



NATIONAL INSTITUTE OF TECHNOLOGY TIRUCHIRAPPALLI
TAMIL NADU - 620 015, INDIA

Probability & Operations Research
(MAIR 31)

End Semester Exam
(Computer Science Engineering)

Date-06/12/2022

Answer all the questions

Maximum Marks: 30

Time: 3 hours

1) Answer the following questions.

[$10 \times 2 = 20$]

- a) The probability that machine A will be performing a usual function in 5 years' time is $\frac{1}{4}$, while the probability that machine B will still be operating usefully at the end of the same period is $\frac{1}{3}$. Find the probability in the following cases that in 5 years' time:
- Only machine B will be operating.
 - At least one of the machines will be operating.
- b) Given that $P(A \cap \bar{B}) = \frac{1}{4}$ and $P(A \cup B) = \frac{3}{4}$, find (i) $P(A)$, (ii) $P(B)$.
- c) A can hit a target 3 times in 5 shots, B 2 times in 5 shots and C 3 times in 4 shots. All of them fire one shot each simultaneously at the target. What is the probability that
- 2 shots hit.
 - At least two shots hit?
- d) An underground mine has 5 pumps installed for pumping out storm water; the probability of any one of the pumps failing during the storm is $\frac{1}{8}$. What is the probability that
- at least 2 pumps will be working.
 - all the pumps will be working during a particular storm.
- e) If the density function of a continuous random variable X is given by
- $$f(x) = \begin{cases} 0, & x < 0 \\ ax, & 0 \leq x \leq 2 \\ a(4-x), & 2 \leq x \leq 4 \\ 0, & x > 4 \end{cases}$$
- Find the value of a and the cumulative distribution function of X .
 - Find $P(X > 2.5)$.
- f) A continuous random variable X has the probability distribution
- $$dF = a e^{-2|x|} dx, \quad -\infty < x < \infty.$$
- Find the value of a . Find the variance of the distribution.
- g) The joint probability distribution function of (X, Y) is given by $p(x, y) = K(3x + 5y)$, $x = 1, 2, 3$; $y = 0, 1, 2$. Find the marginal distribution and conditional probability distribution of X , $P(X = x_i | Y = 2)$, $P(X \leq 2 | Y \leq 1)$.
- h) The joint probability density function of the random variables X and Y is given by $f(x, y) = K(xy + y^2)$, $0 \leq x \leq 1$, $0 \leq y \leq 2$. Find $P\left(X > \frac{1}{2}, Y > 1\right)$ and $P(X + Y \leq 1)$.
- i) If X is normal (μ, σ) , then prove that $E(x) = \mu$ and $Var(X) = \sigma^2$.
- j) If X is normal (μ, σ) , and $\Phi(x)$ is the standard normal distribution, then prove that $P(a \leq X \leq b) = \Phi\left(\frac{b-\mu}{\sigma}\right) - \Phi\left(\frac{a-\mu}{\sigma}\right)$.



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- 2) A CEO has to assign four tasks ($T_i, i = 1, 2, 3, 4$) to his four subordinates ($S_i, i = 1, 2, 3, 4$). His estimates of the time each of his subordinate would take to perform each task is given in the matrix below. How should the tasks be allocated, one to each one, so to minimize the total man-hours? [3]

	S_1	S_2	S_3	S_4
T_1	18	26	17	11
T_2	13	23	14	16
T_3	38	19	18	15
T_4	19	26	24	10

- 3) The details of a project management work are given below: [3]

Activity	Immediate Predecessor	Duration (In weeks)		
		a	m	b
A	-	6	7	8
B	-	1	2	9
C	-	1	4	7
D	A	1	2	3
E	A, B	1	2	3
F	C	1	5	9
G	C	2	2	8
H	E, F	4	4	4
I	E, F	4	4	10
J	D, H	2	5	14
K	I, G	2	2	8

- Construct the project network with minimum number of nodes.
- Find the expected duration and variance of each activity
- Find the critical path and expected project completion time.
- What is the probability of completing the project on or before 35 weeks?

- 4) Consider the following LPP

$$\text{Maximize } Z = 6X_1 + 8X_2$$

Subject to,

$$5X_1 + 10X_2 \leq 60$$

$$4X_1 + 4X_2 \leq 40$$

$$X_1 \text{ and } X_2 \geq 0.$$

[4]

- Solve the problem using simplex method,
- Solve the problem if the right-hand side constants of the constraints are changed from 60 and 40 to 20 and 40 respectively.
- Check whether the addition of the constraint $6X_1 + 3X_2 \leq 48$ affects the optimality. If does, find the new optimum solution.



National Institute of Technology
Tiruchirappalli, Tamil Nadu – 620 015

CSPC31: Principles of Programming Languages – FA

Date: 07.12.2022

Duration: 3 Hours

Time: 09:30 AM – 12:30 PM

Total Marks: 40

Note: MCQ may have multiple answers. In such case, you have to write all the correct choices. Otherwise, mark will not be awarded for that question.

1. a) Using the following grammar, derive the leftmost derivation for the following sentence:

(3 M + 10 M)

$$A = (B * C) + A$$

$\text{<assign>} \rightarrow \text{<id>} = \text{<expr>}$
 $\text{<id>} \rightarrow A \mid B \mid C$
 $\text{<expr>} \rightarrow \text{<expr>} + \text{<expr>} \mid \text{<expr>} * \text{<expr>} \mid (\text{<expr>}) \mid \text{<id>}$

- b) Draw the inheritance diagram and complete Class Inheritance Record (with vtable) for the following program.

```
class Add
{
public:
    int w, x, y;
    virtual void add() { . . . }
    virtual void sub() { . . . }
};

class Sub
{
public:
    int z;
    virtual void sub() { . . . }
    virtual void sum() { . . . }
};

class Div : public Add, public Sub
{
public:
    int u;
    virtual void add() { . . . }
    virtual void sub() { . . . }
};
```

```
virtual void dud() { . . . }  
};
```

2. For the following program:

(2 M + 1 M + 9 M)

- a) Write the basic Activation Record Instance
- b) Write the order in which the function calls are made
- c) Draw the Activation Record Instance [*Hint: Mark all the possible locations of EP and SP using dotted arrows*]

```
procedure Main_2 is  
    X : Integer;  
    procedure Bigsub is  
        A, B, C : Integer;  
        procedure Sub1 is  
            A, D : Integer;  
            begin -- of Sub1  
                A := B + C;  
                procedure Sub2(X : Integer) is  
                    B, E : Integer;  
                    procedure Sub3 is  
                        C, E : Integer;  
                        begin -- of Sub3  
                            E := B + A;  
                        end; -- of Sub3  
                        begin -- of Sub2  
                            . . .  
                            Sub3;  
                            . . .  
                            A := D + E;  
                        end; -- of Sub2  
                        Sub2(7);  
                    end; -- of Sub1  
                    begin -- of Bigsub  
                    sub1();  
                end; -- of Bigsub  
  
                begin -- of Main_2  
                    . . .  
                    Bigsub;  
                    . . .  
                end; -- of Main_2
```

3. a) Consider that a program has 2 classes namely "A" and "B". Class B is a subtype of Class A. Also, Class A and class B has 1 variable each namely "x" and "y" respectively. Suppose, you create an object b1 of type class A and b2 of type class B in stack memory. What will happen if you execute the following statement: $b2 = b1$ (2 M + 1 M + 1 M + 1 M)

- (a) Value of "x" in b2 is alone copied to "x" in b1
- (b) Both "x" and "y" values of b2 will be copied to b1
- (c) Throws error

(c) None of the above

b) In C++ program, a throw keyword without any value/variable_name can _____

- (a) Occur only inside a handler
- (b) Occur anywhere inside a program
- (c) Occur only inside a try loop
- (d) None of the above

c) Any object that is created inside a try loop _____

- (a) Will be deleted at the end of that try loop
- (b) Will be active even outside that try loop
- (c) Will be active throughout the whole program
- (d) None of the above

d) The class at point A and point B are called as _____ respectively.

```
class base <---- Point A
{
    ...
    class derived <---- Point B
    {
        ...
    }
}
```

- (a) Nested and Nesting Class
- (c) Virtual Class and Nesting Class

- (b) Nesting and Nested Class
- (d) Nesting and Virtual Class

4. a) At which point and in what order, the destructor will be called in the following C++ program? **(2 M + 1 M + 1 M + 1 M)**

```
void main()
{
    Base b();
    b.add(); <---- Point A
    Derived d();
    d.sub(); <---- Point B
} <---- Point C
```

Statement

b) Headless Horn clause in Prolog is called as fact statement

c) If the base class members are declared as "private" and the derived class is derived using the access modifier "public", then the class members of base class will become _____

in derived class.

(a) Visible

(b) Hidden

(c) Accessible

d) Write the names of the two types of synchronization that are required when different tasks share data.

5. What will be the output of the following code?

(1 M + 1 M + 3 M)

[Hint: Do step-by-step derivation for question c]

a) (CAR 'A) = **A**

b) (CDR '((A B) C D)) = **C D**

c) (CADDAR '((A B (C) D) E))

----- END -----



NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI
DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
CSPC32- Data Structures

Programme: B.TECH

Final Assessment

Session: JULY/2022

Date: 08.12.2022

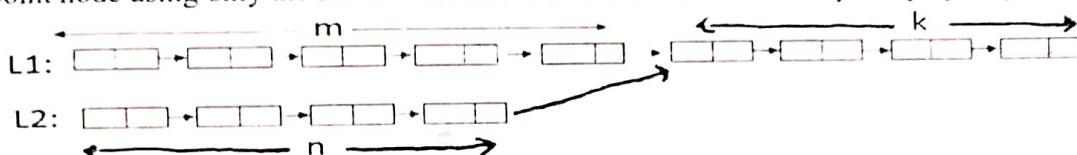
Duration: 3 Hours

Total Marks: 40

Answer all the questions

1. Write a program to reverse the stack elements using only stack operations (push() and pop()). What is the time complexity? [4 M]

2. Two linked lists, L1 and L2, are given as shown in the diagram. The first Linked list L1 length is $(m+k)$ and the second Linked list L2 length is $(n+k)$. Assume that you know the first node addresses of the both lists. Write an algorithm or function to find the intersection point node using only the stack data structure. What is the time complexity? [4 M]



3. Write a program or function to display the single linked list elements from the end (Do not use the other data structures). Your program time complexity should be $O(n)$. [4 M]
4. Write a program or function to find the addition of two polynomials using linked list. [4M]
5. Write a function to find the level of a binary tree that has maximum number of nodes. [4M]
6. Write a program for finding a next immediate higher value for given array elements. Use a suitable data structure to solve this problem. You are allowed to traverse the array only once. **Input:** 5,2,1,4,7,3,8 **Output:** 7,4,4,7,8,8,-1 (Next immediate higher values for the elements 5,2,1,4,7,3,8 are 7,4,4,7,8,8,-1, respectively. The next immediate higher value for the last element assumes as -1) [4 M]
7. Write a function to find the occurrence of a given pattern in a given text. [4 M]
8. Show the step by step process of Heap sort to solve the following list of elements. Derive the time complexity of the Heap sort. 10, 6, 7, 17, 26, 56, 32, 72, 20, 57, 100, 38, 128 [4M]
9. Compare Red-Black and AVL trees. List the properties of Red-Black Trees. Construct the Red-Black tree with the following elements. [4 M]
18, 17, 16, 4, 61, 131, 109, 203, 25, 191, 157, 10, 52, 3, 58
10. Explain linear probing and quadratic probing with examples and write the disadvantages of both techniques. [4 M]



National Institute of Technology, Tiruchirappalli
Department of Computer Science and Engineering

Digital System Design

End Semester Examination

Course/ Branch

: B.Tech/ CSE

Course Code : CSPC33

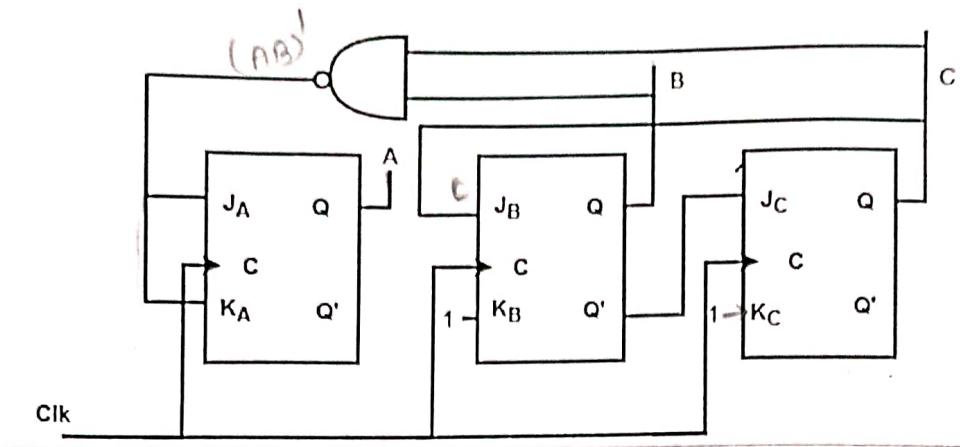
Duration

: 3 Hours

Max Marks : 50

Answer All Questions

1. a) Design a combinational circuit with 4-bit input and 2-bit output. The first output bit is set to 1 if the one's complement value of the input is greater than 5. The second output bit is set to 1, if the XOR value of all the input bits is 1. (5)
b) Solve the following functions using K-map. (5)
i) $F = \sum m(0, 1, 2, 3, 4, 6, 8, 10, 12, 14, 16, 17, 18, 19, 20, 22, 24, 26, 28, 29, 30, 31)$
ii) $G = \prod M(0, 1, 2, 9, 10, 14, 15) + d(5, 6, 13)$
2. a) Implement the following Boolean expression using multiplexer considering B as the input variable.
 $F(A, B, C, D) = \sum m(0, 1, 3, 4, 8, 9, 15)$ (5)
b) Consider you are working in a company where a customer approach you with a problem. He owns a machinery company where he asks your help find faults in machine. A machine is attached with n number of sensors (say temperature sensor, low oil sensor, etc.). All the sensors are connected to LEDs, in which, particular LED will be ON when there is some abnormality (e.g. less oil in machine) in particular sensor. But due to increase in the number of sensors, he can't have one LED for each sensor and would like to reduce the number of LEDs. Given this problem, how will you solve this issue and what solution will you give to the customer? Explain in detail. (5)
3. a) Design a JK counter which counts the following sequence. (5)
0, 5, 6, 9, 4, 11, 7, 3, 12, 10, 8, 0, 5 ...
b) Analyze the following synchronous sequential circuit. Derive the equations, draw necessary tables and state diagram. (5)



4. a) Write a short note on the real-time application of the following terminologies. (4)
- i) Flip-flops ii) Multiplexer iii) Encoders iv) Counters
- b) Design a circuit for voting system for a class to select class representative. There are 12 students in the class amongst which 2 students are standing for the election. Explain the steps, components needed for designing the system. Draw necessary truth tables and circuit diagrams. (6)
5. a) Explain in detail about the conditional statements in verilog. (4)
- b) What is the difference between always and assign statements. (2)
- c) Registers x and y are declared as reg [2:0] x,y;. x and y have initial values of 1 and 2 respectively. Find the value of x and y after each of the following Verilog codes have been executed. (4)
- | | |
|--|--|
| (a) $y = x \&\& y;$
$x = y \& x;$ | (c) $x = (y) ? y : x;$
$y = (x) ? x : y;$ |
| (b) $x <= (y) ? y : x;$
$y <= (x) ? x : y;$ | (iv) $x <= x << 1;$
$x[0] <= x[2];$ |

Best Wishes

NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI
DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING
END SEMESTER EXAMINATION DECEMBER 2022

Subject Code/ Name: CSPC34/ Computer Organization Date: 12 / 12 / 2022

Marks: 50

Time: 9:30 AM–12:30 PM

Answer all the questions

1.

- a. Compilers can have a profound impact on the performance of an application. Assume that for a program, compiler A results in a dynamic instruction count of $1.0E9$ and has an execution time of 1.5 s, while compiler B results in a dynamic instruction count of $1.3E9$ and an execution time of 1.8 s.

i. Find the average CPI for each program given that the processor has a clock cycle time of 1 ns.

ii. Assume the compiled programs run on two different processors. If the execution times on the two processors are the same, how much faster is the clock of the processor running compiler A's code versus the clock of the processor running compiler B's code?

iii. A new compiler is developed that uses only $6.0E8$ instructions and has an average CPI of 1.1. What is the speedup of using this new compiler versus using compiler A or B on the original processor? (5)

- b. Write the MIPS code for the following. Assume that i , j and k are stored in registers \$s1, \$s2, and \$s3 respectively. The base address of the save array is in \$s6 (3)

```
while (save[i]=k)
{
    j+=1;
    k = i+j;
    i++
}
```

- c. How does the ISA influence CPU performance? (2)

2.

- a. Using a table, calculate 16 divided by 5 . You should show the contents of each register on each step. Assume both inputs are unsigned 5-bit integers. (3)

- b. Calculate $3.984375 \times 10^{-1} + (3.4375 \times 10^{-1} + 1.771 \times 10^0)$ by hand, assuming each of the values are stored in the 16-bit half precision. Assume 1 guard, 1 round bit, and 1 sticky bit, and round to the nearest even. Show all the steps, and write your answer in both the 16-bit floating point format and in decimal. (4)

- c. Write briefly about the circuit that can be used to speed up the multiplication operation. (3)

3.

- a. Draw the data path diagram for the MIPS sw instruction. No need to draw the control unit. You could indicate with inward and out-ward arrows the signals each of the resource which is using it. (4)

- b. Consider the following sequence of instructions, and assume that it is executed

on a 5-stage pipelined datapath:

(2+1.5+1.5)



- a. If there is no forwarding or hazard detection, insert nops to ensure correct execution.
- b. If the processor has forwarding, but we forgot to implement the hazard detection unit, what happens when this code executes?
- c. If there is forwarding, for the first five cycles during the execution of this code, specify which signals are asserted in each cycle by hazard detection and forwarding units.
- d. What is VLIW? (1)

4.

- a. For a direct mapped cache design with 32-bit address, the following bits of the address are used to access the cache. (1+1+3)

Tag: bits 31-9, index: bits 8-4, offset: bits 3-0

- i. What is the cache line size in words?
- ii. How many lines does the cache have?
- iii. If starting from power on, the following word addressed cache references are recorded:

0,4,16,140,230,160,1024,30,16,160,3100,180,2180

What is the hit ratio? Show all the steps.

- b. 'Increasing associativity requires more comparators and more tag bits per cache block' - explain with a simple example. (2)

- c. What is a cache miss penalty? (3)

5.

- a. Consider a SEC code that protects 8-bit words with 4 parity bits. If we read the value 0x345, is there an error? If so, correct the error. (4)

- b. How do you calculate the number of parity bits needed for the Hamming code, given the data size? (3)

- c. What are the different RAID levels? How are they useful? (3)



End Semester Examination
CSPE32 – Combinatorics and Graph Theory

Course/Department : B.Tech./CSE

Batch : 2021-2025

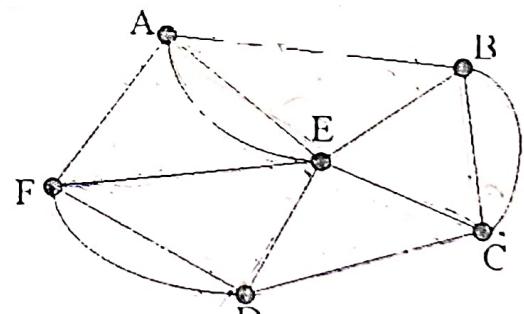
Semester/Section : III B

Session : July/2022

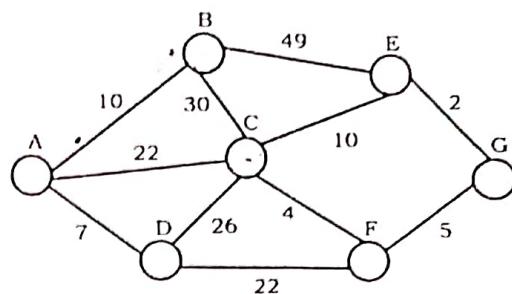
Date and Time : 13-12-2022 & 09.30 AM – 12.30 PM

Marks : 40

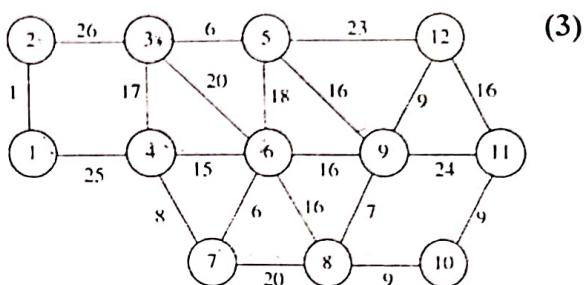
**Answer ALL Questions with proper steps and justification.
Draw diagrams wherever necessary.**

1.
 - a) In how many ways can Sunil distribute 17 sweets among his five children in such a way that the eldest gets only two or three of them? (2)
 - b) In how many ways can three w's, three u's, and three v's be arranged so that no consecutive triples of the same letter appear? (2)
 - c) Five people are assigned to analyze the quality and taste of chips made by two companies. There are 24 sample packets of each type. In how many ways can these 48 sample packets be distributed so that each person gets at least 2 packets of one particular type and at least 3 of the other type? Solve the problem using generating function. (2)
 - d) Using Ferrer's graph, show that the number of partitions of an integer n into summands not exceeding m is equal to the number of partitions of n into at most m summands. (2)
2.
 - a) Prove that a simple graph, G , with $n (>= 3)$ vertices is Hamiltonian, if $d(v) \geq n/2$ for every vertex v of G . (2)
 - b) Prove that a connected planar graph with n vertices and e edges has $e - n + 2$ regions. (3)
 - c) Prove that for a given spanning tree T , a chord c_i that determines a fundamental circuit Γ occurs in every fundamental cut-set associated with the branches in Γ and in no other. (3)
3.
 - a) Identify whether Euler path or circuit exist in the following graph. If so, trace one such path/ circuit. Also, provide a suitable matrix representation of this graph. (3)

 - b) Construct edge induced (S_1) and vertex induced (S_2) subgraphs from the graph G given in Question 3 d. Edge set, $E(S_1) = \{(A,B), (C,E), (A,D), (C,D), (C,F), (A,C)\}$ and vertex set, $V(S_2) = \{A, C, E, F\}$. Perform ring sum operation on S_1 and S_2 to obtain S_3 . Fuse vertices E and G of graph G . Show the resultant subgraphs. (2)
 - c) Perform minimization of the switching function $a'b'c + a'bc' + ab'c' + ab'c + abc' + abc$ using edge covering. (2)

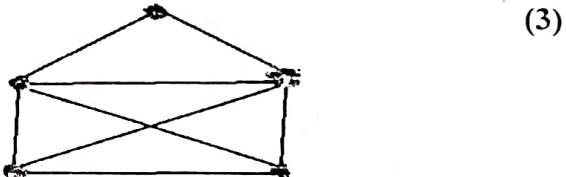
- d) Suppose that you want to provide water connection to a set of houses. The houses are not at equal distances. Given a connected graph where the vertices and edges denote these houses and the possible connections between them respectively. How can you connect these houses for providing water in minimum cost without looking for reliability of connection? What is the cost?



4. a) Suppose the graph represents a network of pipelines for transporting oil, what is the maximum flow possible through the network between vertices 3 and 10?



- b) Find the chromatic number and chromatic polynomial of the given graph.



- c) Check whether the given graph is planar or not by performing elementary reduction.



5. a) There are 6 gifts labeled 1,2,3,4,5, and 6 under the Christmas tree, and 5 children receiving them: Alice, Bob, Charles, Danielle, and Edward. Can the gifts be distributed to each person so that each one of them gets a gift they'll like? Solve the problem by constructing the graph. Give any possible solutions.

CHILDREN	GIFTS
ALICE	G1, G3
BOB	G2, G4, G5, G6
CHARLES	G2, G5
DOT	G1, G2, G3
EDWARD	G2

- b) From the graph, find Maximal Independent sets, and Minimal Dominating sets. Derive your answer by showing required steps.

