GATE

Subject : CS 2012 - SOLUTIONS

TECHNICAL SECTION (Q. NO. 1 – 25) 1 MARKS

1. Let P - it rains and

Q - The cricket will be played

From I_1, $P \rightarrow \neg Q = \neg P \vee \neg Q$

Let's form the truth table

P	Q	$\neg P \vee \neg Q$
F	F	T
F	T	T
T	F	T
T	T	F

$\therefore$ I_1 is correct as the match was played and there was no rain is true.

From I_2,

$P \rightarrow \neg Q = \neg P \vee \neg Q$

If it did not rain, then the cricket match may or may not be played.

$\therefore$ I_2 is false

(B) is the answer.

2. BCNF is stricter than 3NF. Hence, every relation that is in BCNF is also in 3NF.

(C) is the answer.

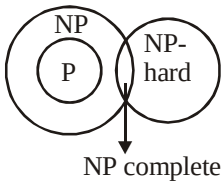
3. The given code does not have a 'break' statement after any of the cases. When a switch-case is executed and if there is no break statement, then the subsequent cases are executed until we find a 'break' statement.

$\therefore$ The program prints choice A

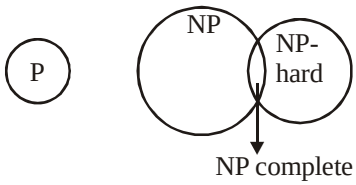
choice B No choice.

(C) is the answer.

4. We know that



But it is given that $P \neq NP$. Hence the diagram will change. It will be as follows:



By looking at the options, we can say (B) is correct as NP-complete $\cap P = \phi$

5. For a balanced binary search tree, height is always $\theta(\log n)$ where 'n' is the number of elements in the BST.

$\therefore$ For $n2^n$ elements,

worst case time complexity $= \theta(\log(n2^n))$

$= \theta(\log n + \log 2^n)$

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

$= \theta(n)$

$\therefore$ (C) is the answer.

6. The given truth table represents the function

$$F = X\bar{Y} + XY$$

$$= X(\bar{Y} + Y)$$

$$\therefore \quad F = X$$

(A) is the answer.

7. In IEEE 754 single precision format, the normalized number (N) is calculated as

$N = (-1)^S \times 1.F \times 2^{(E-127)}$ $\quad 1 \leq E \leq 254$

where S – sign bit

F – fraction

E – exponent

For $N = 0.5$ – in binary form, $N = (0.1)_2$

$N = (-1)^0 \times 2^{-1}$

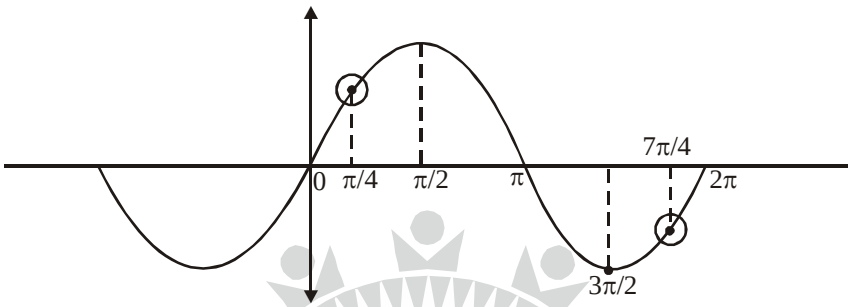
$= (-1)^0 \times 1.0 \times 2^{-1}$

$\therefore$ Exponent = –1 and fraction bits = 0

(B) is the answer.

8. If fork ( ) is called 'n' times,
total process created = 2^n
total child processes created = 2^{n-1}
$\therefore$ for n = 3,
#child processes = 7
(C) is the answer.

9. Consider sinx in the interval $x \in [\pi/4, 7\pi/4]$



Thus in the given interval, we have two points of local minima i.e. at $\pi/4$ and $3\pi/2$.
(D) is the answer.

10.

Layer	PDU (Protocol data unit)
Application	Message
Transport	Segment for TCP
	Datagram for UDP
Network	Packet
Data Link layer	Frame
Physical	Bit

(C) is the answer.

11. $A = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}$

$A = \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$

The characteristic equation is

$$|A - \lambda I| = 0$$
$$\therefore \lambda^2 - (0)\lambda + (-2) = 0$$
$$\therefore \lambda^2 = 2$$
$$\therefore \lambda = \pm\sqrt{2}$$

The eigen values of $(A)^{19}$ will be $(\lambda)^{19}$

$\therefore$ For $\lambda_1 = +\sqrt{2}$

$$\lambda'_1 = \left(\sqrt{2}\right)^{19} = 512\sqrt{2}$$

For $\lambda_2 = -\sqrt{2}$

$$\lambda'_2 = \left(-\sqrt{2}\right)^{19} = -512\sqrt{2}$$

$\therefore$ (D) is the answer.

12. The given NFA accepts the language.

L = {a, aa, aaa,.....}

$\therefore$ $L = a^+$

$\therefore$ Complement of L will be

$$\overline{L} = \Sigma^* - L$$
$$= \{\in\}$$

$\therefore$ (B) is the answer.

13. Let's check for the given options.

(A) There exists some numbers which are either real or rational.

(B) All real numbers are rational numbers

(C) There exists some numbers which are both real and rational

(D) There exists some numbers such that if they are rational then they are real.

$\therefore$ (C) is the correct translation of the given statement.

14. (A) is true when the attribute is a multi valued attribute

(B) is true when the attribute is a composite attribute.

(C) is false as in relational model, the row of relational table cannot have more than one value. It can have exactly one or a NULL value

(D) is true

15. Statement (P) is true. The 'HAVING' clause without a 'group by' clause acts like a 'WHERE' clause Statement (Q) is false.

Statement (R) is false. It is not necessary that all attributes used in the 'group by' clause appear in the 'SELECT' clause.

Statement (S) is true.

$\therefore$ (B) is the answer.

16. The steps to solve tower of Hanoi are as follows :

Consider three pages A, B and C. We have to move 'n' discs from A to C making use of the peg B, i.e. A is the source and C is the destination.

$\therefore$ To move 'n' discs from A to C,

(i) move (n – 1) discs from A to B.

(ii) move nth disc from A to C.

(iii) move (n – 1) discs from B to C.

The recurrence relation for tower of Hanoi is

$T(n) = 2T(n - 1) + 1$

(D) is the answer.

17. For a connected planar graph

$R = E - V + 2$

R – faces or regions

E – edges

V – vertices

$\therefore \quad R = 15 - 10 + 2$

$\therefore \quad R = 7$

So we have to total of 7 faces out of which 6 will be bounded and 1 face will be unbounded.

NOTE: For any connected planar graph with 'R' faces, (R – 1) are bounded faces and one face is an unbounded one.

$\therefore$ (D) is the answer.

18. We know that

$A(n) \leq c.W(n)$ always

$\therefore \quad A(n) = O(W(n))$

(C) is the answer.

19. For a 4 bit multiplier we have

$2^4 * 2^4$ such combinations. Also to store the result, we need 8 bits.

$\therefore$ Total amount of ROM needed $= 2^4 \times 2^4 \times 8$ bit

$= 2 \times 2^{10}$ bits

$= 2K$ bits

$\therefore$ (D) is the answer.

20. In pipelined processors, register renaming is done to handle anti dependence or WAR (write after read) hazards.

$\therefore$ (C) is the answer.

21. The CDF of F(X) is defined as :

$F(X) = P(x \leq X)$

$\therefore \quad F(-1) = P(x \leq -1)$

$= 0.5$

$F(1) = P(x \leq 1)$

$= P(x = -1) + P(x = 1)$

$= 0.5 + 0.5$

$= 1$

$\therefore$ (C) is the answer.

22. SMTP is an application layer protocol used in electronic mail, which in turn uses a transport layer protocol TCP for communication. The question clearly asks for the transport layer protocol.

$\therefore$ (C) is the answer.

23. In IPv4 addressing format for class C, the host bits are 8 and network bits are 24, out of which leading three network bits are fixed as '110'. Hence, we are left with 21 bits for networks. So, possible number of networks in class C = 2^{21}

$\therefore$ (C) is the answer.

24. (1) It is undecidable if a given program ever produces an output.
(2) CFLs are not closed under complementation. Hence the given statement is undecidable.
(3) It is decidable because regular language are closed under complementation.
(4) It is decidable as recursive languages are closed under complementation.

$\therefore$ (D) is the answer.

25. Let X = ab, Y = aa and Z = baa
(1) can be written as XYZXY
(2) can be written as YYZY
(3) cannot be written as any combination of X, Y or Z.
(4) can be written as ZYXY

$\therefore$ (C) is the answer.

TECHNICAL SECTION (Q. NO. 26 – 55) 2 MARKS

26. To verify the isomorphism of two graphs, we need to check the following:
(1) Equal number of vertices
(2) Equal number of edges
(3) Vertex and edge correspondence
(4) Cycles of same length (all possible cycles)

As per the given options only (B) satisfies all the requirements.

$\therefore$ (B) is the answer.

27. In the given transactions, only two serial schedules are possible i.e. $<T_1, T_2>$ and $<T_2, T_1>$. Also, one of the transactions reads the value written by other transactions in the possible serial schedules.
Hence, any non-serial interleaving of T_1 and T_2 will not be conflict serializable.
$\therefore$ (B) is the answer.

28. Bisection-method is a root finding method that repeatedly bisects an interval and then selects a subinterval in which a root must lie for further processing.

$$f(x) = x^4 - x^3 - x^2 - 4;\ x \in [1, 9]$$
$$f(1) = -5 < 0$$

I1: $f(9) > 0$

$\therefore$ mid $= \frac{1+9}{2} = 5$

I2: $f(5) > 0$

$\therefore$ value lies in [1, 5]

mid $= \frac{1+5}{2} = 3$

I3: $f(3) > 0$

$\therefore$ value lies in [1, 3]

mid $= \frac{1+3}{2} = 2$

$f(2) = 0$

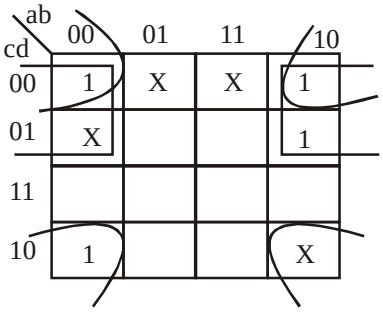
$\therefore$ The method converges to a solution after 3 iterations.
(B) is the answer.

29. In a weighted graph, squaring the weights will not change the minimum spanning tree.
$\therefore$ $T = T'$
Also we know that

$a^2 + b^2 < (a + b)^2$ i.e. $t' < t^2$

i.e. sum of squares of two or more edges of a graph is always smaller than the square of sum, EXCEPT for one case when the MST will have exactly one edge.
In that case, $t' = t^2$
$\therefore$ (D) is the correct option.

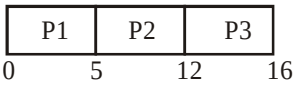
30.



$\therefore$ F = $\overline{b}\overline{c} + \overline{b}\,\overline{d}$

$\therefore$ (B) is the answer.

31. For FCFS,

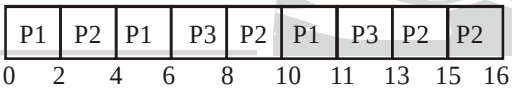


Also in FCFS, the processes are completed in order of their arrival time.

$\therefore$ Order of completion is P_1, P_2, P_3.

For RR with time quantum = 2 units,

Ready queue: P1 P2 P1 P3 P2 P1 P3 P2 P2



$\therefore$ Order of completion of processes is P1, P3, P2

(C) is the answer.

32. Acquire lock is executed only when Fetch_And_Add gets executed with L = 0.

Let process P1 acquire lock and make L = 1. Now process P2 waits for a lock oscillating the value of L between 1 and 2 (assume no other process is waiting for lock). When P1 releases lock by making L = 0, then P2 will execute the statement L = 1. Hence, value of L becomes 1 and no process is in critical section. Hence L can never be 0 again.

$\therefore$ (B) is the correct answer.

33. **Case I:** When the value of die is 1, 2 or 3, (1, 5), (1, 6), (2, 4), (2, 5), (2, 6), (3, 3), (3, 4), (3, 5), (3, 6)

$\therefore$ Total possibilities = 9

Case II: When the value on die is 4, 5, 6

Total possibilities = 1 (i.e. when value = 6)

$\therefore$ Required probability $= \frac{9}{36} + \frac{1}{6}$

$= \frac{15}{36}$

$= \frac{5}{12}$

34. For the given chunk of CIDR,

no. of IP addresses available = $2^{32-20} = 2^{12}$

out of these, half i.e. $\frac{2^{12}}{2} = 2^{11}$ are given to A and quarter i.e. $\frac{2^{12}}{4} = 2^{10}$ are given to B.

$\therefore$ Prefix of A = 32 – 11 = 21

Prefix of B = 32 – 10 = 22

$\therefore$ Options (C) and (D) are ruled out.

For organization A, the ISP needs to take first 20 bits from 245.248.128.0 and fix the 21st bit (either 0 or 1).

Similarly for organization B, the ISP needs to fix 21st and 22nd bits. But we can see that 21st and 22nd bits for organization B in both the options is 0.

$\therefore$ 21st bit of organization A must be 1. Hence (A) is the correct answer.

35. For a circular queue, the queue is empty when REAR = FRONT

For checking if the queue is full, we need to consider the wrap around conditions.

ie. when (REAR + 1)mod size = FRONT

$\therefore$ (A) is the answer.

36. A1 and A2 are defined in main. Hence their access links are pointed to main.

Access link is defined as link to activation record of closest lexically enclosing block in the program text.

A21 is defined in A2. So its access link will point to A2.

Hence as per the calling convention, the correct answer is (D).

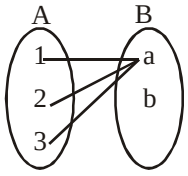
37. Total number of functions is 2^n.

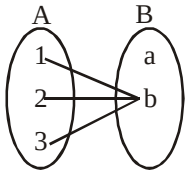
For an onto function, range = codomain.

$\therefore$ There would be 2 such functions which won't be onto. One that will map each element of the 'n' element set to the first element of the '2' element set. And second that will map each element of the 'n' element set to the second element of the '2' element set.

Consider A = {1, 2, 3} and B = {a, b}.

The functions from A to B which are not onto will be

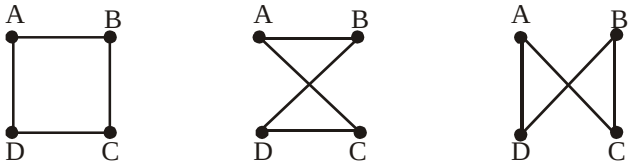




$\therefore$ No. of onto functions = $2^n - 2$

(C) is the answer.

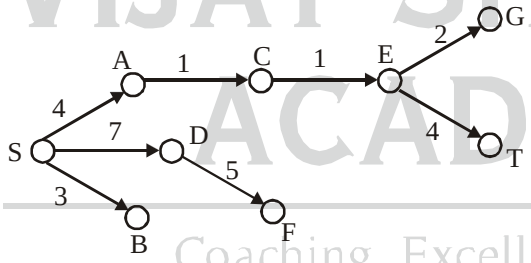
38. To pick 4 distinct vertices from 6 vertices, we have ${}^6C_4$ ways i.e. 15
Now, each set of 4 vertices we have 3 distinct cycles.
e.g.



$\therefore$ Total cycles of length 4 = ${}^6C_4 \times 3 = 45$
Hence, 45 is the correct answer.
In original GATE paper, there was no such option as 45. Hence, marks were given to all.

39. In worst case, merge sort takes O(nlogn) to sort 'n' numbers.
But in this case we are given 'n' strings.
To compare two strings, we will take O(n) time. Hence worst case time complexity to sort 'n' strings in lexicographic order will be O(n.nlogn) = $O(n^2 \log n)$
as for each string, we will need an additional O(n) time to check the lexicographic order.
$\therefore$ (B) is the answer.

40. The following tree will be generated when Dijkstra's shortest path algorithm is run on the given graph.



Hence shortest path from S to T is SACET.
(D) is the answer.

41. Maximum possible size of file

$$= \left(\begin{matrix} \#\text{direct block} \\ \text{addresses} \end{matrix} + \begin{matrix} \#\text{Single indirect} \\ \text{blocks} \end{matrix} + \begin{matrix} \#\text{double indirect} \\ \text{blocks} \end{matrix} \right) \times B$$

$$= \left(8 + \frac{128}{8} + \left(\frac{128}{8} \right)^2 \right) \times 128B$$

$$= 35 \text{ KB}$$

(B) is the answer

42. Using LRU,

1	**2**	**3**	**2**	**4**	**1**	**3**	**2**	**4**	**1**
1	1	1	1	4	4	4	2	2	2
	2	2	2	2	2	3	3	3	1
		3	3	3	1	1	1	4	4
F	F	F	Hit	F	F	F	F	F	F

$\therefore$ #page faults = 9

Using FIFO,

1	**2**	**3**	**2**	**4**	**1**	**3**	**2**	**4**	**1**
1	1	1	1	4	4	4	4	4	4
	2	2	2	2	1	1	1	1	1
		3	3	3	3	3	2	2	2
F	F	F	Hit	F	F	Hit	F	Hit	Hit

$\therefore$ #page faults = 6

Using optimal algorithm,

1	**2**	**3**	**2**	**4**	**1**	**3**	**2**	**4**	**1**
1	1	1	1	1	1	1	1	1	1
	2	2	2	4	4	4	4	4	4
		3	3	3	3	3	2	2	2
F	F	F	Hit	F	Hit	Hit	F	Hit	Hit

$\therefore$ #page faults = 5

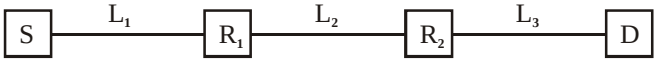
$\therefore$ B is the answer.

43. $R_1(\underline{A}, B)$ and $R(\underline{C}, D)$ are the two schemas. Also it is given that B is a foreign key that refers to C in R_2 i.e. all the entries of B in R_1 are definitely in C of R_2.

Hence $\pi_B(r_1) - \pi_C(r_2) = \phi$ always.

$\therefore$ (A) is the answer.

44. For each of the links L_1, L_2 and L_3



d = 100km = 10^5m

v = 10^8 m/s

BW =1 Mbps = 10^6 bps

file size = 10^6 bits

But file is broken into 1000 packets each of size 1000 bits.

$\therefore$ L = 1000b and n = 1000

T_t (for one link) = $\frac{L}{BW} = \frac{1000b}{10^6 b}$ = 10^{-3} sec = 1 msec

$\therefore$ For 3 links, T_t = 3 × 1 msec = 3 msec

P_t(for one link) = $\frac{d}{v} = \frac{10^5 m}{10^8 m/s}$ = 10^{-3} sec = 1 msec

$\therefore$ For 3 links, P_t = 3 × 1 msec = 3 msec

For the 1st packet, total delay will be = 3 + 3 = 6 msec

And for the next 999 packets, it will result in a pipeline. Each operation will overlap with the previous packets transmission / propagation delay.

Hence total delay = 6 + (1000 – 1)
= 6 + 999
= 1005 msec

$\therefore$ (A) is the answer.

45. Congestion window size

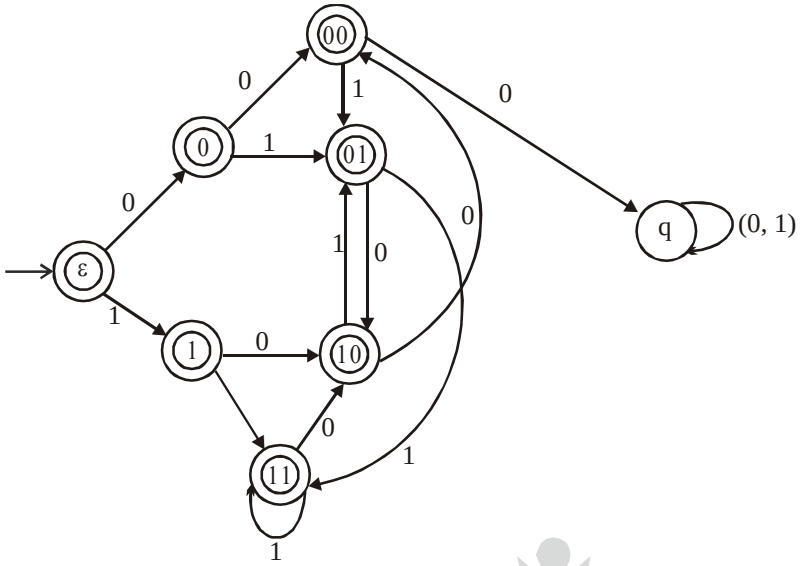
t = 0 2 MSS
t = 1 4 MSS
t = 2 8 MSS ← threshold reached $\therefore$ congestion avoidance
t = 3 9 MSS
t = 4 10 MSS ← Timeout occurred $\therefore$ New threshold = 10/2 = 5

Start from slow start again as timeout occurred.

t = 5 2 MSS
t = 6 4 MSS
t = 7 5 MSS
t = 8 6 MSS
t = 9 7 MSS

$\therefore$ At t = 9, we will have 10th transmission where congestion window size = 7 MSS.

46. The complete DFA for the given language is:



Here, q is the dead state

∴ (D) is the answer.

47. When the left subtree is null and right subtree is not null, we will execute B1.

∴ Height of subtree will be (1 + height (n → right)).

When neither of the left and right subtrees are NULL, we will execute B2 and B2 will be maximum of height of left and right subtrees plus one (for the root node).

i.e. B2 = 1 + max (h1, h2)

∴ (A) is the answer.

48. We know that static variables are initialized only once.

In main program, static int a = 1

When first prtFun ( ) is called,

Static int a = 2

int b = 1

a + = + + b

∴ a = a + (+ + b)

a = 2 + (+ + 1)

= 2 + 2

∴ a = 4 and b = 2 (∵ ++ b)

Now in main function

a + = 1; ∴ a = a + 1

∴ a = 2

when second prtFun ( ) is called,

a = 4

b = 1

a = a + + + b

a = 4 + (+ + 1)

= 4 + 2

∴ a = 6 and b = 2 (∵ ++ b)

When printf function is called in main, a = 2 will be printed and b = 0.

Since b is not declared in main. Hence it will access the global variable b defined outside main. And default value of global variables is 0.

∴ (C) is the answer.

49. We know that auto variables are allocated and deallocated automatically when program flow enters and leaves the variables scope.

In main function,

auto int a = 1

When first prt fun ( ) is called,

register int a = 2

int b = 1;

a + = ++ b

∴ a = a + (+ + b)

= 2 + 2

∴ a = 4 and b = 2 (∵ ++b)

Now in main ( ), a + = 1,

∴ a = a + 1

a = 2

When second prt fun ( ) is called,

register int a = 2

int b = 1

a + = + + b

a = a + (+ + b)

a = 2 + 2

∴ a = 4and b = 2 (∵ + + b)

Now, when printf function is called in main ( ), it will print a = 2 and b = 0.

Global value of variable b is printed and default value of global variables is 0.

∴ (D) is the answer.

50. $A \cup B$ will result in

Id	Name	Age
12	Arun	60
15	Shreya	24
99	Rohit	11
25	Hari	40
98	Rohit	20

The given query will result in the following:

Id	Name	Age	Id	Phone	Area
12	Arun	60	10	2200	02
15	Shreya	24	10	2200	02
99	Rohit	11	10	2200	02
25	Hari	40	10	2200	02
98	Rohit	20	10	2200	02
99	Rohit	11	99	2100	01
98	Rohit	20	99	2100	01

$\therefore$ 7 tuples are returned by the given query

(A) is the answer.

51. The subquery inside ALL will return 0 as there is no tuple in B where name = 'Arun'

Hence the original query will now be SELECT A. id from A

WHERE A.Age > 0

Three such tuples in A satisfy the above condition.

$\therefore$ (B) is the answer.

52. For the given grammar G,

$S \rightarrow aAbB \mid bAaB \mid \in$

$A \rightarrow S$

$B \rightarrow S$

$\text{first}(A) = \text{first}(B) = \text{first}(S)$

$= \{a, b, \in\}$

$\text{follow}(A) = \text{first}(b) \cup \text{first}(a)$

$= \{a, b\}$

$\text{follow}(B) = \text{follow}(s)$

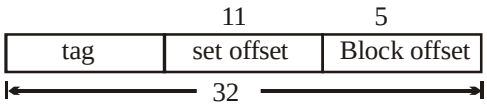
$= \{\$\} \cup \text{follow}(A) \cup \text{follow}(B)$

$= \{a, b, \$\}$

$\therefore$ (A) is the answer.

53. In the LL(1) parsing table of above grammar,
E1: $s \rightarrow aAbB$, $s \rightarrow \in$
E2: $s \rightarrow bAaB$, $s \rightarrow \in$
E3: $B \rightarrow s$ ($\because \$ \in$ follow (B))
$\therefore$ (C) is the answer.

54. 256 kB, 4-way set associative write back cache
Block size = 32 B
Format of set associative memory is



$$\text{Block offset} = \log_2\lceil \text{Block size} \rceil$$
$$= \log_2\lceil 32 \rceil$$
$$= 5 \text{ bits}$$
$$\#\text{lines in cache} = \frac{\text{Cache size}}{\text{Block size}}$$
$$= \frac{256\,\text{KB}}{32\,\text{B}}$$
$$= \frac{2^8.2^{10}}{2^5}$$
$$= 2^{13}$$
$$\#\text{sets} = \frac{\#\text{lines}}{\text{P} - \text{way}}$$
$$= \frac{2^{13}}{4}$$
$$= 2^{13-2}$$
$$= 2^{11}$$
$\therefore$ set offset $= \log_2(\#\text{sets})$
$= \log_2(2^{11})$
$= 11$ bits
$\therefore$ No. of tag bits $= 32 - (5 + 11)$
$= 32 - 16$
$= 16$ bits
$\therefore$ (C) is the answer.

55. Size of cache tag directory = #lines * #tag bits in each line

It is given that in addition to address tag, it also contains 2 valid bits, 1 modified bit and 1 replacement bit.

$\therefore$ Total no. of bits in tag = 16 + 2 + 1 + 1 = 20 bits.

$\therefore$ Size of cache tag directory = $2^{13} \times 20$ bits

= 160 K bits

(A) is the answer.

GENRAL APTITUDE SECTION (Q. NO. 56 – 65) 15 MARKS

56. Cost price = $5q^2$

Selling price = 50q

$\therefore$ Profit = SP – CP

$\therefore$ $P(q) = 50q - 5q^2$

To maximize profit,

$P'(q) = 50 - 10q$

$P'(q) = 0$

$\therefore$ $50 = 10q$

$q = 5$

5 units need to be produced to maximize profit

$\therefore$ (A) is the answer.

57. 'Setbacks' perfectly fits in the given sentence.

Setbacks mean a reversal or check in progress

Synonyms: difficulties, problems, complications.

(B) is the answer.

58. mitigate – alleviate, reduce, diminish

$\therefore$ (A) is the answer.

59. (D) is the incorrect sentence. Rest all are correct.

The correct sentence is:

This country's expenditure on educational reforms is very little.

60. ● 'who' is used to refer to people.

● 'that' is called an essential clause. It adds information that is important with respect to the sentence. 'that' refers to groups or things

● 'which' is a non-essential clause. It adds supplementary information.

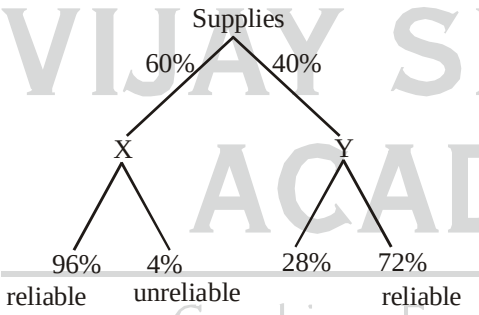
In the given sentence, 'that' is the correct choice.

(A) is the answer.

61. There is no mention of gender in the given extract.
Xenophobia is the fear of that which is perceived to be foreign or strange.
(C) is the answer.

62. $y = 2x - 0.1x^2$
$y' = 2 - 2(0.1)x$
$y' = 0$ [To maximize y]
$\therefore \quad 2 - 0.2x = 0$
$x = 10$
At $x = 10$,
$y = 2(10) - 0.1\ (100)$
$= 20 - 10$
$y = 10m$
$\therefore$ Maximum possible height of the arch is 10 metres.
(B) is the answer.

63. $\therefore$ Required probability $= \dfrac{0.4 \times 0.72}{(0.4 \times 0.72 + 0.6 \times 0.96)} = 0.334$



$\therefore$ (B) is the answer.

64. P is ture
Consider the elements: 1, 2, 3
Mean = 2
Adding 7 to the elements: 8, 9, 10
Mean = 9
= (2 + 7)
R is true
Doubling each entry in the list: 2, 4, 6
Mean = 4 = 2(2)
$\therefore$ (C) is the answer.

65. AD CG FK JP

For first letter:

For second letter

∴ OV is the next term.

(A) is the answer.