

INDIAN INSTITUTE OF ENGINEERING SCIENCE AND TECHNOLOGY, SHIBPUR  
 B.TECH. 4<sup>th</sup> SEMESTER (CST) EXAMINATION, 2019  
 Analysis and Design of Algorithms (CS 401)

TIME: 3 Hrs

FULL MARKS: 70

Answer Q.1 and any three from the rest.

Q.1 Answer any five of the following:-

- (a) Find the smallest odd integer base for which 25 behaves like pseudo prime, providing all calculation steps. Discuss how such pseudo primes can be detected through algorithm.
- (b) What is the complexity of formula satisfiability when formula is presented in the disjunctive normal form? Explain its implication on the NP completeness of formula satisfiability problem.
- (c) What is the worst case time complexity for Euclid algorithm to find GCD of two integers? Explain when is that achieved.
- (d) How are the elements of the disjoint set organised in case of Union by rank and path compression heuristics so that it leads to  $\log n$  complexity?
- (e) Which properties of the roots of unity become useful for designing a divide and conquer algorithm to multiply two polynomials and why?
- (f) What kind of data structure should be used for working with dynamic sets where elements of the universe follow normal distribution and why?

$$(5 \times 5 = 25)$$

2. Compare in terms of data structure, method and time complexity as applicable:-(5x3=15)

- (a) Randomized pivot and median of medians as pivot for selection of i-th smallest element;
- (b) Prim's algorithm and Kruskal's algorithm for finding minimum spanning tree;
- (c) Successful search of elements with collision resolved through chaining / open addressing.

$$(5 \times 3 = 15)$$

3. Write short notes on the following:-

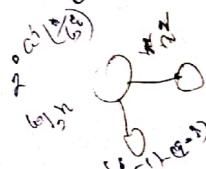
- (a) Correctness of Matroid theory for greedy algorithm;
- (b) Solutions for polygon triangulation problem;
- (c) Number theoretic algorithm for public key and private key generation in RSA cryptosystem.

$$x^{(1,2)} \\ \vdots \\ x^{(n,2)}$$

$$(5 \times 3 = 15)$$

4. Discuss about the optimality of the following:-

- (a) Huffman coding for data compression;
- (b) 0-1 knapsack problem;
- (c) Time and space complexity of quick sort algorithms.



$$(5 \times 3 = 15)$$

5. Solve the following problems:-

- (a) A problem of size  $n$  is divided into 2 subproblems of size  $n/2$  each and  $n^2$  amount of additional work is done for problem size  $n$ . Find  $T(n)$  using the concept of recursion tree.
- (b) Find the connected components of a given graph with ten vertices [A ... J] with edges (A,B); (A,C); (E,B); (H,J); (I,J); (F,I); (A,E); (D,G); (A,G); (F,H) using appropriate disjoint set operations and count the number of operations required.
- (c) Perform modular exponentiation for  $3^{13} \pmod{31}$ . Find the multiplicative inverse of the result  $\pmod{31}$  using extended Euclid algorithm. Show the calculation steps.

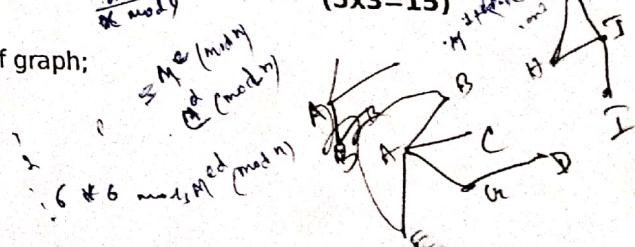
$$(5 \times 3 = 15)$$

6. Show the mapping / reducibility relationship:-

- (a) Clique in a graph with 3CNF satisfiability;
- (b) Travelling salesman problem with Hamiltonian cycle of graph;
- (c) Any problem in NP with Circuit satisfiability problem.

$$\begin{array}{l} \text{ok mod } 3 \\ \text{ok mod } 5 \\ \text{ok mod } 7 \end{array}$$

$$(5 \times 3 = 15)$$



INDIAN INSTITUTE OF ENGINEERING SCIENCE AND TECHNOLOGY, SHIBPUR  
 4<sup>TH</sup> SEMESTER (CS) FINAL EXAMINATION, April 2019  
 Computer Architecture and Organization - I (CS 402)

FULL MARKS: 70

TIME: 3 Hrs

1. Answer any ten questions with the necessary explanation. 2x10

(A) How many input-output data lines and address lines are needed for each of the following memories?

(i) 8Kx32 (ii) 256Kx64 (iii) 32Mx32 (iv) 4Gx8

(B) Match the followings (left hand side with right hand side) in the context of memory hierarchy from top to bottom

- |                          |               |
|--------------------------|---------------|
| (i) Size                 | (1) Increases |
| (ii) Cost/bit            | (2) Decreases |
| (iii) Access time        | (3) No change |
| (iv) Frequency of access |               |

Choose the correct option: (a) (i)1(ii)1(iii)2(iv)2, (b) (i)2(ii)1(iii)2(iv)1, (c) (i)1(ii)2(iii)1(iv)2,  
 (d) (i)2(ii)2(iii)1(iv)1

(C) Relative mode of addressing is most relevant for writing (i) Position independent code (ii) Sharable code (iii) Interrupt handler (iv)None

(D) Match the followings (left hand side with right hand side) in the context of RAID organization.

RAID levels	Number of disks
(i) RAID 0	(1) N+1
(ii) RAID 1	(2) N+2
(iii) RAID 5	(3) N
(iv) RAID 6	(4) 2N

(E) Match the followings (left hand side with right hand side) in the context of control unit design.

- |                                    |                             |
|------------------------------------|-----------------------------|
| (i) Horizontal microprogramming    | (1) Fastest                 |
| (ii) Hardwired control unit design | (2) Maximum parallelism     |
| (iii) Vertical microprogramming    | (3) Encoded control signals |

(F) In set associative mapping if set size is one then it is (i) 1 way set associative (ii) Direct mapping (iii) Both

(G) IO devices can't be connected directly to the system because of (i) Speed mismatch (ii) Different data format (iii) Both

(H) Daisy chain is for

- |  |
|--|
| (i) Connecting number of devices to a computer                   |
| (ii) Connecting number of controllers to a device                |
| (iii) Interconnecting number of devices to number of controllers |

(I) If one instruction is executed in 4 nsec then what is the throughput of the system?

(J) The number of instructions which may possibly be executed by a computer depends upon the size of (i) Opcode (ii) PC (iii) MAR (iv) Word

(K) The address of the location of the operand is given explicitly as a part of the instruction in (i) Absolute mode (ii) Immediate mode (iii) Indirect mode (iv) Index mode

(L) The performance of two computers A and B are 1000 MIPS and 2000 MIPS respectively. Two programs of length 250 and 500 instructions are executed in A and B respectively. Which one will complete the execution first and why?

2. Answer any ten questions with the necessary explanation. 3x10

(A) The microinstruction stored in the control memory of a processor has a width of 20 bits. Each microinstruction is divided into 2 fields: a control field of size 9 bits and next address field of size X bits. Total number of micro operations is 46 and degree of parallelism is 2. Find the size of each control field, value of X and the size of control memory.

(B) What is the maximum speed up factor of n stage pipeline and why? Why it is not possible to achieve maximum speed up?

C) What is the decimal value of the following floating point number?

0 10000011 001010000000000000000000

Why normalization is used in floating point number system?

D) How many memory reference is required by a CPU to execute immediate address instruction and why?

E) Consider a computer having 12 bit memory cell. How many bytes of memory can be accessed using 12 bit address? If a single memory cell is used to store a single character how many different characters could be represented by a cell?

F) How many characters per second (7 bits+parity) can be transmitted over 2400 bps line in asynchronous mode having one start bit and one stop bit?

G) If a disk rotates at 6000 rpm and track on the disk has 1024 sectors, what is the data transfer rate if the sector size is 1024 bits?

H) How many 32Kx8 RAM chips are needed to provide a memory capacity of 1M bytes? How many address lines are needed? How many lines must be decoded for the chip select inputs? Specify the size of the decoder.

I) A computer has a cache with access time 10 ns, a hit ratio of 80% and average memory access time is 24 ns. Then what is the access time for physical memory?

J) What do you mean by conflict miss, capacity miss and compulsory miss?

K) How much time a two stage pipeline takes to complete the execution of the following loop?

for I=1 to 100 do A[I]=B[I]\*C[I]+D[I]

First stage of the pipeline is for multiplication (10 ns) and the second stage of the pipeline is for addition (10 ns). How the execution time of the above loop is affected in presence of latch (2 ns) in the pipeline?

L) Consider a machine with a byte addressable main memory of  $2^{16}$  bytes and block size of 8 bytes. Assume that a direct memory cache consists of 32 blocks is used with this machine. How 16 bit memory address is divided into tag, block number and byte number? How many total bytes of memory can be stored in the cache?

3. Answer any four questions.

A) Derive an expression to show the relation between speed up, efficiency and throughput of a k-stage pipeline. What is the maximum possible value of efficiency of this pipeline? What are the basic differences between asynchronous and synchronous model of linear pipeline processor?

B) What are the drawbacks of programmed IO? How the interrupt request and DMA request eliminate these drawbacks? [2+1+2]

C) Discuss the followings in the context of memory. [2+1.5+1.5]

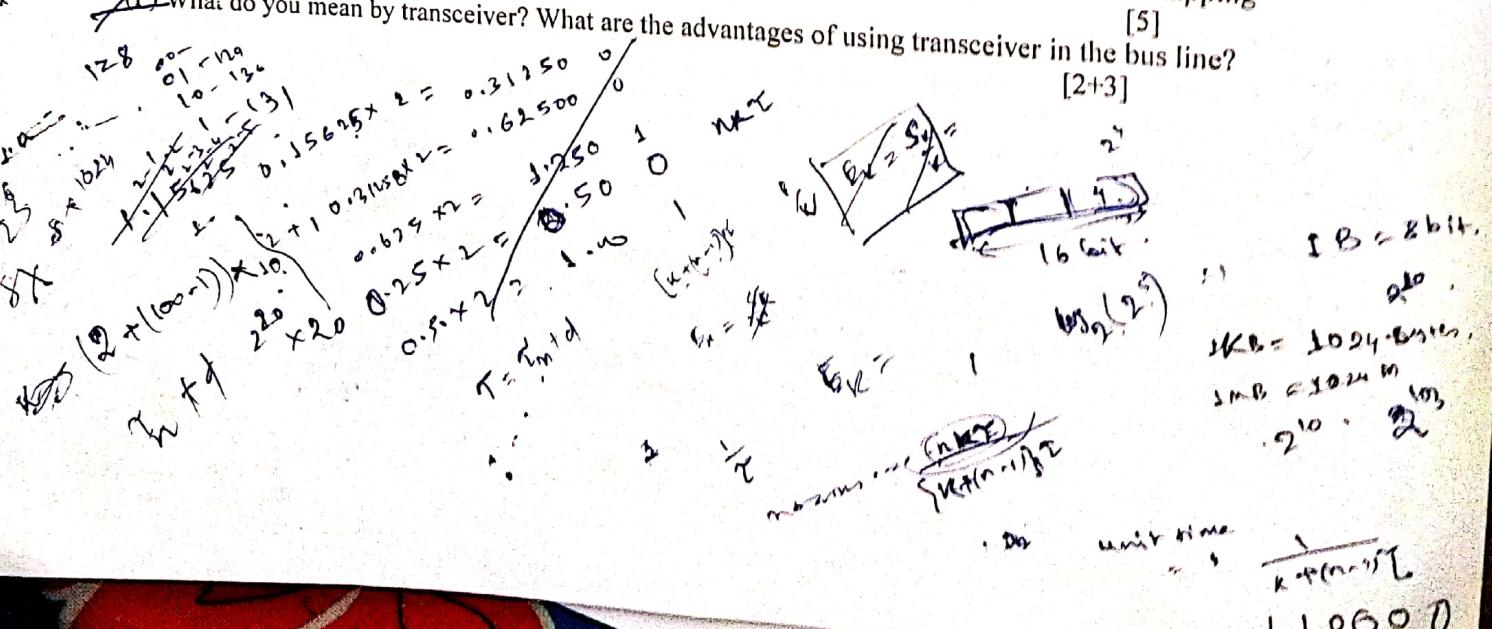
i) Access time ii) Access mode iii) Relation between access time and access mode [1.5+1.5+2]

D) Show the advantage of using carry save adder in the multiplier circuit with suitable example. [5]

E) Compare the performance of direct mapping, fully associative mapping, set associative mapping in the context of hardware requirement. [5]

F) What do you mean by transceiver? What are the advantages of using transceiver in the bus line? [5]

[2+3]



Full Marks: 70

Answer Section A completely and any three from Section B.  
Do not use separate answerscript for each section

Section A

1. a) Assembly is which type of programming language?  
i) 1GL ii) 3GL iii) 5GL iv) none
- ✓ b) In a function with a default argument, which value is accepted when user's value is given?  
i) user's value ii) default value iii) garbage value iv) value of previous call
- c) Which operator is used to signify the namespace?  
i) conditional operator ii) sizeof operator iii) scope resolution operator iv) none
- d) In  $\lambda$ -Calculus, what does  $\lambda S z . S(z)$  represent?  
i) 2 ii) 1 iii) 3 iv) none
- ✓ e) Which of the following permits function overloading in C++?  
i) type & order of arguments ii) type & number of arguments iii) type, number & order of arguments iv) none
- ✓ f) What is the output? 

```
int main()
{
    int arr[] = {2, 5, 6, 7};
    int *p = arr;
    cout << *p+1 << * (p+1);
    return 0;
}
```

  
i) 2 3 ii) 3 3 iii) 3 5 iv) 2 5
- g) Which of the following is a valid class declaration in C++?  
i) class A { int x; }; ii) class A {} iii) public A {} iv) object A { int x; };
- h) Which concept of Java is achieved by combining methods and attributes into a class?  
i) Encapsulation ii) Inheritance iii) Polymorphism iv) Method overriding
- i) Which of the following supports multiple inheritance in Java?  
i) Interface ii) Multithreading iii) Protected method iv) none
- j) Which keyword in Java, is used to indicate base class variable if base class and derived class have same variable name?  
i) super ii) this iii) final iv) classname itself

(10 x 1=10)

2. Write short note on the following with appropriate code segment/ diagram/ use wherever possible.

- a) Various programming styles  
b) Polymorphism in Java  
c) Procedure abstraction and data abstraction in Scheme Lisp

(3x6=18)

(P.T.O)

18  
10  
28  
25

### Section B

3. a) Which keyword in C++ is used to prevent modification of a value? Mention its appropriate syntax.  
 b) Prepare a class 'Simple calculator' in C++ for addition, subtraction, multiplication and division operations. Hence, without modifying the class, upgrade it to a 'Scientific calculator' that supports at least logarithm, trigonometric, exponent functions and number system conversion (binary and decimal only). You are allowed to use standard library functions if necessary. Draw an appropriate class diagram for the above. (2+(10+2))

4. a) What is the difference between C++ and Java?  
 b) Develop a class, 'Matrix' in Java that supports matrix operations like addition of its elements, addition of its each row, addition of its upper & lower triangular parts and finding number of zeros & nonzero elements. Similarly, develop another class 'Set' that supports some set operations like addition of its elements, number of zeros & nonzero elements and sum of elements lies between a user defined range. Use the concept of 'Abstract class' to solve the problem. Draw an appropriate class diagram for the above. (2+(10+2))

5. Evaluate the following expressions in Scheme Lisp and discuss output with examples.  
 a)  $\phi(n, a, b, r) = {}^n C_0 a^0 b^n + {}^n C_1 a^1 b^{n-1} + {}^n C_2 a^2 b^{n-2} \dots + {}^n C_r a^r b^{n-r}$ ,  $a, b, n, r \in \{0, 1, 2, 3, \dots\}$   
 Do not use the procedure, 'exp' or 'expt'.

$$\begin{aligned}
 \text{b) } A(m, n) &= n+1 && \text{if } m = 0 \\
 &= A(m-1, 1) && \text{if } m > 0, n = 0 \\
 &= A(m-1, A(m, n-1)) && \text{if } m > 0, n > 0
 \end{aligned}$$

(7+7)

6. a) Using  $\lambda$ -Calculus, Prove  $2+3 \equiv 4+1$   
 i. Define Predecessor function  
 b) Prove that multiplication is a primitive recursive function. (5+5+4)

Handwritten notes and sketches related to the questions:

- Sketches of class diagrams for Simple and Scientific calculators.
- Diagram illustrating the evaluation of  $\phi(n, a, b, r)$  using binomial coefficients.
- Diagram illustrating the recursive definition of  $A(m, n)$ .
- Notes on  $\lambda$ -Calculus, including definitions of const, define(f), and, log, and sketches of proofs for  $2+3 \equiv 4+1$  and multiplication as a primitive recursive function.
- Notes on Poly, PRDC, WO, Dom ab, ghi, patterns, and various numbers (27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100).

# Indian Institute of Engineering Science and Technology, Shibpur

B. Tech. (CST) 4<sup>th</sup> Semester End-Term Examination, April 2019

Theory of Computation (CS 404)

Full Marks: 70

Time: 3 hours

- Attempt question 1 and any three(3) from the remaining five(5) questions.
- Answers should be precise and to the point.
- Make your own assumptions, if necessary, and state them at proper places.

1. State whether the statement is true or false (1 mark)! Justify your answer (3 marks)!

- (a) Grammars can compute functions from strings to strings only.  
 (b) Automata can have only finite number of states.  
 (c) Functions having more than one arguments can be expressed in Lambda Calculus.  
 (d) Let  $\omega \in \Sigma_1^*$  as well as  $\omega \in \Sigma_2^*$ . Godel number for  $\omega$ , however, will always be same. [4 × 4]

2. For each of the following languages construct a specific type of grammar (as stated at its side) that generates the language.

- (a)  $\{\omega \in \{a, b\}^* \mid \omega \text{ does not contain } abba \text{ as a substring.}\}$  [Construct a Regular Grammar.] 15  
 (b)  $\{a^m b^n \mid m \leq n \leq 2m\}$  [Construct a Context-Free Grammar.]  
 (c)  $\{a^m b^n c^p d^q \mid m + n = 2(p + q)\}$  [Construct a Context-Free Grammar.]  
 (d)  $\{a^{n^2} \mid n \geq 0\}$  [Construct an Unrestricted Grammar.] [4½ × 4]

3. (a) Systematically construct a non-deterministic finite automaton  $M = (K, \Sigma, \Delta, s, F)$  to accept the language represented by  $((ab \cup aab)^* a^*)^*$ . 5

(b) Some authors define a nondeterministic finite automaton (NDFA) to be a quintuple  $(K, \Sigma, \Delta, S, F)$ , where  $K, \Sigma, \Delta$  and  $F$  are defined as usual and  $S \subseteq K$  is a finite set of initial states, in the same way that  $F$  is a finite set of final states. The automaton may nondeterministically begin operating in any of these initial states. Formally define the concept of such an automaton accepts a string  $\omega$ . Prove why this definition of NDFA is not more general than the standard one in any significant way. P

(c) Given a nondeterministic finite automaton  $M = (K, \Sigma, \Delta, s, F)$ , propose an algorithm to compute  $E_M(q)$ , the empty closure of the state  $q$  under  $M$ . [5+8+5]

4. (a) Prove that the language  $\{\omega\omega^R : \omega \in \{a, b\}^*\}$  is not regular. [ $\omega^R$  is reverse of  $\omega$ .]  
 (b) Prove that the class of context free languages is not closed under intersection.  
 (c) Prove that the intersection of a context-free language and a regular language is a context-free language. [5+5+8]

5. (a) Prove from the definition that the following functions are primitive recursive.

- i.  $K_j^k : N^k \rightarrow N$  such that,  $K_j^k(\bar{n}) = j$  for any  $\bar{n} \in N^k$ .  
 ii.  $\text{abs}(n, m) = |n - m|$ . (x-y) + (y-x)  
 iii.  $\text{max}(n, m) = \text{larger of } n \text{ and } m, \text{ or } n, \text{ if they are equal.}$  n + (x-y)

(b) Let Projection functions  $\Pi_j^k$  be defined as  $\Pi_j^k(\bar{n}) = n_j$ ,  $\bar{n} = (n_1, n_2, \dots, n_k) \in N^k$ ,  $1 \leq j \leq k$ . Show that the projection functions  $\Pi_j^k$  are Turing computable. [3 × 4 + 6]

[Contd.]

6. Write short notes on the following.

6. Write short notes on the following

  - Arithmetic operations in Lambda Calculus
  - Deterministic Simulation of Non-Deterministic Turing Machine
  - Encoding any arbitrary Turing Machine as a string over a fixed alphabet, say  $\{I, c\}$ .

[6 × 3]

*Key all*

rabbits

A hand-drawn diagram of a rectangular frame. Inside the rectangle, there are several small circles representing nodes. Arrows point from the top-left node to the top-right node, and from the top-right node to the bottom-right node. There are also arrows pointing from the top-right node to the bottom-left node, and from the bottom-left node back to the top-left node, forming a cycle.

$s \rightarrow e$   
 $s \rightarrow \alpha$   
 $s_1 \rightarrow$

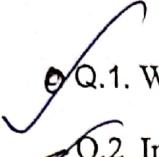
B.Tech. 4<sup>th</sup> SEMESTER END TERM EXAMINATION, 2019  
INTRODUCTION TO MANAGEMENT &  
INDUSTRIAL SOCIOLOGY  
[ HU-3401 ]  
[Branches : ETC, EE, CST, IT ]

Full Marks: 35+35=70

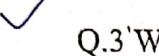
Time : 3 hrs.

1<sup>st</sup> Half (Introduction to Management )

Answer Q. No. 1 and any two from the rest.

 Q.1. Why Horizontal Integration Strategy is frequently used by companies? (15)

 Q.2 In what way Industrial markets differ from Consumer markets? (10)

 Q.3 What information can SWOT Analysis provide to strategic planners in a Company? (10)

 Q.4 Write short notes (any two) (5x2=10)

(a) Market Development Strategy.

 (b) Value Chain analysis - its importance.

(c) Logistics management.

 (d) Marketing Mix.

(e) Communication Process.

Q. 5 Importance of R&D to a Company. (10)

## 2<sup>nd</sup> Half: Industrial Sociology

Answer question number 6 and any two from the rest.

Q.6. Case Study:

The Temptation: Manufacturing executives today are confronted with an enormous variety of promising new technologies, ranging from artificial intelligence to connected machinery to 3D printing, all of them offering some combination of cost savings, quality improvements and increased flexibility. It is tempting to think that a manufacturer could modernize itself simply by replacing its old processes with new ones that feature these technologies. But the historical record suggests that isn't enough.

The History: Process change is an evolving, time consuming and problematic endeavor. The two most important factors affecting a change in manufacturing process are: risk of uncertain outcome and market volatility. Mere technological up gradation has never been free of downturn.

And You: Provide the problem location in the case and suggest at least two remedies. [10]

Q.7. Discuss the significant points of difference between bureaucrat, technocrat, and infocrat.

Give illustrations in support of your answer.

[12.5]

Q.8. The educated urban middle income group has a very specific way of looking at the subaltern. Explicate the perspective in reference to the cucumber vendor of Chennai.

[12.5]

Q.9. Is free market a reality? Elucidate the relationship between an entrepreneur and the collective labour working with her/him in a globalized market. [3.5+9=12.5]

Q.10. For over a century now private mode of transport has become well entrenched in the contemporary culture and psyche at the costs of public mode of transport and ecological imbalance. Do you agree with the statement? Elaborate your position. [12.5]

---x---