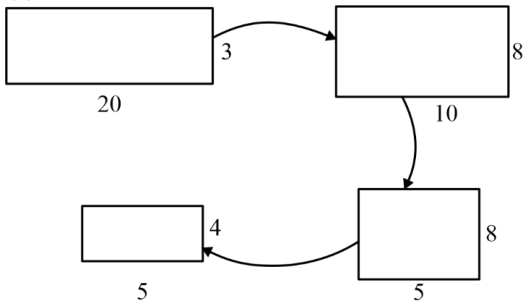
[MCQ]

Q.1. A rectangular paper of 20 cm × 8 cm is folded 3 times. Each fold is made along the line of symmetry. Which is perpendicular to its long edge. The perimeter of the final folded sheet (in cm) is

(a) 24 (b) 20

(c) 18 (d) 21

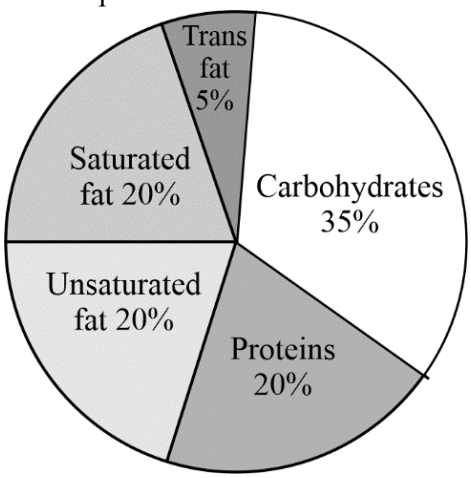
Sol. **(c)**



So, Required perimeter = 2 (5 + 4) = 18

[MCQ]

Q.2. The pie chart presents the percentage of contribution of different macronutrients to a typical 2,000 kcal diet of a person.



The typical energy density (kcal/g) of these macronutrients is given in the table.

Macronutrient	Energy density (kcal/g)
Carbohydrates	4
Proteins	4
Unsaturated fat	9
Saturated fat	9
Trans fat	9

The total fat (all three types), in grams, this person consumes is

(a) 100 (b) 77.8

(c) 44.4 (d) 3600

Sol. **(a)**

Total kcal from fat = (5% + 20% + 20%) of 2000 = 45% of 2000 = 900 kcal.

So that fat in gm consumes by person = $\frac{900}{9} = 100$

[MCQ]

Q.3. For positive non-zero real variables p and q. if

$\log(p^2 + q^2) = \log p + \log q + 2\log 3$,

then, the value of $\frac{p^4 + q^4}{p^2 q^2}$ is

(a) 81 (b) 9

(c) 83 (d) 79

Sol. **(d)**

We have given, $\log(p^2 + q^2) = \log(p\,q) + \log(3^2)$

Or $\log\left(\frac{p^2 + q^2}{pq}\right) = \log 9 \Rightarrow \frac{p}{q} + \frac{q}{p} = 9$ _____(1)

$$\frac{p^4 + q^4}{p^2 q^2} = \frac{p^2}{q^2} + \frac{q^2}{p^2} = \left(\frac{p}{q}\right)^2 + \left(\frac{q}{p}\right)^2$$

$$= \left(\frac{p}{q} + \frac{p}{q}\right)^2 - 2$$

$= (9)^2 - 2 = 81 - 2 = 79$

[MCQ]

Q.4. The number of coins of ₹21, ₹25, and ₹10 denominations that a person has are in the ratio 5:3:13. Of the total amount, the percentage of money in ₹25 coins is

(a) 21% (b) 30%

(c) 10% (d) $14\frac{2}{7}\%$

Sol. **(c)**

Number of coins = 5 : 3 : 13

($C_1 : C_5 : C_{10}$)

So money in the ratio = 5 : 15 : 130 i.e.

C_1 = 5krs, C5 = 15rs, C_{10} = 130k

Total money = 5k + 15k + 130k = 150k

Now 15k rs is how much % of 150k?

Let it is x then $15k = \frac{x}{100} \times 150k$

$\Rightarrow x = \frac{1500}{150} = 10\%$

[MCQ]

Q.5. A rectangular paper sheet of dimensions 54 cm × 4 cm is taken. The two longer edges of the sheet are joined together to create a cylindrical tube. A cube whose surface area is equal to the area of the sheet is also taken.

Then, the ratio of the volume of the cylindrical tube to the volume of the cube is_____.

(a) $\frac{3}{\pi}$ (b) $\frac{1}{\pi}$

(c) $\frac{4}{\pi}$ (d) $\frac{2}{\pi}$

Sol. **(b)**

A cube

$54 \times 4 = 6a^2$

$a^2 = \frac{\cancel{54}^{15} \times \cancel{4}^{2}}{\cancel{6}_{1}} = 36, \quad a = 6$

Now, $2\pi r = 4$

$r = \frac{2}{\pi}$

height = 54

volume of cylinder = $\frac{1}{3} \times \pi \times r^2 \times h$

volume of cube = a^3

Ratio of the volume of the cylindrical tube to the volume of the cube is

$= \frac{1}{3} \times \pi \times r^2 \times h \times \frac{1}{a^3} = \frac{\pi \times \frac{4}{\pi^2} \times 54}{216} = \frac{1}{\pi} = 0.318$ approx.

[MCQ]

Q.6. If two distinct non-zero real variables x and y are such that (x + y) is proportional to (x – y) then the value of $\frac{x}{y}$

(a) is a constant

(b) depends only on y and not on x

(c) depends only on x and not on y

(d) depends on xy

Sol. **(a)**

$x + y \propto x - y$

or $x + y = k(x - y)$

$(1 - k)x = (-k - 1) \Rightarrow$

$\frac{x}{y} = 1 - \frac{k-1}{1-k} =$ constant.

[MCQ]

Q.7. If →' denotes increasing order of intensity, then the meaning of the words [dry → arid → parched] is analogous to [diet → fast →' _____]. Which one of the given options is appropriate to fill the blank?

(a) feast (b) deny
(c) starve (d) reject

Sol. **(c)**

Dry → Arid → Parched?

Dry → Very Dry →Completely dry.

Diet → Fast → ?

diet - a well scheduled food time table

fast - skipping meal for any cause

[MCQ]

Q.8. In the given text, the blanks are numbered (i)-(iv). Select the best match for all the blanks.

Steve was advised to keep his head ___(i)___ before heading ___(ii)___ to bat; for, while he had a head ___(iii)___ batting, he could only do so with a cool head ___(iv)___ his shoulders.

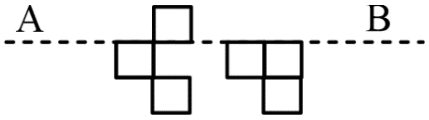
(a) (i) on (ii) down (iii) for (iv) on
(b) (i) down (ii) down (iii) on (iv) for
(c) (i) down (ii) out (iii) for (iv) on
(d) (i) on (ii) out (iii) on (iv) for

Sol. **(c)**

(i) down (ii) out (iii) for (iv) on

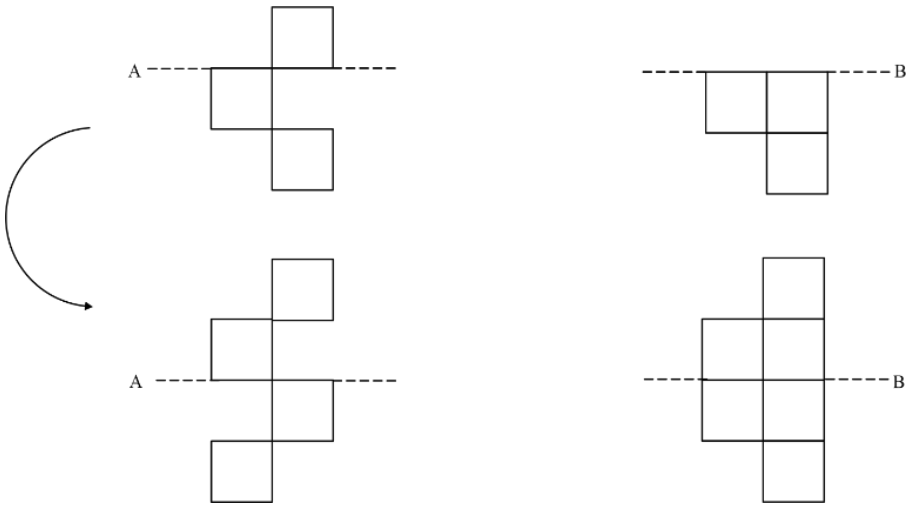
[MCQ]

Q.9. The least number of squares to be added in the figure to make AB a line of symmetry is



(a) 6 (b) 5
(c) 4 (d) 7

Sol. **(a)**



So least number os squares added = 6

[MCQ]

Q.10. Consider the following sample of numbers:

9, 18, 11, 14, 15, 17, 10, 69, 11, 13

The median of the sample is

(a) 14 (b) 13.5

(c) 11 (d) 18.7

Sol. **(b)**

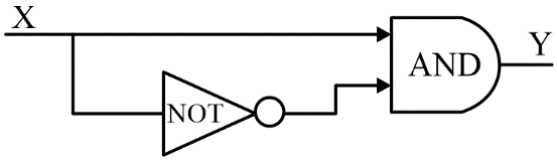
Given numbers are arranged in ascending order 9, 10, 11, 11, 13, 14, 15, 17, 18, 69

Number of observations = 10 so, the middle numbers are 13 and 14.

Thus, the median = $\frac{13+14}{2} = 13.5$.

[MSQ]

Q.1. Consider the circuit shown below where the gates may have propagation delays. Assume that all signal transitions occur instantaneously and that wires have no delays. Which of the following statements about the circuit is/are CORRECT?



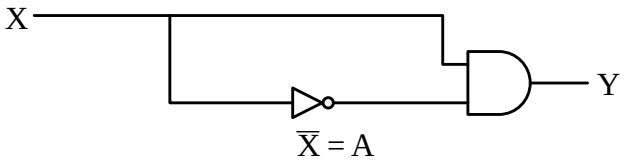
(a) With propagation delays, the output Y can have a transient logic Zero after X transitions from logic One to logic Zero

(b) With no propagation delays, the output Y is always logic One

(c) With no propagation delays, the output Y is always logic Zero

(d) With propagation delays, the output Y can have a transient logic One after X transitions from logic Zero to logic One

Sol. **(c, d)**



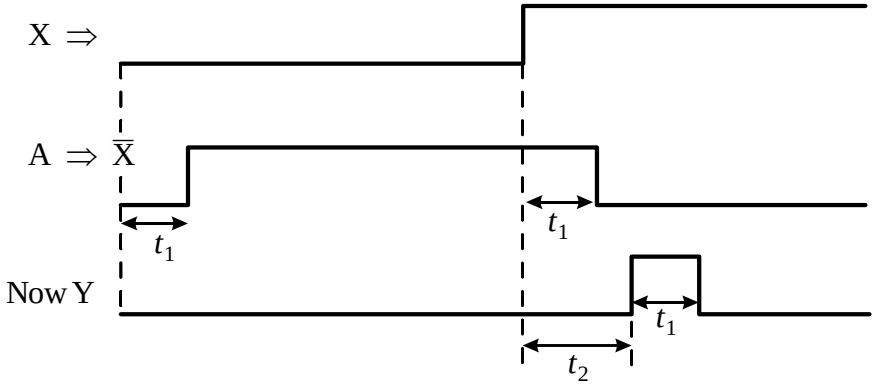
Case-I : When delay is zero.

Then Y will always be $X \cdot A = X \cdot \overline{X} = 0$ for any value of X (i.e. $X = 0$ or $X = 1$).

Case-II : When delay is non-zero then : Let us assume that delay of Not gate is t_1 and delay of AND gate is t_2.

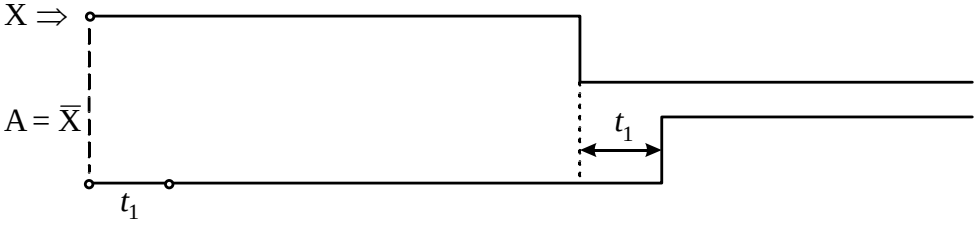
$[t_2 > t_1]$

Let us take the case when X = 0 for long time and taking transition from 0 to 1 →



So, if X is changing from 0 to 1 then there will be transient of '1' duration t_1.

If we take the case when X = 1 for a long time and taking transition for 1 to 0 →



Now, Y = 0 always

- With no propagation delays, the output Y is always logic Zero
- With propagation delays, the output Y can have a transient logic One after X transitions from logic Zero to logic One.

[MSQ]

Q.2. Which of the following statements about a relation R in first normal form (INF) is/are TRUE?

(a) R cannot have a foreign key
(b) R can have a multi-attribute key
(c) R cannot have more than one candidate key
(d) R cannot have a composite attribute

Sol. **(b, d)**

A relation R in INF can have multi-attribute key. While it can have a foreign key, can have more than one candidate key and also composite key.

Relation not in 1NF if it has composite or multivalued attributes.

[MCQ]

Q.3. Given an integer array of size N, we want to check if the array is sorted (in either ascending or descending order). An algorithm solves this problem by making a single pass through the array and comparing each element of the array only with its adjacent elements. The worst-case time complexity of this algorithm is

(a) neither O(N) nor Ω(N)
(b) both O(N) and Ω(N)
(c) Ω(N) but not O(N)
(d) O(N) but not Ω(N

Sol. **(b)**

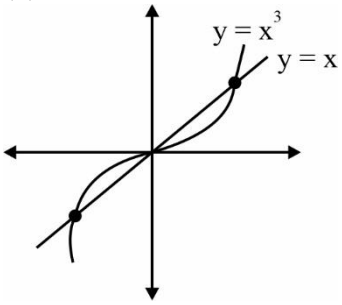
The above array can be sorted using bubble sort, which will take one iteration is it will take O(n), Ω(n) which is θ(n).

[MCQ]

Q.4. Let f: R → R be a function such that $f(x) = \max\{x, x^3\}$, $x \in \square$, where $\square$ is the set of all real numbers. The set of all points where f(x) is NOT differentiable is

(a) {–2, –1, 1}
(b) {–1, 0, 1}
(c) {–1, 1, 2}
(d) {0, 1}

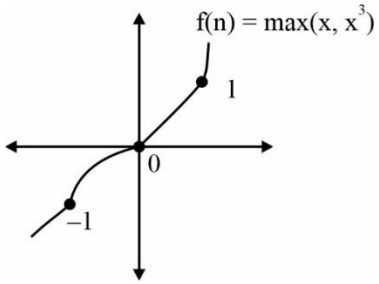
Sol. **(b)**



Putting $x^3 = x$

$x(x^2 - 1) = 0$

$x = 0, -1, 1$



So we have three sharp points at x = –1, 0, 1. so, these are non-differentiable points.

$$\text{M-IF} \rightarrow f(x) = \max\{x, x^3\} = \begin{cases} x & ; n < -1 \\ x^3 & -1 < n < 0 \\ x & ; 0 < x < 1 \\ x^3 & , n > 1 \end{cases}$$

$$f'(x)\begin{cases} 1 & ; n < -1 \\ 3x^3 & -1 < n < 0 \\ x & ; 0 < x < 1 \\ 3x^3 & , n > 1 \end{cases}$$

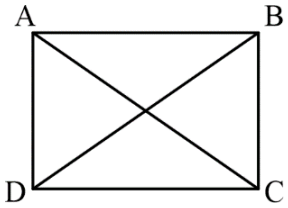
∵ at n = –1, 0 and 1, LHD ≠ RHD so all three points are non-differentiable points.

[NAT]

Q.5. The number of spanning trees in a complete graph of 4 vertices labelled A, B, C and D is ____.

Sol. **(16 to 16)**

The number of spanning tree with n node of a complete graph = n^{n-2}.



Here n = 4

Number of spanning tree = $4^{4-2} = 4^2 = 16$

[MSQ]

Q.6. Let A and B be two events in a probability space with P(A) = 0.3, P(B) = 0.5, and P(A ∩ B) = 0.1, Which of the following statements is/are TRUE

(a) The two events A and B are independent

(b) P(A ∪ B)=0.7

(c) $P(A \cap B^c) = 0.2$. where B^c is the complement of the event B

(d) $P(A^c \cap B^c) = 0.4$, where A^C and B^C are the complements of the events A and B. respectively

Sol. **(b, c)**

1. A and B are true events ⇒ P(A) = 0.3

P(A) = 0.3

P(B) = 0.5

P(A ∩B) = 0.1

$P(A \cap B) = 0.1 \neq P(A \times P(B) = 0.3 \times 0.5 = 0.15$

Thus they are not independent.

Option b: $P(A \cup B) = 0.7$

$P(A \cup B) = P(A) + P(B) - P(A \cap B)$

$= 0.3 + 0.5 - 0.1 = 0.7$

So, option b is correct.

Option c: $P(A \cap B^c) = 0.2$

$P(A \cap B^c) = P(A - B) = P(\text{only A}) = 0.2$

From Above venn diagram it is clear that this is True.

So, option c is correct.

Option d: $P(A^c \cap B^c) = 0.4$

$P(A^c \cap B^c) = P\left((A \cup B)^c\right) = 1 - P(A \cup B)$

From venn diagram it is clear that this value is 0.3 not 0.4.

This statement is False.

So, option d is incorrect.

[MSQ]

Q.7. Which of the following fields is/are modified in the IP header of a packet going out of a network address translation (NAT) device from an internal network to an extemal network?

(a) Header Checksum
(b) Source IP
(c) Destination IP
(d) Total Length

Sol. **(a, b)**

For outgoing packet at NAT device.
1. Private IP will be replaced by Public IP in the Source IP field.
2. Destination IP is not changed. (Decided by Source Host Only)
3. New Header Checksum evaluated as modification in Source IP field.
4. Total Length field is remained same. (Decided by source only)

[MSQ]

Q.8. Consider a 5-stage pipelined processor with Instruction Fetch (IF). Instruction Decode (ID), Execute (EX). Memory Access (MEM), and Register Writeback (WB) stages. Which of the following statements about forwarding is/are CORRECT?

(a) In forwarding. data from the output of the MEM stage can be passed on to the input of the EX stage of the next instruction
(b) Forwarding cannot prevent all pipeline stalls
(c) In a pipelined execution, forwarding means the result from a source stage of an earlier instruction is passed on to the destination stage of a later instruction
(d) Forwarding does not require any extra hardware to retrieve the data from the pipeline stages

Sol. **(a, b, c)**

(a) MEM can load data from memory and can be forwarded directed to ALU in EX phase
(b) Forwarding can only prevent only some type of dependencies of RAW pipeline hazards
(c) It is the definition of forwarding

[NAT]

Q.9. Consider the operator precedence and associativity rules for the integer arithmetic operators given in the table below.

Operator	Precedence	Associativity
+	Highest	Left
–	High	Right
×	Medium	Right
/	Low	Right

The value of the expression 3 + 1 + 5 × 2/7 + 2 – 4 – 7 – 6/2 as per the above rules is_____.

Sol. **(6)**

$$3+1+5\times\frac{2}{7}+2-4-7-\frac{6}{2}$$

$$4+5\times\frac{2}{7}+2-4-7-\frac{6}{2}$$

$$9 \times \frac{2}{7} + 2 - 4 - 7 - \frac{6}{2}$$

$$9 \times \frac{2}{9} - 4 - 7 - \frac{6}{2}$$

$$9 \times \frac{2}{9} - 4 - \frac{1}{2}$$

$$9 \times \frac{2}{9} - \frac{3}{2}$$

$$9 \times 2 \times \frac{6}{2}$$

$$18 \times \frac{6}{2}$$

$$\frac{18}{3} = 6$$

[MCQ]

Q.10. The product of all eigenvalues of the matrix $\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$ is

(a) 1 (b) –1
(c) 2 (d) 0

Sol. **(d)**

Product of eigen values = determinate of the matrix $\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix} = A$

$$|A| = \begin{vmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{vmatrix}$$

$R_3 \rightarrow R_3 \rightarrow R_2$

$R_2 \rightarrow R_2 \rightarrow R_1$

$$\begin{vmatrix} 1 & 2 & 3 \\ 3 & 3 & 3 \\ 3 & 3 & 3 \end{vmatrix}$$

The determinant of A is 0, thus, the product of eigen values is 0.

[MCQ]

Q.11. Consider a system that uses 5 bits for representing signed integers in 2's complement format. In this system, two integers A and B are represented as A = 1010 and B = 11010 Which one of the following operations will result in either an arithmetic overflow or an arithmetic underflow?

(a) A – B (b) B – A
(c) A + B (d) 2 × B

Sol. **(a)**

Since 2's complement is used

A = 01010 $\Rightarrow$ 10

B = 11010 ⇒ –6

Since 5 bits are used here

So range is – 16 to 15

So A – B i.e 16 is outside the range

[MCQ]

Q.12. Consider the following C program:

```
#include <stdio.h>
void fX() {
int main()
        fx ();
        return 0;}
void fX();
        char a;
if((a-getchar()) != '\n')
        fX();
if(a != '\n')
        putchar(a); }
```

Assume that the input to the program from the command line is 1234 followed by a newline character. Which one of the following statements is CORRECT

(a) The program will terminate with no output

(b) The program will not terminate

(c) The program will terminate with 4321 as output

(d) The program will terminate with 1234 as output

Sol. **(c)**

Sting

1	2	3	4	/0

The fx() function will check the string until it reaches the end or NULL character. Once, the function reaches end of the string it will start printing it in reverse order. So, we can say that fx() function simply prints the reverse of given string. Hence it will print 4, 3, 2, 1 as output and program will terminate.

So, option (c) is the correct answer.

[NAT]

Q.13. Let A and B be non-empty finite sets such that there exist one-to-one and onto functions (i) from A to B and (ii) from A × A to A ∪ B. The number of possible values of [A] is____.

Sol. **(2 to 2)**

The number of possible values of |A| is 2.

[MSQ]

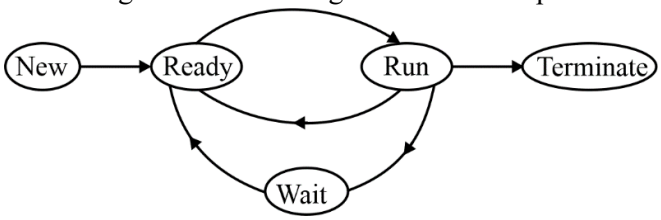
Q.14. Which of the following process state transition is/are NOT possible?

(a) Ready to waiting (b) Running to Ready

(c) Running to Terminated (d) Waiting to Running

Sol. **(a, d)**

The process state diagram the following transitions take place.



Transition Ready to wait is not possible and wait to run is not possible.

[MCQ]

Q.15. In a B+ tree, the requirement of at least half-full (50%) node occupancy is relaxed for which one of the following cases?

(a) All leaf nodes (b) Only the root node

(c) All internal nodes (d) Only the leftmost leaf node

Sol. **(b)**

In a B^+ tree at least half full (50%) node occupancy is relaxed for only the root node.

[MSQ]

Q.16. Which of the following is/are Bottom-Up Parser(s)?

(a) LL(1) Parser (b) Predictive Parser

(c) Shift-reduce Parser (d) LR Parser

Sol. **(c, d)**

Top down = LR parser and SR Parser

Bottom up = LL(1) and predictive.

[MCQ]

Q.17. Consider the following C program:

```
#include <stdio.h>
int main() {
    int a = 6
    int b = 0
    while (a < 10) {
      a = a / 12 + 1
      a+= b; }
    printf("%d", a);
```

return 0; }

Which one of the following statements is CORRECT?

(a) The program gets stuck in an infinite loop
(b) The program prints 9 as output
(c) The program prints 10 as output
(d) The program prints 6 as output

Sol. **(a)**

$a = \boxed{\not{6}}1$

$b = \boxed{0}$

$6 < 12$ I[st] iteration

$$a = \frac{6}{12} + 1$$

$a = 0 + 1 = 1$

$a = a + b = 1 + 0 = 1$

II[nd] iteration

$1 < 10$

$$a = \frac{1}{12} + 1 = 0 + 1 = 1$$

$a = a + b = 1 + 0 = 1$

Now In every iteration a value will come out to be 1____1

Hence, program get stuck is an infinite loop.

[MCQ]

Q.18. Consider a permutation sampled uniformly at random from the set of all permutations of {1, 2, 3,..., n} for some n ≥ 4. Let X be the event that 1 occurs before 2 in the permutation, and Y the event that 3 occurs before 4. Which one of the following statements is TRUE?

(a) Event X is more likely than event Y
(b) The events X and Y are independent
(c) The events X and Y are mutually exclusive
(d) Either event X or Y must occur

Sol. **(b)**

1 2 3 4 = x , y	3 1 2 4 = x, y
1 2 4 3 = x	3 1 4 2 = x,y
1 3 2 4 = x, y	3 2 1 4 = y
1 3 4 2 = x, y	3 2 4 1 = y
1 4 2 3 = x	3 4 1 2 = x, y
1 4 2 3 = x	3 4 2 1 = y
2 1 3 4 = y	4 1 2 3 = x
2 1 4 3 = .	4 1 2 3 = x
2 3 1 4 = y	4 2 3 1 =
2 3 4 1 = y	4 2 1 3 =

2 4 1 3 = 4 3 1 2 = x
2 4 3 1 = 4 3 2 1

$P(x)=\frac{12}{24}, P(y)=\frac{12}{24}, P(x \cap y)=\frac{6}{24}$

$\because P(\cap y) = P(x) \cdot P(x) \cdot P(y)$ so Ind.

[MSQ]

Q. 19. TCP client P successfully establishes a connection to TCP server Q. Let N_p denote the sequence number in the SYN sent from P to Q. Let N_Q denote the acknowledgement number in the SYN ACK from Q to P. Which of the following statements is/are CORRECT?

(a) The sequence number N_p is always 0 for a new connection

(b) The acknowledgement number N_Q is equal to $N_p + 1$

(c) The sequence number N_p is chosen randomly by P

(d) The acknowledgement number N_Q is equal to N_p

Sol. **(b, c)**

Nq = Np + 1

Np : chosen randomly to prevent some kind of attacks.

[NAT]

Q. 20. Consider the following two relations, R(A, B) and S(A, C):

	R
A	B
10	20
20	30
30	40
30	50
50	94

S	
A	C
10	90
30	45
40	80

The total number of tuples obtained by evaluating the following expression $\sigma_{B<C}(R \bowtie_{R.A = S.A} S)$ is_____.

Sol. **(2)**

$\sigma_{B<C}(R \bowtie_{R.A = S.A} S)$ is nateral join

Hence, tuples selected will be

A	B	A	C
10	20	10	30
30	40	30	45
30	50	30	45

Now, from here select B < C

Hence, tuples selected will be

A	B	A	C
10	20	10	30
30	40	30	45

[MCQ]

Q.21. A user starts browsing a webpage hosted at a remote server. The browser opens a single TCP connection to fetch the entire webpage from the server. The webpage consists of a top-level index page with multiple embedded image objects. Assume that all caches (e.g., DNS cache, browser cache) are all initially empty. The following packets leave the user's computer in some order.

(i) HTTP GET request for the index page
(ii) DNS request to resolve the web server's name to its IP address
(iii) HTTP GET request for an image object
(iv) TCP SYN to open a connection to the web server

Which one of the following is the CORRECT chronological order (earliest in time to latest) of the packets leaving the computer?

(a) (iv), (ii), (iii), (i)
(b) (ii), (iv), (i), (iii)
(c) (iv), (ii), (i), (iii)
(d) (ii), (iv), (iii), (1)

Sol. **(b)**

(i) DNS request to resolve the web server's name to its IP address
(ii) TCP SYN to open a connection to the web server
(iii) HTTP GET request for the index page
(iv) HTTP GET request for an image object

[MCQ]

Q.22. Which one of the following statements is FALSE?

(a) In the cycle stealing mode of DMA, one word of data is transferred between an I/O device and main memory in a stolen cycle
(b) The CPU can start executing an interrupt service routine faster with vectored interrupts than with non-vectored interrupts
(c) For bulk data transfer, the burst mode of DMA has a higher throughput than the cycle stealing mode
(d) Programmed I/O mechanism has a better CPU utilization than the interrupt driven I/O mechanism

Sol. **(d)**

(a) Cycle stealing mode of DMA, in one cycle one prepared word is transferred from IO to memory
(b) When non-vectored interrupts are received then CPU take some extra time to explore the situation and then start service of interrupt
(c) In burst mode bulk data is transferred together
(d) To improve the performance of CPU programmed IO is replaced interrupt IO

[MSQ]

Q.23. Let L_1, L_2 be two regular languages and L_3 a language which is not regular. Which of the following statements is/are always TRUE?

(a) $\overline{L_1} \cup \overline{L_2}$ is regular

(b) $L_1 = L_2$ if and only if $L1 \cap \overline{L_2} = \phi$

(c) $L_1 \cup L_3$ is not regular

(d) $\overline{L_3}$ is not regular

Sol. **(a, d)**

L_1 = Regular

L_2 = Regular

L_3 = Non- Regular

(a) $\overline{L_1} \cup \overline{L_2} = \overline{Reg} \cup \overline{Reg} = Reg$

(b) $\overline{\text{Non-reg}}$ = Non -regular.

(c) if and only if given so, false

(d) $L_1 \cup L_3$ Can be regular.

[MSQ]

Q.24. Which of the following statements about threads is/are TRUE?

(a) Threads can only be implemented in kernel space

(b) All the threads belonging to a process share a common stack

(c) Threads belonging to a process are by default not protected from each other

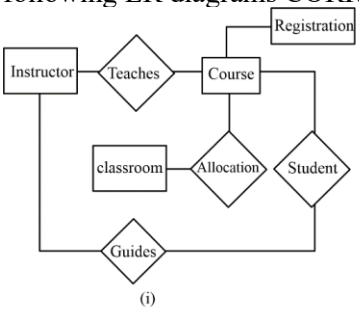
(d) Each thread has its own file descriptor table for open files

Sol. **(c)**

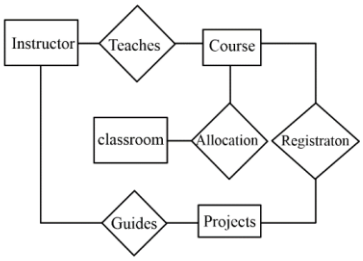
Thread belonging to a process are by default not protected each other: **True.**

[MCQ]

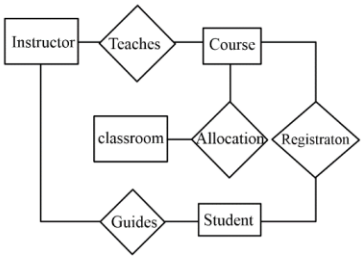
Q.25. Let S be the specification: "Instruction teach course. Students regions for courses, Courses are allocated classrooms. Instruction guide students." Which one of the following ER diagrams CORRECTLY represents S?



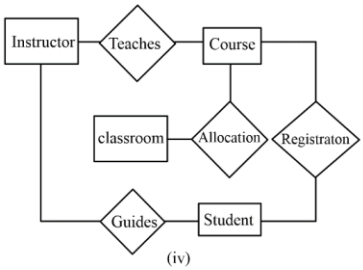
(i)



(ii)



(iii)



(iv)

(a) (iv) (b) (iii)
(c) (i) (d) (ii)

Sol. **(a)**

In option (i): Student should be an entity not a relation (◊) so it is incorrect.
In option (ii): No student entity set exists in fact an entity named "project" exists which is not mentioned in the question specification.
In option (iii): There exists no relationship set between course and classroom, hence it is incorrect.
In option (iv): Depicts the correct representation of given specification in the question.

[MCQ]

Q.26. Consider a network path P-Q-R between nodes P and R via router Q. Node P sends a file of size 10 bytes to R via this path by splitting the file into chunks of 103 bytes each. Node P sends these chunks one after the other without any wait time between the successive chunk transmissions. Assume that the size of extra headers added to these chunks is negligible, and that the chunk size is less than the MTU.

Each of the links P-Q and Q-R has a bandwidth of 10 bits/sec, and negligible propagation latency. Router Q immediately transmits every packet it receives from P to R. with negligible processing and queueing delays. Router Q can simultaneously receive on link P-Q and transmit on link Q-R.

Assume P starts transmitting the chunks at time t = 0. Which one of the following options gives the time (in seconds. rounded off to 3 decimal places) at which R receives all the chunks of the file?

(a) 15.992 (b) 16.000
(c) 8.008 (d) 8.000

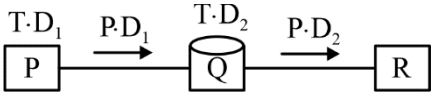
Sol. **(c)**

Given that, file size = 10^6bytes

Packet size = 10^3 bytes

$$\text{Number of packets} = \frac{10^6}{10^3} = 10^3 = 1000$$

Band width = 10^6 bits/sec



TD_1 = Transition delay at sender, P

PD_1 = Propagation delay between P and Q

$T{\cdot}D_2$ = Transition delay at router, Q

$P{\cdot}D_2$ = Propagation delay from Q to R.

Given, Propagation, processing, Queuing delays neglected for 1 packet. Total time to reach 'R' is $TD_1 + TD_2 = 2{\cdot}TD$

Transition delay of 1 packet $= \frac{\text{Packet size}}{\text{Band width}} = \frac{1000 \text{ bytes}}{10^6 \text{ bits / sec}}$

$= \frac{1000 \times 8 \text{ bits}}{10^6 \text{ bits / sec}} = 8\text{m sec}$

Packet total time = 8 + 8 = 16 msec

Time for file = 16 + (1000 – 1)8 = 16 + 999 × 8 = 8008m = 8.008sec

[MSQ]

Q.27. Consider the following read-write schedule S over three transactions T_1, T_2 and T_3 where the subscripts in the schedule indicate transaction IDs:

S:$r_1(z)$; $w_1(z)$; $r_2(x)$; $r_3(y)$; $w_3(y)$; $r_2(y)$; $w_2(x)$; $w_2(y)$;

Which of the following transaction schedules is/are conflict equivalent to S?

(a) $T_1T_3T_2$ (b) $T_1T_2T_3$

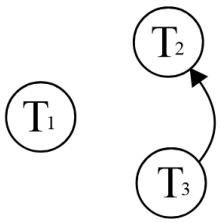
(c) $T_3T_1T_2$ (d) $T_3T_2T_1$

Sol. **(a, c, d)**

Given schedule

S: $r_1(z)$; $w_1(z)$; $r_2(x)$; $r_3(y)$; $w_3(y)$; $r_2(y)$; $w_2(x)$; $w_2(y)$

T_1	T_2	T_3
r(z)		
	r(x)	
		r(y)
		W(y)
	r(y)	
	w(x)	
	w(y)	



Order possible T_3 T_2 T_1 and T_1 T_3 T_2 and T_3 T_1 T_2

[MSQ]

Q.28. Consider two set-associative cache memory architectures: WBC, which uses the write back policy, and WTC. which uses the write through policy. Both of them use the LRU (Least Recently Used) block replacement policy. The cache memory is connected to the main memory. Which of the following statements is/are TRUE?

(a) A write miss in WTC always writes the victim cache block to main memory before loading the missed block to the cache

(b) A write hit in WBC can modify the value of the dirty bit of a cache block

(c) A read miss in WBC never evicts a dirty block

(d) A read miss in WTC never triggers a write back operation of a cache block to main memory

Sol. **(b, d)**

(a) In write through cache the victim block is replaced directly from cache, write back is not needed. Because there is no any inconsistency of data between cache and main memory

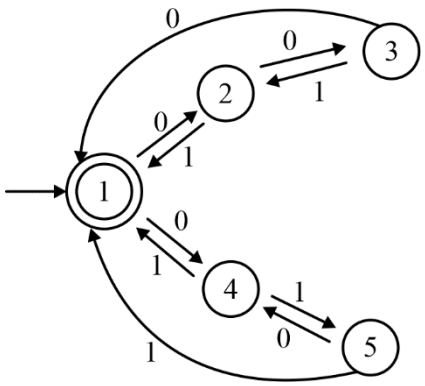
(b) Write back cache has dirty data hence writing in cache leads to dirty bit modification

(c) Read or write miss can make write back cache having a block from main memory to cache and hence replacing a block from cache

(d) Write through cache does not require write back

[MSQ]

Q.29. Consider the 5-state DFA M accepting the language L(M) ⊂ subset (0 + 1) * shown below. For any string w ∈ (0 + 1)* let n_0 (w) be the number of 0's in w and n_1 (w) be the number of 1's in w.



Which of the following statements is/are FALSE?

(a) States 2 and 4 are distinguishable in M

(b) States 2 and 5 are distinguishable in M

(c) Any string W with n_0 (w) = n_1 (w) is in L(M)

(d) States 3 and 4 are distinguishable in M

Sol. **(b, d)**

(a)	States 2 and 4 are distinguishable in M	**True**
(b)	States 2 and 5 are distinguishable in M	**False**
(c)	Any string W with n_0 (w) = n_1 (w) is in L(M)	**False**
(d)	States 3 and 4 are distinguishable in M	**True**

[NAT]

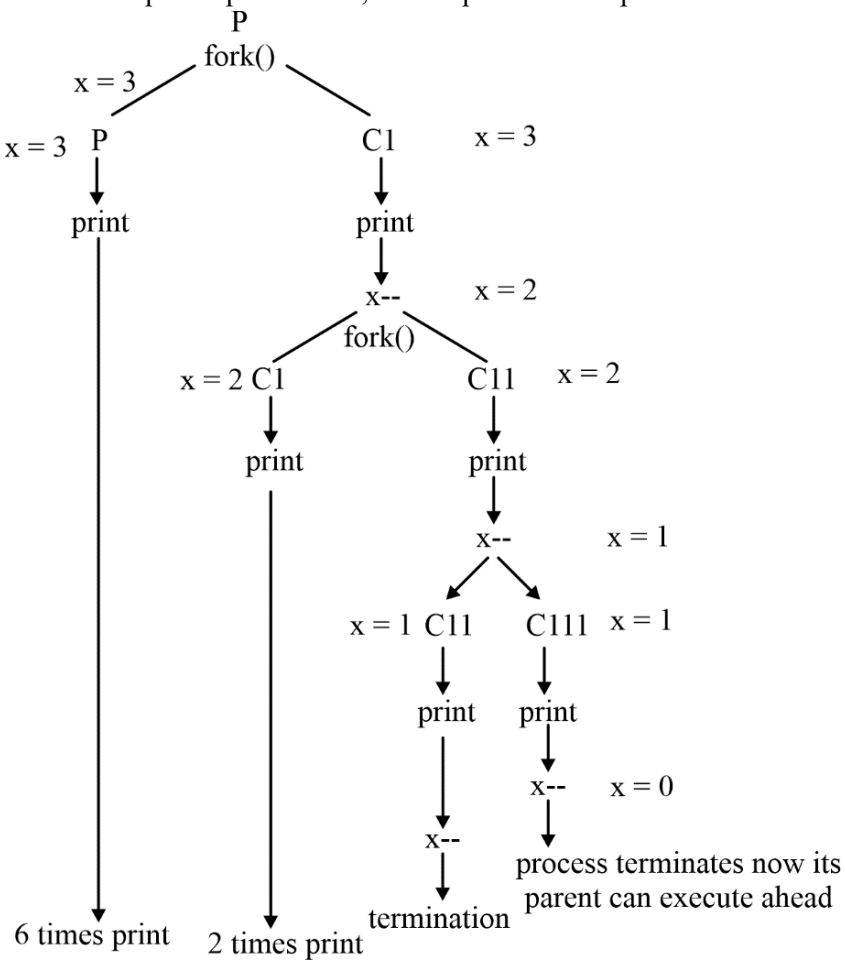
Q.30. Consider the following code snippet using the fork() and wait() system calls. Assume that the code compiles and runs correctly, and that the system calls run successfully without any errors.

```
int x = 3 ;
while (x > 0) {
        fork();
        printf("hello");
        wait (NULL);
        x--;
    }
```

The total number of times the printf statement is executed is _____

Sol. **(14)**

Let assume parent process is P, let C represent child process.



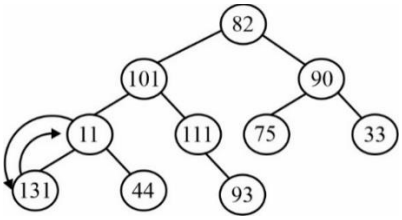
[MCQ]

Q.31. An array [82, 101, 90, 11, 111, 75, 33, 131, 44, 93] is heapified. Which one of the following options represents the first three elements in the heapified array?

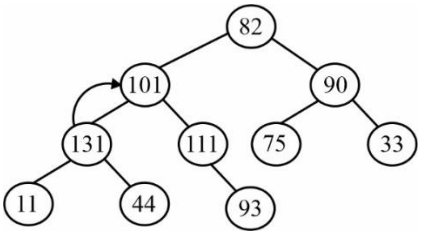
(a) 131, 11, 93 (b) 131, 111, 90

(c) 82, 11, 93 (d) 82, 90, 101

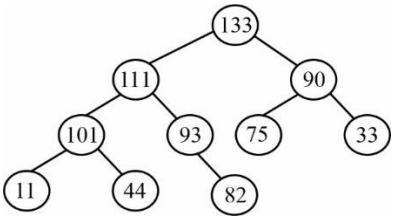
Sol. **(b)**



Lets heapify above tree. As heapify start from non-leaf node (93).



After heapify tree will look like



∴ option (b) is correct.

[MCQ]

Q.32. Consider the following grammar G, with S as the start symbol. The grammar G has three incomplete productions denoted by (1), (2), and (3).

$S \rightarrow daT \mid \underline{(1)}$

$T \rightarrow aS \mid bT \mid \underline{(2)}$

$R \rightarrow \underline{(3)} \mid \in$

The set of terminals is {a, b, c, d, f}. The FIRST and FOLLOW sets of the different non-terminals are as follows.

FIRST(S)= {c, d, f}, FIRST(T) = {a, b, ∈), FIRST(R) = {C, E}

FOLLOW(S) = FOLLOW(T) = {c, f, $}, FOLLOW(R) = {f}

Which one of the following options CORRECTLY fills in the incomplete productions?

(a) (1) $S \rightarrow Rf$ (2) $T \rightarrow \in$ (3) $R \rightarrow cTR$

(b) (1) $S \rightarrow fR$ (2) $T \rightarrow cT$ (3) $R \rightarrow cR$

(c) (1) $S \rightarrow fR$ (2) $T \rightarrow \in$ (3) $R \rightarrow cTR$

(d) (1) $S \rightarrow Rf$ (2) $T \rightarrow cT$ (3) $R \rightarrow cR$

Sol. **(a)**

Correct sequence is S → Rf, T → ∈, R → cTR

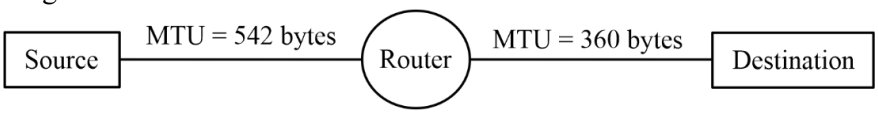
all follow and first are satisfied.

[NAT]

Q.33. Consider sending an IP datagram of size 1420 bytes (including 20 bytes of IP header) from a sender to a receiver over a path of two links with a router between them. The first link (sender to router) has an MTU (Maximum Transmission Unit) size of 542 bytes, while the second link (router to receiver) has an MTU size of 360 bytes. The number of fragments that would be delivered at the receiver is _____

Sol. **(6 to 6)**

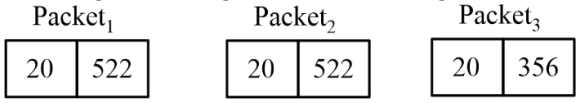
Fragments = 6



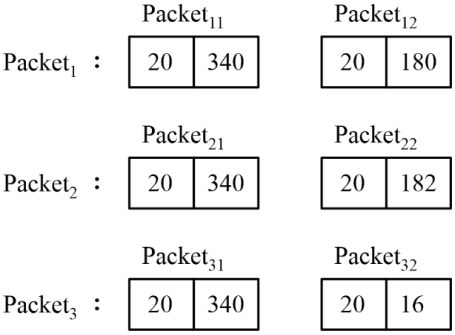
IP Datagram size = 1420 bytes

Header size = 20 bytes Payload size = 1400 bytes

- Due to 542 bytes MTU Maximum payload size can be 522 bytes
- IP Datagram is fragmented into 3 fragments.



- Due to 360 bytes MTU maximum payload size can be 340 bytes
- Each IP datagram is fragmented according.



[MCQ]

Q.34. Consider a binary min-heap containing 105 distinct elements. Let k be the index (in the underlying array) of the maximum element stored in the heap. The number of possible values of k is

(a) 52 (b) 27

(c) 1 (d) 53

Sol. **(d)**

There are 105 distinct elements,

MIN heap is given, there is K index which is of maximum element.

Number of leafs = $\left\lceil \frac{105}{2} \right\rceil = \lceil 52.2 \rceil = 53$

[MSQ]

Q.35. Consider a Boolean expression given by $F(X, Y, Z) = \sum(3,5,6,7)$.

Which of the following statements is/are CORRECT?

(a) $F(X, Y, Z)$ is independent of input X

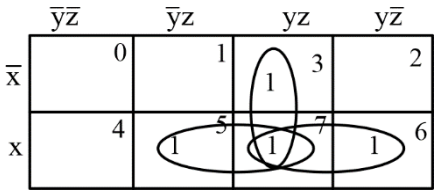
(b) $F(X, Y, Z) = XY + YZ + XZ$

(c) $F(X, Y, Z)$ is independent of input Y

(d) $F(X, Y, Z) = \pi(0, 1, 2, 4)$

Sol. **(b, d)**

The k-map for given function $F(X, Y, Z) = \sum(3,5,6,7)$ is as follows:



$F(X, Y, Z) = xz + xy + yz.$

And POS form of $F(X, Y, Z) = \pi(0, 1, 2, 4)$.

[NAT]

Q.36. Consider the entries shown below in the forwarding table of an IP router. Each entry consists of an IP prefix and the corresponding next hop router for packets whose destination IP address matches the prefix. The notation "TN" in a prefix indicates a subnet mask with the most significant N bits set to 1.

Prefix	Next hop router
10.1.1.0/24	R1
10.1.1.128/25	R2
10.1.1.64/26	R3
10.1.1.192/26	R4

Tins router forwards 20 packets each to 5 hosts. The IP addresses of the hosts are 10.1.1.16. 10.1.1.72. 10.1.1.132. 10.1.1.191. and 10.1.1.205 . The number of packets forwarded via the next hop router R2 is

Sol. **(40)**

- Router forwarded 20 packets to each hosts
- Number of packets forwarded via the next hop router R_2 = ?

(i) **$Host_1$ IP: 10.1.1.16**

Net ID when masked with 25 bit netmask = 10.1.1.0

Packets to $host_1$ is not forwarded via R_2.

(ii) **$Host_2$ IP: 10.1.1.72**

Net ID when masked with 25 bit netmask = 10.1.1.0

Packets to $host_2$ is not forwarded via R_2

(iii) **$Host_3$ IP : 10.1.1.132**

Net ID when masked with 25 bit netmask = 10.1.1.128

Net ID when masked with 26 bit netmask = 10.1.1.128

Packets to $Host_3$ is forwarded via R_2

(iv) **$Host_4$ IP: 10.1.1.191**

Net ID when masked with 25 bit netmask = 10.1.1.128

Net ID when masked with 26 bit netmask = 10.1.1.128

Packets to $Host_4$ is forwarded via R_2.

(v) **$Host_5$ IP: 10.1.1.128**

Net ID when masked with 25 bit netmask = 10.1.1.128

Net ID when masked with 26 bit netmask = 10.1.1.192

Packets to $host_5$ is forwarded via R_4

Router will choose more specific option over generic.

[20 packets $host_3$ + 20 packet $host_5$]

: 40 packets via R_2

[MCQ]

Q.37. Consider the following recurrence relation:

$$T(n) = \begin{cases} \sqrt{n}\,T\left(\sqrt{n}\right) + n & \text{for } n \geq 1, \\ 1 & \text{for } n = 1 \end{cases}$$

Which of the following option is CORRECT?

(a) $T(n) = \Theta(n \log \log n)$

(b) $T(n) = \Theta(n \log n)$

(c) $T(n) = \Theta(n^2 \log \log n)$

(d) $T(n) = \Theta(n^2 \log n)$

Sol. **(a)**

$$T(n) = \sqrt{n} \cdot T\left(\sqrt{n}\right) + n$$

$n = 1$

$$T(n) = \sqrt{n} \cdot T\left(\sqrt{n}\right) + n \quad .....(1)$$

$= n^{1/2} \cdot T\left(n^{1/2}\right) + n$ .....(1)

$T\left(n^{1/2}\right) = n^{1/4} \cdot T\left(n^{1/4}\right) + n\,1/2$ .....(2)

Sub (2) in (1)

$T(n) = n^{1/2}\left(n^{1/4} \cdot T\left(n^{1/4} + n^{1/2}\right)\right) + n$

$= n^{3/4} \cdot T\left(n^{1/4}\right) + 2n$....(3)

$= n^{1-1/2^2} \cdot T\left(n^{1/2^2}\right) + 2n$....(4)

$= n^{1-1/2^k} \cdot T\left(n^{1/2^k}\right) + k \cdot n$

$= \frac{n}{n^{1/2^k}} \cdot T\left(n^{1/2^k}\right) + k \cdot n$

$= \frac{n}{2} \cdot T(1) + n \log\log n$

$= \theta(n \log \log n)$

[NAT]

Q.38. Consider a 512 GB hard disk with 32 storage surfaces. There are 4096 sectors per track and each sector holds 1024 bytes of data. The number of cylinders in the hard disk is

Sol. **(4096)**

Disk size = number of surfaces × number of tracks per surface × number of sectors per track × sector

512 GB = 32 × tracs × 4096 × 1024B

$2^9 \times 2^{30}$ B = 2^5 × tracks × $2^{12} \times 2^{10}$ B

Tracks = 2^{12}

Number of cylinders in disk = number of tracks per surface = $2^{12} = 4096$

[MSQ]

Q.39. Consider the operators ◊ and □ defined by a ◊ b = a + 2b. a □ b = ab. for positive integers. Which of the following statements is/are TRUE?

(a) Operator ◊ obeys the associative law

(b) Operator □ over the operator ◊ obeys the distributive law

(c) Operator ◊ over the operator □ obeys the distributive law

(d) Operator □ obeys the associative law

Sol. **(b, d)**

Option (a)

(a ◊ b) ◊ c = a ◊ (b ◊ c)

(a + 2b) ◊ c

a + 2b + 2(a +2b).c

a ◊ (b +2 c)
a + 2a(b+ 2c)
not equal
option (b) is correct
□ is distributive area ◊ means
a □ (b ◊ c) = (a □ b) ◊ (a □ c)
Check
a □ (b ◊ c)
= a □ (b + 2c)
= (a □ b) + (a □ 2c)
= ab + a.2c
LHS
(a □ b) ◊ (a □ c)
ab ◊ ac
= ab + 2 ac
RHS
Same for c not correct
Option (d)
Simple multiplication.

[NAT]

Q.40. Consider the following two regular expressions over the alphabet {0,1}:

r = 0* + 1*
s = 01* + 10*

The total number of strings of length less than or equal to 5. which are neither in r nor in s. is

Sol. **(44)**

Total possible string up to 5 length = $2^{5+1}-1 = 63$
0 length strings = 1 = ∈
1 length strings = 2 = 0,1
2 length strings = 4 = 00, 01, 10, 11
3 length strings = 2 + 2 = 000,100,011,111
4 length strings = 2 + 2 = 0000, 0111, 1000,1111
5 length strings = 2 + 2 = 00000,01111,10000,11111
Strings which are not present in both expression
= 63 – 19 = 44.

[MSQ]

Q.41. Let A be any n × m matrix, where m > n. Which of the following statements is/are TRUE about the system of linear equations Ax = 0?

(a) There exists a non-zero solution in which at least m — n variables are 0
(b) There exist m — n linearly independent vectors such that every solution is a linear combination of these vectors
(c) There exists a solution in which at least n variables are non-zero
(d) There exist at least m — n linearly independent solutions to this system

Sol. **(d)**

Rank(A) ≤ n

So, number of free columns ≥ (m – n) and number of LI solutions = number of free columns

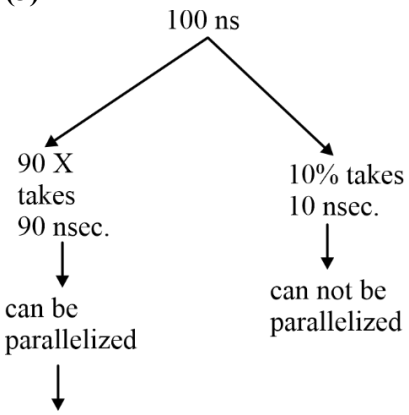
So, this is True.

[NAT]

Q.42. The baseline execution time of a program on a 2 GHz single core machine is 100 nanoseconds (ns). The code corresponding to 90% of the execution time can be fully parallelized. The overhead for using an additional core is 10 ns when running on a multicore system. Assume that all cores in the multicore system run their share of the parallelized code for an equal amount of time.

The number of cores that minimize the execution time of the program is _____.

Sol. **(3)**



Let $(x-1)$ new cores are added {total cores become $1+x = x$} for parallelized code

$$ET = \left[\left(\frac{90}{x}\right) + 10\times(x-1)\right] + 10$$

(for 10% remaining; 10 nsec. overhead because of every near core)

Minimization

$$\frac{d}{dx}[ET] = 0 \Rightarrow \frac{d}{dx}\left[\frac{90}{x} + 10(x-1) + 1\right]$$

$$\Rightarrow \frac{-90}{x^2} + 10 = 0$$

$$\Rightarrow x^2 = 9 \Rightarrow \boxed{x = 3}$$

[MSQ]

Q.43. The symbol → indicates functional dependency in the context of a relational database.

Which of the following options is/are TRUE?

(a) $(X \rightarrow Y \text{ and } Y \rightarrow Z)$ implies $X \rightarrow Z$

(b) $(X, Y) \rightarrow Z$ and $W \rightarrow Y)$ implies $(X, W) \rightarrow Z$

(c) $(X, Y) \rightarrow (Z, W)$ implies $(X, Y) \rightarrow Z$

(d) $(X, Y) \rightarrow (Z, W)$ implies $X \rightarrow (Z, W)$

Sol. **(a, b, c)**

The symbol $\rightarrow$ implies following functional dependencies:

1. $x \rightarrow y$ and $y \rightarrow z$ implies $x \rightarrow z$
2. $xy \rightarrow zw$ implies $xy \rightarrow z$
3. $xz \rightarrow z$ and $w \rightarrow y$ implies $xw \rightarrow z$

[NAT]

Q.44. Let G = (V, ∑, S, P) be a context-free grammar in Chomsky Normal Form with ∑ = {a, b, c} and V containing 10 variable symbols including the start symbol S. The string W = $a^{30}b^{30}c^{30}$ is derivable from S. The number of steps (application of rules) in the derivation S →* W is

Sol. **(179)**

$w = a^{30}b^{30}c^{30}$

Length of string = 90

Number of steps in CNF = 2n – 1

= 2 × 90 – 1 = 179

[MSQ]

Q.45. Let G be a directed graph and T a depth first search (DFS) spanning tree in G that is rooted at a vertex v. Suppose T is also a breadth first search (BFS) tree in G, rooted at r. Which of the following statements is/are TRUE for every such graph G and tree T ?

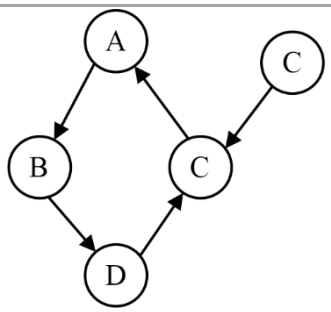
(a) There are no cross-edges in G with respect to the tree T

(b) There are no back-edges in G with respect to the tree T

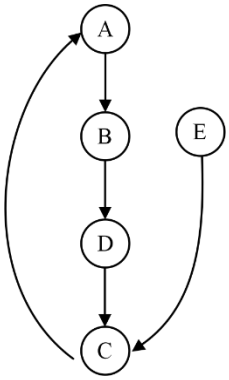
(c) There are no forward-edges in G with respect to the tree T

(d) The only edges in G are the edges in T

Sol. **(c)**



BFS →



Back edge
Cross edge
Edge not in T

[NAT]

Q.46. Consider a memory management system that uses a page size of 2 KB. Assume that both the physical and virtual addresses start from 0. Assume that the pages 0, 1,2 and 3 are stored in the page frames 1, 3, 2 and 0. respectively. The physical address (in decimal format) corresponding to the virtual address 2500 (in decimal format) is_____.

Sol. **(6596)**

$$\text{Page Number} = \left\lfloor \frac{2500}{2048} \right\rfloor = 1$$

Offset(d) = 2500% 2048 = 452

Page 1 is present on frame 3.

Hence physical address is = (3 × 2048) + 452

= 6596

[NAT]

Q.47. A given program has 25% load/store instructions. Suppose the ideal CPI (cycles per instruction) without any memory stalls is 2. The program exhibits 2% miss rate on instruction cache and 8% miss rate on data cache. The miss penalty is 100 cycles. The speedup (rounded off to two decimal places) achieved with a perfect cache (i.e., with NO data or instruction cache misses) is_____.

Sol. **(3)**

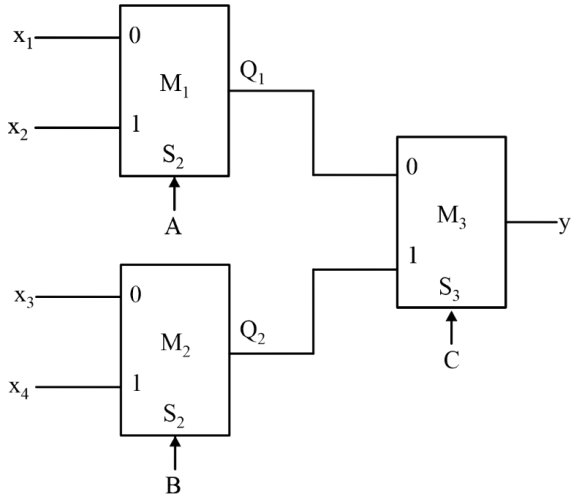
CPI with a Perfect Cache: 2

CPI with the Actual Cache: 2 (ideally) + 0.02*100(stall cycles for instruction cache miss) + 0.25*0.08*100(stall cycles for data cache miss) = 6

Speedup with a perfect cache = 6/2 = 3.00

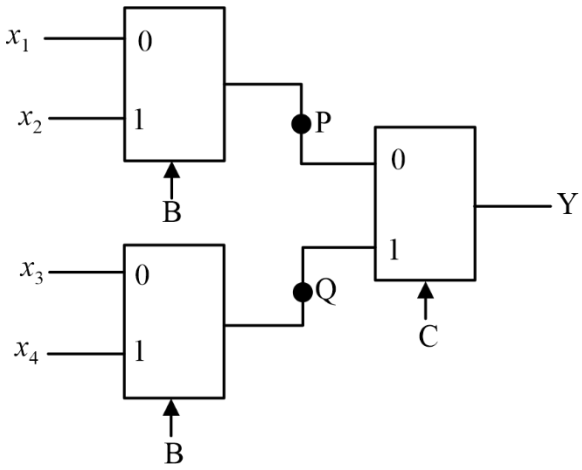
[NAT]

Q.48. Consider a digital logic circuit consisting of three 2-to-l multiplexers M_l. M_2, and M_3 as shown below. X_1 and X_2 are inputs of M_l. X_3 and X_4 are inputs of M_2. A, B, and C are select lines of M_l, M_2, and M_3, respectively.



For an instance of inputs X1 = l, X2 = l, X3 = 0. and X4 = 0. the number of combinations of A. B. C that give the output Y=1 is

Sol. **(4)**



Here, $X_1 = 1$

$X_2 = 1$

$X_3 = 0$

$X_4 = 0$

$P = \bar{A}\, x_1 + A\, x_2 = \bar{A} + A = 1$

$Q = \bar{B}\, x_3 + B\, x_4 = 0 + 0 = 0$

$\therefore\ Y = \bar{C}\, P + CQ = \bar{C}$

$\therefore\ Y = \left(A + \bar{A}\right)\left(B + \bar{B}\right) \bar{C}$

$= AB\bar{C} + A\bar{B}\bar{C} + \bar{A}B\bar{C} + \bar{A}\bar{B}\bar{C}$

$\therefore$ 4 combination of (A, B, C)

[MCQ]

Q.49. Consider the following syntax-directed definition (SDD).

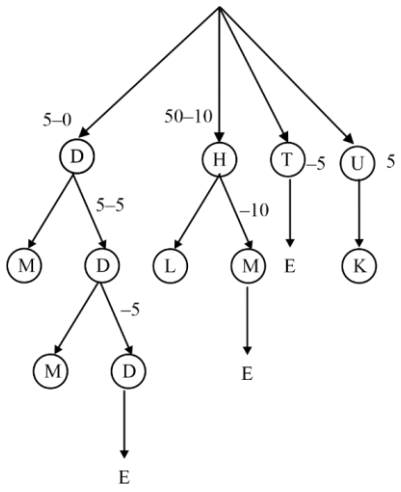
$S \rightarrow DHTU$	{S. val = D.val + H.val + T.val + U.val; }
$D \rightarrow$ "M" D_1	{D. Val = 5 + D_1 Val;}
$D \rightarrow \varepsilon$	{D. val = –5;}
$H \rightarrow$ "L" $H1_1$	{H. Val = 5 * 10 + H_1 . val;}
$H \rightarrow \varepsilon$	{H. val = – 10;}
$T \rightarrow$ "C" T_1	{T. val = 5 * 100 + T_1. val;}
$T \rightarrow \varepsilon$	{T. val = – 5;}
$U \rightarrow$ "K"	{U. val = 5;}

Given "MMLK" as the input which one of the following options is the CORRECT value computed by the SDD (in the attribute S. val)?

(a) 65 (b) 45

(c) 55 (d) 50

Sol. **(b)**



S. Val = 5 + 40 – 5 + 5 = 45

[MCQ]

Q.50. Consider the following pseudo-code.

L1: t1 = –1

L2: t2 = 0

L3: t3 = 0

L4: t4 = 4 * r3

L5: t5 = 4 * t2

L6: t6 = t5 * M

L7: t7 = t4 4 t6

L8: t8 = a[t7]

L9: it t 8 ⇐ max goto L11

L10: t1 = t8

L11: t3 = t3+ 1

L12: if t3 < M goto L4

L13: t2 = t2 + 1

L14: if t2 < N goto L3

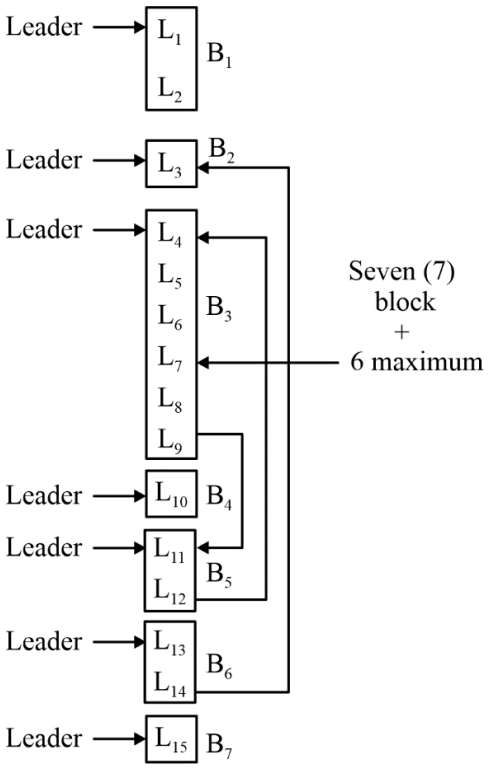
L15: max = t1

Which one of the following options CORRECTLY specifies the number of basic blocks and the number of instructions in the largest basic block, respectively?

(a) 7 and 7 (b) 6 and 6

(c) 7 and 6 (d) 6 and 7

Sol. **(c)**



[MCQ]

Q.51. Consider the following two threads T_1 and T_2 that update two shared variables a and b. Assume that initially a = b = 1. Though context switching between threads can happen at any time, each statement of T_1 or T_2 is executed atomically without interruption.

T_1	T_2
a = a + 1;	b = 2 * b;
b = b + 1;	a = 2 * a;

Which one of the following options lists all the possible combinations of values of a and b after both T_1 and T_2 finish execution?

(a) (a = 4, b = 4): (a = 3, b = 3):(a = 4, b = 3)

(b) (a = 2, b = 2): (a = 2, b = 3):(a = 3, b = 4)
(c) (a = 3, b = 4); (a = 4, b = 3):(a = 3, b = 3)
(d) (a = 4, b = 4); (a = 4, b = 3): (a = 3, b = 4)

Sol. **(a)**

Initially a = b = 1

T_1	T_2
a = a + 1;	b = 2 * b;
b = b + 1;	a = 2 * a;

- Let 1st T_1 runs completely followed by T_2.
  a = a + 1 ⇒ 2
  b = b + 1 ⇒ 2
  b = 2 × b ⇒ 4
  a = 2 × a ⇒ 4
- Let 1st T_2 runs completely followed by T_1.
  b = 2 × b ⇒ 2
  a = 2 × a ⇒ 2
  a = a + 1 ⇒ 3
  b = b + 1 ⇒ 3
- Let 1st statement of T_1 runs and gets pre-empted to T_2 and after that T_1 runs its 2nd statement.
  a = a + 1 ⇒ 2
  b = 2 × b ⇒ 2
  a = 2 × a ⇒ 4
  b = b + 1 ⇒ 3
- Let 1st statement of T_2 run and then gets pre-empted to T_1, T_1 runs completely and after that lastly T_2 execute 2nd statement.
  b = 2 × b ⇒ 2
  a = a + 1 ⇒ 2
  b = b × 1 ⇒ 3
  a = 2 × a ⇒ 4

[NAT]

Q.52. The number of edges present in the forest generated by the DFS traversal of an undirected graph G with 100 vertices is 40. The number of connected components in G is____.

Sol. **(60)**

The number of connected components,

n – k

= 100 – 40 = 60.

[MSQ]

Q.53. Consider the following C function definition.

```
int f(int x, int y) {
    for (int i =0; i < y; i ++) {
        x = x + x + y;
    }
    return x;
}
```

Which of the following statements is/are TRUE about the above function?

(a) If the inputs are x = 20, y = 10, then the return value is less than 2^{10}

(b) If the inputs are x = 20, y = 20, then the return value is greater than 2^{20}

(c) If the inputs are x = 20, y = 10, then the return value is greater than 2^{20}

(d) If the inputs are x = 10, y = 20. then the return value is greater than 2^{20}

Sol. **(b, d)**

The loop runs total y times in the loop

Iteration	Value
1	$2x + y$
2	$2(2x + y) + y = 2^2x + 2y + y$
3	$2^3x + 4y + 2y + y$
4	$2^4x+ + 8y + 4y + 2y + y$
….	
Y	$2^yx+2^{y-1}y_{+....}2y+y$

Hence the value

$$2^y x + y\left(1 + 2 + 2^2 + ...2^{y-1}\right)$$

$$= 2^y x + y\left(\frac{1(2^y - 1}{2 - 1}\right)$$

$$= 2^y x + y2^y - y$$

$$= (x + y)2^y - y$$

Option A false , x =20, y=10 value is will be greater than 2^{10}

Option B TRUE , x =20, y=20 value is will be greater than 2^{20}

Option C false , x =20, y=10 value is will not be greater than 2^{20}

Option D TRUE , x =10, y=20 value is will be greater than 2^{20}

[NAT]

Q.54. A bag contains 10 red balls and 15 blue balls Two balls are drawn randomly without replacement. Given that the fust ball drawn is red. the probability (rounded off to 3 decimal places) that both balls drawn are red is_____.

Sol. **(0.375)**

There is 10 red balls & 15 blue balls.

Given that 1st ball drawn is red.

So, it becomes 9 red balls & 15 blue balls.

Now, Required probability = P(red ball in 2nd draw)

$$\Rightarrow \quad \frac{9}{15+9} = 0.375 .$$

[MSQ]

Q.55. The chromatic number of a graph is the minimum number of colorus used in a proper colouring of the graph. Let G be any graph with n vertices and chromatic number k. Which of the following statements is are always TRUE?

(a) G contains a complete subgraph with k vertices

(b) G contains at least k(k — l)/2 edges

(c) G contains an independent set of size at least n/k

(d) G contains a vertex of degree at least k

Sol. **(b, c)**

G contains at least k (k – 1)/2 edges: **True**

G contains an independent set of size at least n/k: **True**

❑❑❑