

Computer Science and Engineering

Paper - 2

Time Allowed: 3 hours

Maximum Marks: 150

Name:

Roll No.

QUESTION PAPER SPECIFIC INSTRUCTIONS

Please read each of the following instructions carefully before answering the questions.

There are 32 questions in total.

Candidate has to attempt all the questions.

Marks carried by each question/part is indicated against it.

All parts of the question must be answered at one place.

Unless otherwise mentioned, symbols and notations have usual standard meanings.

Answer must be written in *English* only.

Candidate must write the exam on the assumption that the questions are correct.

1. (5 points) What is the minimum number of nodes required in a DAG (Directed Acyclic Graph) for the following block?

$$U = Z = V + W$$

$$X = Y = U + 1$$

$$A = X + Y$$

2. (5 points) What is the size of the physical address space in a paging system, which has a page table containing 64 entries of 11 bit each (including valid and invalid bit) and a page size of 256 bytes.

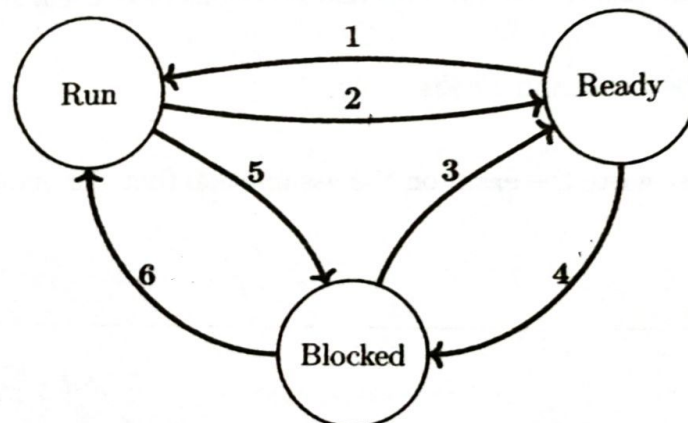
3. (5 points) The execution of a program occurs on a 250 GHz processor that executes millions of instructions. Type, CPI (cycles per instruction) and % of four instructions are provided in the table.

Instruction Type	%	CPI
Data Manipulation	45	1
Data Transfer	19	3
Sequence & Control	21	5
Input and Output	15	6

Compute the average CPI and MIPS (millions of instructions per second) rate of the processor.

4. (5 points) A system X with 2GHz clock speed runs a program in 10 seconds. We want to build a system Y to run the same program in 6 seconds. For this, system Y needs 1.2 times as many clock cycles as system X. What should be the clock speed of the system Y?

5. (6 points) The figure shown below indicates a thread's movement between 3 states (i.e., run, ready, and blocked). Explain what causes each arrow? Say N/A if it doesn't happen.



6. (4 points) Compute the hit rate and miss/fault rate in least recently used page replacement algorithm for the given reference string with 4 page frames. String: 7 0 1 2 0 3 4 2 3 0 3 2 1 2 0 1
7. (2 points) _____ is an IEEE 1003.1C standard API for thread creation and synchronization in operating system.
8. (5 points) If the disk head is initially located at track 32, find the number of disk moves required with First Come First Serve (FCFS) scheduling criteria if the disk queue of I/O blocks requests are: 90 77 24 104 55 87.
9. (5 points) Assume that in a certain computer, the virtual addresses are 64-bit long, the physical addresses are 48-bit long, and the memory is word-addressable. The page size is 16KB and the word size is 8B. Translation Look-aside Buffer (TLB) in the address translation path has 256 valid entries. At most, how many distinct virtual addresses can be translated without any TLB miss?
10. (5 points) Construct a Deterministic Finite Automaton (DFA) with 5 states that accepts all strings with 0101 as a substring.
11. (7 points) A context-free grammar is in Chomsky Normal Form if every rule is of the form

$$A \rightarrow BC$$

$$A \rightarrow a$$

where a is a terminal, A, B and C are variables except B and C cannot be start variables. We only permit rule $S \rightarrow \epsilon$ if S is a start variable.

Given the following grammar, convert it to Chomsky Normal Form.

$$S \rightarrow ASB \mid aB$$

$$A \rightarrow B \mid S$$

$$B \rightarrow b \mid \epsilon$$

12. (6 points) Let L_1 and L_2 be two languages decidable by Non-deterministic Turing machines M_1 and M_2 . Using M_1 and M_2 , construct a Non-deterministic Turing machine for the following languages.
- (a) (2 points) $L_1 \cup L_2$

(b) (2 points) $L = \{a \circ b \mid a \in L_1, b \in L_2\}$ where $a \circ b$ denotes the concatenation of the strings a and b

(c) (2 points) $L_1 \cap L_2$

13. (4 points) Let L be the following language.

$$L = \{P(x_1, x_2, \dots, x_n) \mid P \text{ is a polynomial with an integral root}\}.$$

Explain why the following Turing Machine description cannot decide the language L .

Description of M: The input is a polynomial P over the variables x_1, \dots, x_n .

- Try all possible settings of x_1, \dots, x_n to integer values.
- Evaluate the polynomial on all values.
- If any of these settings evaluate to 0, accept. Else, reject.

14. (5 points) A relational database contains two tables movie, and genre, in which movie table has columns movie_no, movie_name, and genre_id, while genre table has columns genre_id, and genre_name. Following insert statements were executed successfully to populate the empty table.

Insert into genre values (1,'Action')

Insert into genre values (2,'Drama')

Insert into movie values (1,'Chennai Express',1)

Insert into movie values (2,'K3G',2)

Insert into movie values (3,'Dhoom',1)

How many rows and columns will be retrieved by the following SQL statement?

Select * from movie, genre

15. (5 points) Answer the following.

- (2 points) _____ is the operation that reverses the normalization to de-normalization form.
- (2 points) _____ removes all the rows of the given table.
- (1 point) Which of the following are not keys in the database?
 - Compliment
 - Agreement
 - Construct

(iv) Supplement

16. (3 points) Suppose the IP addresses of A and B are 10.105.1.113 and 10.105.1.91, respectively. They both use the same netmask N. Which of the following values of N given below should not be used if A and B should belong to the same network, and why?
- (a) 255.255.255.0
 - (b) 255.255.255.128
 - (c) 255.255.255.192
 - (d) 255.255.255.224
17. (6 points) 1020 bytes long packet must be routed through an interface with MTU of 256 bytes. Assuming the smallest possible IPv4 header size, fragmentation will be required for the transmission. For the second fragment created in this process, find the values of Flag field (in binary), Fragment Offset field (in decimal), and Total Length field (in decimal) of IPv4 header.
18. (3 points) For the following two 16-bit messages, find the Internet checksum:
- ```
0001 1000 0001 0010
1011 1000 1011 0011
```
19. (3 points) Both the payload and 2D (even) parity bits are shown below. Some of these bit(s) have been flipped. Indicate the row and column of the flipped bit(s) in format (col, row); e.g., top left bit is (0,0).
- ```
1000 0001 1111 1010 | 0
1011 0110 0010 1111 | 0
0110 1110 0111 0010 | 1
1101 1010 1000 1101 | 0
1100 0100 0011 0011 | 0
-----
0110 0111 0101 1001 | 1
```
20. (5 points) An organization is granted the IPv4 address block 130.56.0.0/16. The network administrator wants to create 1024 subnets. Find the first and last addresses in the third subnet.
21. (2 points) You work for a company X in Bangalore. Due to floods, you have been allowed to work from home. You have your code in the server in the company and

you have to access it securely to edit and modify. What is the one critical security protocol/tool that enables you to connect to your server securely?

22. (5 points) A hash table contains 10 buckets and uses linear probing to resolve collisions. The key values are integers and the hash function used is $Key \% 10$. If we insert values 43, 165, 62, 123, 152 sequentially in the table, in what bucket will the key 152 be inserted?

23. (5 points) Fill in the table below to create firewall rules that perform the actions described below on a local network with address 1.2.3.0 (subnet 255.255.255.0). Assume that by default, all traffic will be accepted. You can refer to an entire network by its corresponding network address. You can use '*' to mean 'any'.

(a) (2.5 points) Action A: Block all traffic to any server on the local network. Write as Rule 1.

(b) (2.5 points) Action B: Block traffic from client 1.2.3.4 on the local network to web server on the network 9.22.99.0 (subnet 255.255.255.0). Write as Rule 2.

Rule	Source IP	Source Port	Destination IP	Destination Port
Rule 1				
Rule 2				

24. (5 points) Compute the following: $3^{32} \bmod 80$.

25. (7 points) Assume when encrypting 3-bit plaintext with a block cipher with key K, the following ciphertext is obtained:

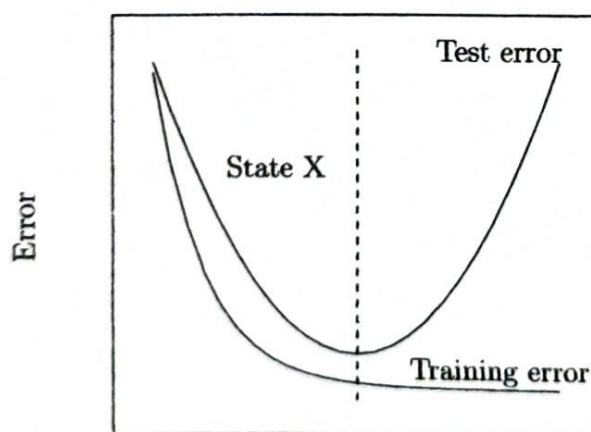
Plaintext	Ciphertext
000	110
001	001
010	111
011	010
100	000
101	011
110	101
111	100

The following ciphertext was encrypted with the above cipher with key K in counter mode (with initial counter value = 0):

$C = 100110000$.

What was the plaintext?

26. (5 points) Suppose A and B use Diffie-Hellman key exchange. Let the commonly agreed (i.e., global public) prime number $(q) = 13$ and the primitive root $(\alpha) = 6$. If A chose the private value $(X_A) = 5$ and B chose the private value $(X_B) = 4$. Find the shared secret key (K) between A and B.
27. (7 points) A transposition cipher (but not a rail-fence cipher) was used to produce the following ciphertext:
 X 2 ! H M E S S E 2 Y T A 2 I I A
 The key used was: 5 2 6 3 4 1.
 What was the plaintext used (in English)?
28. (4 points) Provide the correct answer for the following:
- (a) (2 points) _____ is not the best evaluation metric for cancer prediction problem.
- (b) (2 points) The phenomena in which training error of the model decreases but test error increases is called _____.
29. (4 points) $\max(0, x)$ and $\max(0.1x, x)$ are _____ and _____ activation functions, respectively, which are non-linear in nature.
30. (5 points) Given an input image of size 230×230 with convolution filter of size 5×5 and stride 3. What would be the size of the output?
31. (2 points) What is the State X called for the following machine learning model?



32. (5 points) A perceptron consists of weights $[w_1, w_2, w_3, w_4] = [0.5, 2, 1, -3]$. The activation function is provided as $y = f(z) = 1$ if $z \geq 2$ otherwise 0, where $z = \sum(w.d)$. What is the output y for the following four data samples d ?

	p_1	p_2	p_3	p_4
d_1	1	-1	0	1
d_2	1	-1	1	1
d_3	0	0	1	-1
d_4	1	0	1	-1

