Answer Keys

1	D	**2**	A	**3**	A	**4**	C	**5**	B	**6**	C	**7**	C
8	C	**9**	D	**10**	C	**11**	C	**12**	B	**13**	D	**14**	A
15	D	**16**	D	**17**	C	**18**	3	**19**	21	**20**	84	**21**	250
22	16384	**23**	B	**24**	C	**25**	D	**26**	A	**27**	C	**28**	D
29	B	**30**	D	**31**	A	**32**	C	**33**	A	**34**	5	**35**	8
36	0.95	**37**	1379.36	**38**	516	**39**	B	**40**	B	**41**	C	**42**	D
43	B	**44**	C	**45**	D	**46**	5	**47**	50	**48**	D	**49**	B
50	564	**51**	98	**52**	C	**53**	A	**54**	D	**55**	B		

Explanations:-

1. 1's complement $\rightarrow -7$

   2's complement $\rightarrow +8$

   Sign magnitude $\rightarrow 0$

2. Number of functions from A to B = $\left[n(B)\right]^{n(A)}$ i.e. $\left[O(B)\right]^{O(A)}$. Since 47 is a prime number, we can conclude that 47 is the only possibility. $\therefore O(B) = 47$ and $O(A) = 1$

3. $x = e^{-x}$

   $x - e^{-x} = 0$

   $\Rightarrow f(x) = x - e^{-x}$

   $\Rightarrow f(x_n) = x_n - e^{-x_n}$

   $\Rightarrow f'(x_n) = 1 + e^{-x_n}$

   We have $x_{n+1} = x_n - \dfrac{f(x_n)}{f'(x_n)}$

   $$= x_n - \frac{x_n - e^{-x_n}}{1 + e^{-x_n}} = \frac{x_n + x_n e^{-x_n} - x_n + e^{-x}}{1 + e^{-x}} = \frac{(1 + x_n) e^{-xn}}{1 + e^{-x_n}}$$

4. 36+(5*5)+(5*3*3)+3 =109

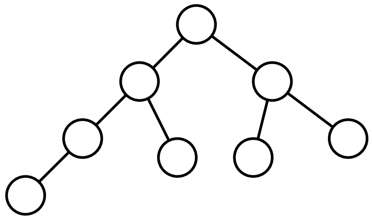
5. According to program,

   F(n) = n + 2F(n-1) for n>=2

   = 0 for n=1

   F(5) = 5+2(4+2(3+2(2+2(0)))) = 41

6.



Height $= 3$
Min elements $= 8 \approx 2^h$
Max elements $= 15 = 2^{h+1} - 1$

7. i) 0*(10*)* is equivalent to (1*0)*1*, because both regular expressions generate same set of strings.
   ii) (r*+s*)*=(r+s)*, but given is (r*+s*)=(r+s)*, so they are not equivalent.
   iii) (a +b)* = (a* + b)* = (a + b*)* = (a*b*)* = (a* + b*)*, so given (a* + b)* & (a + b*) are equivalent.
   iv) (PQ)*P and P(QP)* are equivalent by shifting rule of regular expression.

8. (A) statement is true as REL are not closed under set difference and complementation.
   (B) Complement of context free language is recursive.
   (C) Membership problem is decidable under recursive languages. Turing machine for recursive language will either accept the given input string or it will reject the input string, so statement is false.

9. Secret key $= \dfrac{n(n-1)}{2} = \dfrac{17 \times 16}{2} = 136$

   Public key $= 2n = 2 \times 17 = 34$

11. XML is case sensitive.

12. Down counter as flip-flop is negative edge triggered and $\overline{Q}$ is connected to clock input of next flip flop

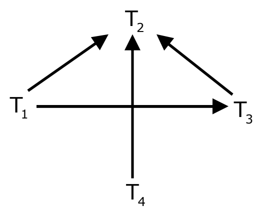
13. Contiguous allocation needs consecutive chunks/blocks of memory for file allocation, so randomly available memory chunks cannot be used for allocation, so it results into external fragmentation.
    Whereas indexed and linked allocation can allocate non – consecutively available memory chunks.

14. Immediate: The 2nd operand gives the value directly in instruction.

15. I. Statement is false, as terminals in a SDD can have only synthesized attributes.
    II. Statement is true, as attribute values of terminals is supplied by lexical analyzer by providing the lexeme value.
    III. The start symbol does not have an inherited attributes because it has no parent and no sibling, so statement is true.
    IV. Attribute grammar is a SDD in which attributes or function in semantic rules are just evaluations, but no side effect, so given statement is false.

16. 1) Increasing the clock rate will increase the frequency and will decrease the clock period, thus execution of typical program will be fast (improved)
    2) Disallowing any forwarding in the pipeline will produce stall (unproductive) clock cycles, thus will take more time in execution of a program.
    3) Doubling the size of instruction cache and data cache without changing clock cycle time decrease the average execution time, because availability of data will be more (Hit ratio increases), so execution of program will be improved.
    4) Increasing the pipeline depth will allow more overlapping of instructions (i.e. parallelism), so execution of program will be fast with more number of stages in pipeline.

17. Procedures graph



18. 0011101111$\cancel{0}$01111$\cancel{0}$10101111$\cancel{0}$

19. Level $1 = 1$, Level $2 = 4$, Level $3 = 16$

Total $= 1 + 4 + 16 = 21$

20. $E(b_1 + b_2 + b_3 + \ldots b_8) = E(b_1) + E(b_2) 1 \ldots E(b_8)$

Since every ball has equal likely probability of being drawn then

$E(b_1) = E(b_2) - — = E(b_8)$

$$E(b_1) = 1 \times \frac{1}{20} + 2 \times \frac{1}{20} + 3 \times \frac{1}{20} + \ldots\ldots 20 \times \frac{1}{20}$$

$$= \frac{1}{20}\left(\frac{20(21)}{2}\right) = \frac{21}{2}$$

$$\text{Total expected sum} = 8 * E(b_1) = 8 * \frac{21}{2} = 84$$

21. Effective access time $= 0.75 \times 200\text{ns} + 0.25 \times (200 + 200)\text{ns} = 250\,\text{ns}$

22.

⟵ 20 bits ⟶

Opcode	Add 1	Add 2
4	8	8

256 words $= 2^8$ words, Hence 8 bits for address

With 4 bit opcode, we can have 16 operations but only 8, 2-add operations are used, so possible 1-address instructions $= (16 - 8) \times 2^8 = 2^{11}$ instructions

Now possible 0-address instructions $= (2^{11} - 1984) \times 2^8 = 64 \times 2^8 = 2^{14}$

23. Because integer 'b' is redeclared in block B_3, so earlier declaration loses its scope in B_3.

24. Outermost loop runs $O(n)$ times

Middle loop runs $O(\log n)$ times

Innermost loop runs $O(\sqrt{n})$ times, as $(K^2 < n)$

Hence order is $\left(n\sqrt{n}\log n\right) \approx \left(O\left(n^{3/2}\log n\right)\right)$

26. $$I = \int_{\pi/6}^{\pi/3} \frac{dx}{1+\sqrt{\tan x}} = \int_{\pi/6}^{\pi/3} \frac{\sqrt{\cos x}}{\sqrt{\cos x}+\sqrt{\sin x}}\,dx \quad ....(1)$$

$$\text{then, } I = \int_{\pi/6}^{\pi/3} \frac{\sqrt{\sin x}}{\sqrt{\sin x}+\sqrt{\cos x}} \left\{ \begin{matrix} \text{using} \\ \int_a^b f(x)\,dx = \int_a^b f(a+b-x)\,dx \end{matrix} \right\} ....(2)$$

Now adding (1) and (2)

$$2I = \int_{\pi/6}^{\pi/3} \frac{\sqrt{\sin x}+\sqrt{\cos x}}{\sqrt{\sin x}+\sqrt{\cos x}}\,dx$$

$$2I = \int_{\pi/6}^{\pi/3} dx = \frac{\pi}{6}$$

$$I = \frac{\pi}{12}$$

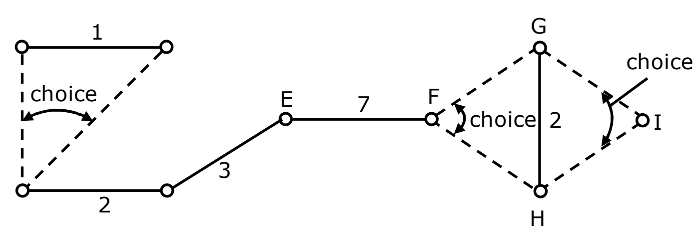
27. It is actually be:

$\forall x\left[\left(\text{singular}(x) \wedge \text{orthogonal}(x)\right) \rightarrow \sim \text{symmetric}(x)\right]$

$P \rightarrow Q \Leftrightarrow \neg P \vee Q$ So, above formula can be written as

$\forall x\left[\left(\sim \text{singular}(x) \vee \sim \text{orthogonal}(x)\right) \vee \sim \text{symmetric}(x)\right]$

28.



$2 \times 2 \times 2 = 8$ total

29. (B) Dependencies are preserved

But it is lossy because $(R_1 \cup R_2) \cap R_3 = \phi$ and all other combinations of R_1, R_2 and R_3 will result the same.

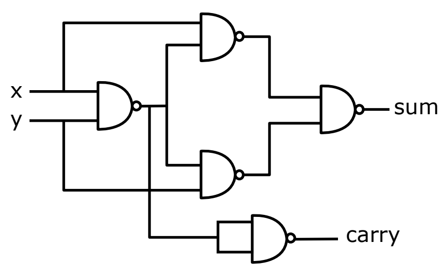
30. As we should use the subnet mask as 255.255.255.192
192-11000000
The broadcast address need to have all 1's in the host part.

32.

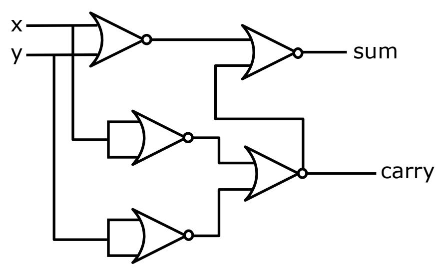
Process	Max. Need	Current Allocation	Need
P_0	11	8	3
P_1	5	3	2
P_2	9	3	6
P_3	13	9	4

Total number of available resources = 25-23=2, with these two resources only process p1 can be executed, once p1 is executed available resources will be 5, with these P_0 or P_3 can be executed but not P_2.

33. Using NAND gate only



Using NOR gate only



Using MUX we need 3 2×1 MUX
2 for implement EXOR (sum)
1 for implement AND gate (carry)

Size of decode is 2×4 (has two inputs only)

34. Customer ($\underline{\text{cid}}$, ename, Add) $\rightarrow$ entity type

R_1 ($\underline{\text{cid , phone}}$) $\rightarrow$ multivalue attribute

Car ($\underline{\text{Car} - \text{no}}$, model) $\rightarrow$ entity type

R_2 ($\underline{\text{Car} - \text{no, color}}$) $\rightarrow$ multivalue attribute

R_3 ($\underline{\text{Cid, car} - \text{no}}$) $\rightarrow$ m : n relationship

35. $\text{First}(R) = \{b, \varepsilon\}$ $\qquad$ $\text{Follow}(T) = \{\$, C\}$

$\text{First}(T) = \{a, b\}$

Augment $T' \rightarrow T$ to above grammar

$I_0 : T' \rightarrow \bullet T$
$\quad T \rightarrow \bullet R$
$\quad T \rightarrow \bullet aTc$
$\quad R \rightarrow \bullet \in$
$\quad R \rightarrow \bullet bR$

$I_1 : \text{Goto}(I_0, T)\quad T' \rightarrow T\bullet$
$I_2 : \text{Goto}(I_0, R)\quad T \rightarrow R\bullet$
$I_3 : \text{Goto}(I_0, a)\quad T \rightarrow a \bullet Tc$
$\quad T \rightarrow \bullet R$
$\quad T \rightarrow \bullet aTc$
$\quad R \rightarrow \bullet \in$
$\quad R \rightarrow \bullet bR$

$I_4 : \text{Goto}(I_0, b)$
$\quad R \rightarrow b \bullet R$
$\quad R \rightarrow \bullet \in$
$\quad R \rightarrow \bullet bR$
$I_5 : \text{Goto}(I_3, T)$
$\quad T \rightarrow aT \bullet c$
$I_6 : \text{Goto}(I_4, R)$
$\quad R \rightarrow bR\bullet$
$I_7 : \text{Goto}(I_5, c)$
$\quad T \rightarrow aTc\bullet$

Total 8 item sets

36.

Elevator(Scan) Algorithm		SSTF Algorithm	
$67 \rightarrow 77$	$= 10$	$67 \rightarrow 77$	$= 10$
$77 \rightarrow 92$	$= 15$	$77 \rightarrow 92$	$= 15$
$92 \rightarrow 111$	$= 19$	$92 \rightarrow 111$	$= 19$
$111 \rightarrow 155$	$= 44$	$111 \rightarrow 155$	$= 44$
$155 \rightarrow 164$	$= 9$	$155 \rightarrow 164$	$= 9$
$164 \rightarrow 200$	$= 36$	$164 \rightarrow 200$	$= 36$
$200 \rightarrow 248$	$= 48$	$200 \rightarrow 248$	$= 48$
$(248 \rightarrow 250 = 2)$	$= 2$	$248 \rightarrow 12$	$= 236$
$250 \rightarrow 12$	$= 238$		417
	421		

$$\% \text{ movements saved} = \frac{421 - 417}{421} \times 100 = 0.95\%$$

37. $500\,\text{KB of data} = \dfrac{500 \times 2^{10}\ \text{bytes}}{512\ \text{bytes}} = 1000\ \text{sectors}$

$1000\ \text{sectors} = \dfrac{1000}{63} \simeq 16\ \text{tracks}\,(15.87)$

$\text{Seek time for 16 tracks} = (50 \times 16)\,\text{ms} = 800\,\text{ms}$

$\text{Rotational delay for 15 tracks} = (5 \times 15)\,\text{ms} = 75\,\text{ms}$

$\text{On 16th track 55 remaining sectors} = \left(\dfrac{55}{63}\right) \times 5\,\text{ms} = 4.36\,\text{ms}$

$\text{To transfer 1000 sectors} = (0.5\,\text{ms}) \times 1000 = 500\,\text{ms}$

$\text{total time} = (800 + 75 + 4.36 + 500)\,\text{ms} = 1379.36\ \text{ms}$

38. The token rotation time(TRT) is equal to total time for token to go around the ring + time taken at each station to transmit the token.

$\text{TRT} = \text{Ring latency} + 8 * \left(\dfrac{\text{Frame size}}{\text{Data Rate}}\right)$

$\text{TRT} = 500\mu\,\text{sec} + 8 * \left(\dfrac{2\,\text{KB}}{1000\,\text{MBps}}\right)$

$\text{TRT} = 500\mu\,\text{sec} + 16\mu\,\text{sec}$

$\text{TRT} = 516\mu\,\text{sec}$

39.

←30→

Tag	Lines	Words
(16)	(10)	(4)

$\text{so total Tag size} = \text{Number of Lines} \times \text{tag bits} = 2^{10} \times 16 = 2^{14}\ \text{Bits}$

$\text{Size in bytes} = \dfrac{2^{14}}{2^{3}} = 2^{11}$

40.

EQUI JOIN (vs) NATURAL JOIN
Both returns same no of rows. But in Natural Join, the common columns will exist only ONCE, where as in Equi Join, the common columns repeats twice one for each table.

41. Matrix A is symmetric so A^{20} will also be symmetric

Let $A^{20} = \begin{bmatrix} a & b \\ b & a \end{bmatrix}$

Trace of matrix $(a+a) =$ sum of eigen values

Eigen values of $A = 1, 3$

Eigen values of $A^{20} = 1, 3^{20}$

So, $a = \dfrac{3^{20}+1}{2}$

To find b : $\left|A^{20}\right| =$ product of eigen values $= 1 \times 3^{20} = 3^{20}$

But $\det = a^2 - b^2$

$\left(\dfrac{3^{20}+1}{2}\right)^2 - b^2 = 3^{20}$

Solving this will give $b = \left(\dfrac{3^{20}-1}{2}\right)$

42. Since matrix multiplication is not commutative.

43. C4, C5 are not CFLs because they take 2 comparisons each. C2 is not CFL because we will get c's only after a's and b's (so not possible to design PDA which will check number of b's is equal to the sum of number of a's and c's).

44. L_2 represented by G_2 is a regular language, then L_4 have to be regular in turn context free,

L_1 represents set of strings with equal number of a's and b's hence L_1 is also regular

So, $L_3 = L_1 \cap L_2$ is regular, as regular languages are closed under intersection, so they are context free also.

45. One collision each for keys 28 and 40 and three collisions for key 50.

46.

	a	b
$\rightarrow q_0$	1	4
q_1	5	2
q_2	3	6
q_3	3	3
q_4	1	4
q_5	1	4
q_6	3	7
q_7	3	6

Combind

Combine

Hence total distinguished set of states is 5

47. $\frac{L_t}{B} \le \frac{d}{v} + \frac{mb}{B}$, where L_t is the length of the token

B : Bandwidth of channel $= 8\,kbps$

d : Ring size $= 2\,km$

v : propagation speed $= 200\,m/\mu\,sec$

m : Number of stations $= 25$

b : Bit delay per station $= 2$ bits

$$L_t \le \left(\frac{2000}{200} + \frac{25\times 2}{8000}\right)8000\,\text{bits}$$

or, $L_t \le 50.08$ bits

So, the maximum token length is 50 bits

49. Let $E_1 =$ 1st person being alive 35 years

$E_2 =$ 2nd person being alive 35 years

$E_1 \cap E_2 =$ both person being alive 35 years

$P(E_1) = \frac{5}{11+5} = \frac{5}{16}$ $\quad P(E_2) = \frac{3}{5+3} = \frac{3}{8}$

(i) $P(E_1 \cap E_2) = P(E_1)\ P(E_2)$

$$= \frac{5}{16} \times \frac{3}{8} = \frac{15}{128} \begin{Bmatrix} \text{since } E_1 \text{ and } E_2 \\ \text{are independent events} \end{Bmatrix}$$

(ii) $P(E_1 \cup E_2) =$ E_1 and E_2 are independent

$P(E_1 \cup E_2) \Rightarrow E_1^c$ & E_2^c also independent

$= 1 - P\left\{(E_1 \cup E_2)^c\right\}$

$= 1 - P\left(E_1^c \cap E_2^c\right)$

$= 1 - P\left(E_1^c\right)P\left(E_2^c\right)$

$= 1 - \left[\left\{1 - P(E_1)\right\}\left\{1 - P(E_2)\right\}\right]$

$= 1 - \left[\left(1 - \frac{5}{16}\right)\left(1 - \frac{3}{8}\right)\right]$

$= 1 - \left[\frac{11}{16} \times \frac{5}{8}\right]$

$= 1 - \left[\frac{55}{128}\right] = \frac{73}{128}$

50. MTBF = MTTF + MTTR

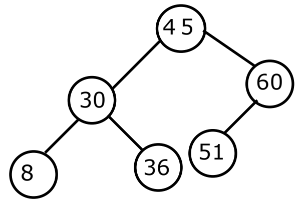
$\therefore$ MTTF = MTBF – MTTR = 24days – 12hrs=23.5 days= 564 hours

51. 24 days = 576 hrs $\quad$ $\text{Availability} = \left(\frac{\text{MTTF}}{\text{MTBF}}\right) \times 100\%$

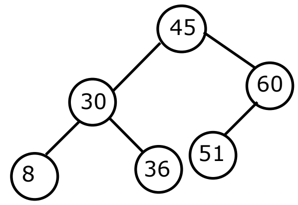
$$= \frac{564}{576} \times 100\% = 97.91 \approx 98\%$$

23.5 days = 564 hrs

52.



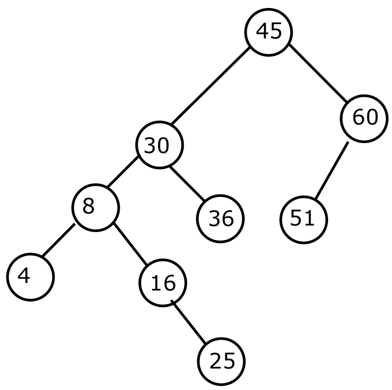
BST



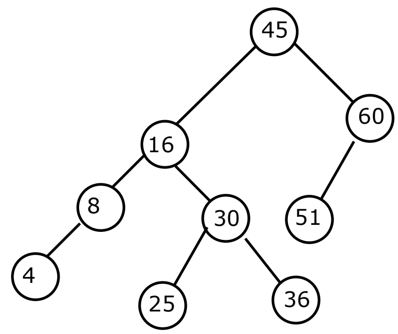
AVL Tree

Here BST and AVL tree are identical. So Difference in their height is 0.

53.



BST

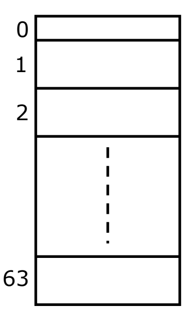


AVL Tree

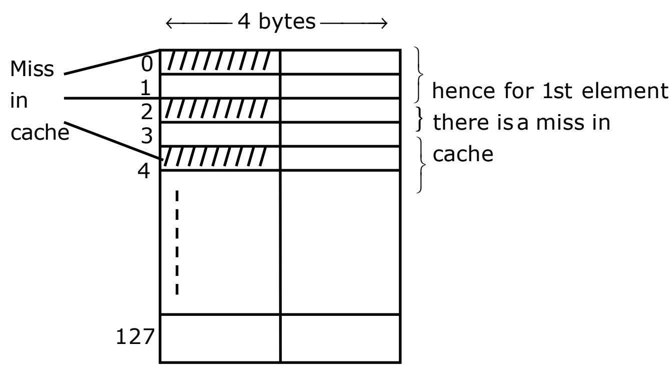
From the figure, the difference in height of BST and AVL tree is 1.

54. $\text{Miss rate} = \dfrac{\text{total number of misses}}{\text{total memory access}}$

$$\text{no. of blocks in cache} = \frac{512 \text{ bytes}}{8 \text{ bytes}} = 64$$



Cache organization
(direct mapped)



Array Organization

$$\text{So, miss rate} = \frac{1}{4} = 25\%$$

55. If we increase block size by twice, then number of elements in a block is$=\frac{\text{size of block}}{\text{size of integer}}=\frac{16}{2}=8$ elements

So miss rate $=\frac{1}{8}$ (half of miss rate of previous question)

60. $\text{S.I for 1 year} = \text{Rs.}(900-800)=\text{Rs.}100$

$\text{S.I for 4 years} = \text{Rs.}(100\times 4)=\text{Rs.}400$

$\text{Principal}=\text{Rs.}400$

62. Suppose X will cost 40 paisa more than Y after 2 years, then

$(4.20+0.40Z)-(6.30+0.15Z)=0.40$

$0.25Z=0.40+2.10 \Rightarrow Z=10$

$\text{Required year}=2001+10=2011$

63. C's 1 day of work $=\frac{1}{3}-\left(\frac{1}{6}+\frac{1}{8}\right)=\frac{1}{24}$

A's wages : B's wages : C's wages $=\frac{1}{6}:\frac{1}{8}:\frac{1}{24}=4:3:1$

C's share for 3 days $3\times\frac{1}{24}\times 3200=\text{Rs.}400$

64. Let the three integers be $x,\ x+2,\ x+4$

$3x=2(x+4)+3 \Rightarrow x=11$

$\text{Third integer}=11+4=15$

65. From the data it is not given that percentage of proteins in skin is 16%
Rather it is given that percentage entire human body is 16%
Therefore, we should not do 16% of 1/10