) = 4T(\frac{n}{2} + 2) + n$. Use the substitution method to verify your answer.
3. [6 Marks] Write an algorithm for 3-way Merge Sort algorithm as discussed in the class. Also, specify complexity of your approach.
4. [6 Marks] Attempt any one from the two choices.

for i = 0 to n
if 3 > 0.
maxp = maxp
(maxp)
(i, j)

- (a) Write an optimal algorithm (using any technique) for maximum product subarray problem where you are given any array having positive and negative numbers and find the maximum product subarray. Justify your solution.

OR

- (b) Given n pairs of parentheses, write an efficient algorithm (using recursion technique) to generate all combinations of well-formed parentheses.
Input: $n = 3$
Output: ["((())", "(())", "(())", "(()()", "())()"]
Input: $n = 1$
Output: ["()"]



5. [6 Marks] Attempt any one from the two choices.

- (a) What is the best way to multiply a chain of matrices with dimension that are $10 \times 5, 5 \times 2, 2 \times 20, 20 \times 12, 12 \times 4$, and 4×60 . Show your work. No need to write algorithm.

OR

- (b) Let $S = \{a, b, c, d, e, f, g\}$ be a collection of objects with benefit-weight values as follows: a:(12,4), b:(10,6), c:(8,5), d:(11,7), e:(14,3), f:(7,1), and g:(9,6). What is the optimal solution to the fractional knapsack for S assuming we have sack (bag) that can hold objects with total weight 18? Show your work.

24
25
49

6. [5+5=10 Marks] Attempt any one from the two choices.

- (a) You are given with n files having records and you are asked to merge those files in optimal way. The good news is all records are sorted in the file and when you merge them then don't worry about sorting part. However, you have to create always a new file to merge two files at a time. Write an algorithm to find an optimal merging way to merge n files. Use your optimal binary merge pattern for ten files whose length are 28, 32, 12, 5, 84, 53, 91, 35, 31, 11.

and 11.

OR

- (b) You arrive at Disney Land, where you can participate in various activities and games. Each activity or game has different costs. You can choose only one activity. You've been given a set C of n coins in various values $(c_1, c_2, c_3, \dots, c_n)$. Write an algorithm to find the fewest number of coins to pay for your activity assuming that you have infinite number of coins for every element in set C. Justify your algorithm by taking a suitable example with minimum 10 coins.