Answer Keys

1	5	**2**	B	**3**	B	**4**	2048	**5**	10	**6**	A	**7**	C
8	A	**9**	375	**10**	700	**11**	A	**12**	B	**13**	D	**14**	A
15	200	**16**	B	**17**	A	**18**	B	**19**	D	**20**	D	**21**	C
22	32	**23**	C	**24**	D	**25**	B	**26**	B	**27**	D	**28**	133
29	3.25	**30**	A	**31**	C	**32**	A	**33**	A	**34**	6	**35**	D
36	B	**37**	D	**38**	D	**39**	D	**40**	C	**41**	B	**42**	D
43	D	**44**	B	**45**	D	**46**	B	**47**	D	**48**	5	**49**	10
50	B	**51**	A	**52**	C	**53**	B	**54**	A	**55**	A	**56**	D
57	C	**58**	D	**59**	D	**60**	B	**61**	D	**62**	B	**63**	C
64	D	**65**	C										

Explanations:-

1. Graph G be a connected graph with n vertices and m edges. The spanning tree contains '$n-1$' edges only. No. of edges that must be deleted in order to get spanning tree of $G = m - n + 1$ this is called circuit Rank.
So, circuit rank= 15-11+1=5

2. $\sum_{x=0}^{n} \frac{x}{n} \cdot \binom{n}{x} p^x q^{n-x} = \frac{1}{n} \sum_{x=0}^{n} x \binom{n}{x} p^x q^{n-x} = \frac{1}{n} . E(x) = \frac{1}{n} . np = p$

3. $P \rightarrow (\neg r + \neg q)$

$P \rightarrow (r \vee \neg q)$

$\left[\because \text{contrapositive of } x \rightarrow y = \neg y \rightarrow \neg x\right]$

$\neg(r \vee \neg q) \rightarrow \neg p$

$\left[\because x \rightarrow y = \neg x \vee y\right]$

$(r \vee \neg q) \vee \neg p$

4. Frame size $= 64\,B = 2^9$ bits

In 1 sec 1 Giga bit is transferred

$\therefore$ In 1ms 1×10^{-3} Gb is transferred

$1 \times 10^{-3} Gb = \frac{2^{30} \times 10^{-3}}{2^9}$ frames $=$ 2048 frames

5.

P_1	P_2	P_3	P_1	P_2	P_3	P_1	P_3	P_1	P_1	P_1

0 1 2 3 4 5 6 7 8 9 10 11

6.

A \ BC	00	01	11	10
0	0	X		X
1	X	0	0	0

B $\quad \overline{A}$

$F = \overline{A}.B$

(or

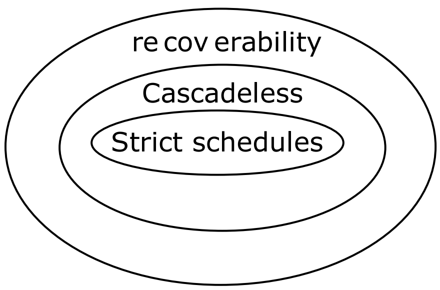
$F = \overline{A}.C$

7. Number of serial schedules possible with n transactions $= n!$
2 transactions $= 2! = 2.$

No. of concurrent schedules possible with $T_1 = n_1, T_2 = n_2$

$$\text{instructions} = \frac{(n_1 + n_2)!}{n_1!n_2!} = \frac{(2+5)!}{2!5!} = \frac{7!}{2!5!} = \frac{6 \times 7}{2} = 21$$

8.



9. Total Data to transfer= 2000 x 4= 8000 B
10^7 B -------------------------- 1 s
8000 B------------------------$8000/10^7$ s
$8000/10^7$ s= RTT + transmission time
$8000/10^7$ s = 2*prop delay+ transmission time
$8000/10^7$ s = 2*prop delay+ 50 μs
Prop delay= 375 μs

10. Total input data for 60 sec $= 50 \text{ kB} \times 10 + 10 \text{ kB} \times 50$
$= 1000 \text{ kB}$

Now output rate $= 5 \text{ kB/S}$

$\therefore$ Output data for 60 sec $= 5 \text{ kB} \times 60 = 300 \text{ kB}$

Hence Bucket size $= (1000 - 300) \text{ kB} = 700 \text{ kB}$

11. In a perfect binary tree number of nodes will be always odd
In a perfect binary of height h, total number of nodes = 2^{h+1} -1

$\therefore n = 2^{h+1} - 1;$ number of internal nodes

$$= 2^h - 1 = \frac{n}{2} - \frac{1}{2} = \left\lfloor \frac{n}{2} \right\rfloor \text{(Because n is always odd)}$$

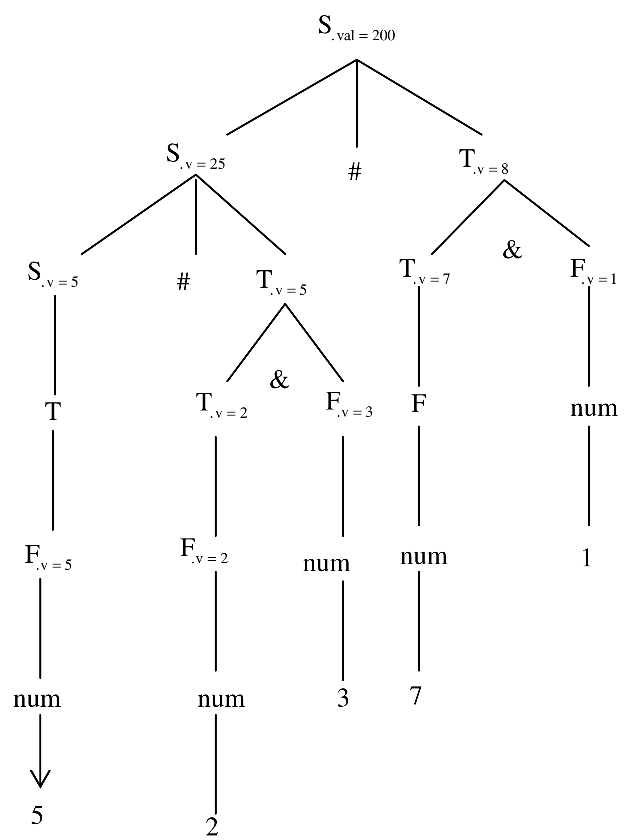
12. According to program,
$F(n) = n + 2F(n-1)$ for $n >= 2$
$= 0$ for $n = 1$

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

13. In a binary min heap the max element can be found among the leaf nodes. For a heap with n nodes there are at most ceil(n/2) leaf nodes all of those need to be searched, hence it takes $\Theta(n)$ time.

14. Effort applied $= a_b \times (KLOC)^{b_b} = 2.4 \times (64)^{1.05} \approx 189\,PM$

15.



16. (2) is finite, hence regular
Let us use pumping lemma for (3)
For $m \geq 3$, a y value of "aa" or "bb" will always pump the string. Hence (3) is regular
(4) is regular as it can be expressed with regular expression $0(0+1)^{+}0+1(0+1)^{+}1$

17. $(R*S)*$ can produce $\in$. But $(R+S)*S$ cannot, hence they are not equivalent

18. $1-(1-0.6)*(1-0.4)*(1-0.5) = 0.88$.

19. output equation is $\overline{x}.1 + xy = \overline{x} + y$ $\left[\text{absorption law } \overline{x} + xy = \overline{x} + y\right]$

$\Rightarrow \overline{x} + y = a + b \Rightarrow x = \overline{a} \;\&\; y = b$

20.

x \ yz	00	01	10	11
0			1	1
1	1	1	1	1

This is the K – MAP for expression $y + x.\overline{y}$

x \ yz	00	01	10	11
0	0	1	3	2
1	4	5	7	6

So answer is (d) $\sum m(2,3,4,5,6,7)$

21. Given number = 1111 1111 1011

2's complement of the given number =00101=$(-5)_{10}$

So $(-15)_{10}$ is divisible by $(-5)_{10}$

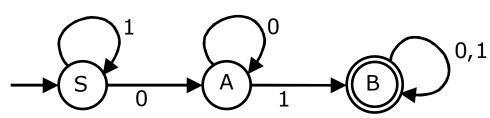
Because 2's complement of 1001=$(-15)_{10}$

22. Size of required address is 20 bit, so 16 chips of 64k words makes 2^{20} words each of size 4 bits. As we need word size as 8 bits and available is 4 bits so we need to put another 16 chips in parallel.

23. The DFA corresponding to option (C) is

$1*00*1(0+1)*$

$= 1*0*01(0+1)*$



So, this DFA accepts all string with a sub string 01.

24. $\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix} = \begin{bmatrix} l_{11} & 0 \\ l_{21} & l_{22} \end{bmatrix} \begin{bmatrix} 1 & u_{12} \\ 0 & 1 \end{bmatrix}$

$\text{Solving, we get } L = \begin{bmatrix} 1 & 0 \\ 3 & -2 \end{bmatrix}, U = \begin{bmatrix} 1 & 2 \\ 0 & 1 \end{bmatrix}$

25. $V(2x+3) = 2^2 V(x) = 4 \times 6 = 24$

26. Main memory size = 2^{21} words

Cache memory size=32 kb

Word size= 16 bit= 2B

Block size=1kw=2^{11}B=2B×2^{10}

For word addressable memory, physical address bits =21 bits

So bytes in main memory =2^{21} words=$2^{21}\times$2B= 2^{22} bytes

For byte addressable memory, physical address bits =22 bits

$\therefore \text{Number of blocks } M = \frac{2^{22}B}{2^{11}B} = 2048 \text{ blocks}$

27. $\% \text{ CPU free time} = \frac{\text{data transfer time}}{\text{total time}}$

$\text{total time} = \text{initialization time} + \text{termination time} + \text{data transfer time}$

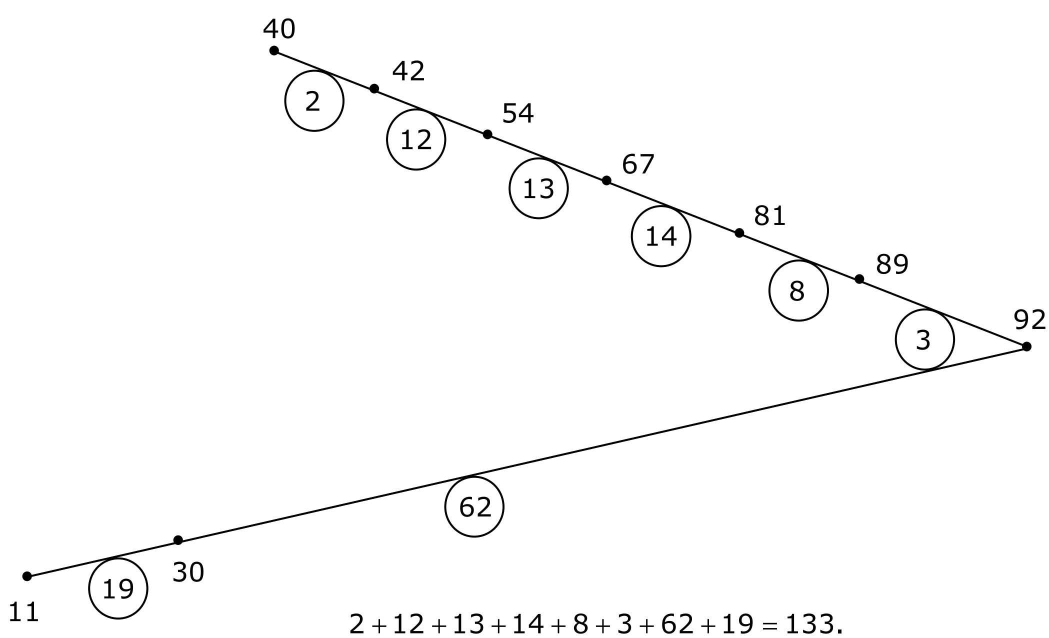
$\text{Initial set up time} = 1000 \text{ clocks} * 1 \text{ clock cycle time} = \frac{1000}{2*10^9} s = 0.5\mu s$

$\text{Termination time} = 700 * \frac{1}{2*10^9} \sec = 0.35\mu s$

$\text{Data transfer time for 16kB} = \frac{16kB}{4000kB} \sec = 4*10^{-3} \sec = 4000\mu s$

$\% \text{ CPU free} = \frac{4000\mu s}{(0.5\mu s + 0.35\mu s + 4000\mu s)} * 100 = 99.97\%.$

28.



$2+12+13+14+8+3+62+19=133.$

29. Response time = first response time – arrival time

Gant chart:

P_1	P_2	P_2	P_4

0 5 6 8 13

So, response time of

$P_1 = 0 - 0 = 0$

$P_2 = 5 - 1 = 4$

$P_3 = 6 - 2 = 4$

$P_4 = 8 - 3 = 5$

The average response time $= \dfrac{0+4+4+5}{4} = 3.25$

30. Minimum number of nodes $= 1 + 2 + 2.\left\lceil \dfrac{k}{2} \right\rceil + ... + 2.\left\lceil \dfrac{k}{2} \right\rceil^{h-1}$

$$= 1 + 2\left[\frac{\left\lceil \frac{k}{2} \right\rceil^{h} - 1}{\left\lceil \frac{k}{2} \right\rceil - 1}\right]$$

$$1 + 2\left[\frac{3^4 - 1}{3 - 1}\right] = 81.$$

Maximum number of nodes $= 1 + k + k^2 + ... + k^h$

$$= \frac{k^{h+1} - 1}{k - 1} = \frac{5^{4+1} - 1}{5 - 1} = \frac{5^5 - 1}{4} = \frac{3125}{4} = 781 \Leftarrow \frac{3124}{4}.$$

31. The output table is

A	B	C	D
1	2	3	1
1	2	4	1
2	1	3	5
3	1	3	null
4	2	null	1
3	2	null	1

33. g(0)=0
g(1)=30
//Item 3
g(2)=max[64 + g(0), 30 + g(1)]=64
//Item 1
g(3)=max[64 + g(1), 81 + g(0), 30 + g(2)]=94
//Item 1,3
g(4)=max[64 + g(2), 81 + g(1), 30 + g(3)]=128
//Item 1
g(5)=max[64 + g(3), 81 + g(2), 30 + g(4), 25 + g(0)]=158
//Item 1,3

34. 45 mod 20 = 5 ; No collision
25 mod 20 = 5 -> 9 mod 20 = 9 ; 1 collision
10 mod 20 = 10 ; No collision
5 mod 20 = 5 -> 9 mod 20 = 9 -> 13 mod 20 = 13 ; 2 collisions
9 mod 20 = 9 -> 13 mod 20 = 13 -> 17 mod 20 = 17; 2 collisions
30 mod 20 = 10 -> 14 mod 20 = 14 ; 1 collision

35. Total 1 + 2 + 2 + 1=6 collisions
$T(n) = 1$ if $n <= 4$
$T(n) = T(\sqrt{n}) + \log n$ if $n>4$
Taking $m = \log n$, the equation becomes
$T(2^m) = 2\,T(2^{m/2}) + m$,
Now renaming $S(m) = T(2^m)$, the recurrence relation becomes
$S(m) = 2\,S(m/2) + m$.
Using Master's theorm,
$S(m) = T(2^m)= \Theta(m \log m) = \Theta(\log n \log\log n)$

36. Propagation time$=45000\text{x}10^3/(2\text{x}10^8)=0.225$ s
So RTT=2*0.225=0.45 s
So bandwidth delay product=1 mbps x 0.45 s
So Bandwidth utilization=127x150x8/bandwidth delay product=33.87%

38. The mask is 255.255.255.0 = 11111111. 11111111. 11111111. 000000000 which is same as the default class C mask. Hence no. of subnet bits = 0.
$\therefore$ Maximum no. of subnets = $2^\circ = 1$ and no. of host bits = 32-24=8. Hence host per subnet $= 2^8 - 2 = 254$

39. Copy propagation reduces the copying of variable values. It replaces all the uses of j directly by s and thus j=s may be eliminated.

40. (A) $(1+01)*(0+\lambda)$

$(11)(\lambda)=(11)$

(B) $(1+01)*(0+\lambda)$

$(01)(\lambda)=01$

(D) $(1+01)*(0+\lambda)$

10

(C) In the given regular expression '00' never comes as a substring or string.

42.

	a	b
q_0	q_0 or q_1	q_0 or q_1
q_1	q_0 or q_1	q_0 or q_1

Non-final

	a	b
q_0	q_0	q_0
q_0	q_0 or q_1	q_0 or q_1

Final

2x2x2x2 = 16 ---------------- (1)

2x2 = 4 ---------------- (2)

No. of possible DFA's = 16+4 = 20

43. $Z(p,q,r,s)=\bar{r}\bar{s}+\bar{r}sq+rs=\sum m(0,3,4,5,7,8,11,12,13,15)$

44. Inner query returns total number of departments and outer query groups WORKS_IN table by the attribute eno. And it filters the groups based on number of tuples in each group(this number should be equal to total number of departments returned by outer query then only that respective eno of the group will be selected)

45. Let $f(u)=\tan x \;=\; \dfrac{x^3+y^3}{x-y}$

$\therefore f(u)$ is a homogenous function of degree 2

$$\therefore x\frac{\partial u}{\partial x}+y\frac{\partial u}{\partial y} = n\frac{f(u)}{f'(u)}$$

$$=2\,\frac{\tan u}{\sec^2 u} = 2\frac{\sin u}{\cos u}\cos^2 u = \sin 2u$$

46 . If $(x_m - x_n)$ divisible by 7, then we will have 7 possible remainders $\{0,1,2,3,4,5,6\}$.

If $(y_m - y_n)$ is divisible by 3, then we have 3 possible remainders $\{0,1,2\}$ So by pigeon hole principle it can be proved that least number of pairs required $= (7 \times 3) + 1 = 22$

$x_m - x_n$ is divisible by 7 iff

x_m remainder $7 = x_n$ remainder 7

Remainder option x	Remainder option y	
0	0	21 options, so after 21 such pair 22nd pair will definitely match any of these, hence satisfy the given condition.
1	1	
2	2	
3		
4		
5		
6		

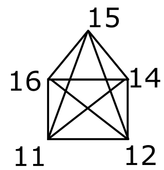
47.

X	Y	Q_n	Q_{n+1}	J	K
0	0	0	1	1	×
0	0	1	0	×	1
0	1	0	1	1	×
0	1	1	1	×	0
1	0	0	0	0	×
1	0	1	1	×	0
1	1	0	0	0	×
1	1	1	0	×	1

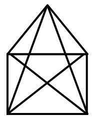
X \ YQ_n	00	01	11	10
0	×	1		×
1	×		1	×

$$K = \bar{X}\bar{Y} + XY$$
$$= \overline{X \oplus Y}$$
$$= X \odot Y$$

48. Number of elements in maximum clique of graph = clique number of graph (Any subset of a graph in which all the vertices are connected to each other directly is called clique of a graph and largest possible subset is called maximum clique. So in the given graph maximum clique is as follows



49. Number of vertices in the line Graph of



is equal to the number of edges in graph $\frac{5(5-1)}{2} = 10.$

50. eg: A={5, 4, 3, 2, 1}
Here (1,2), (1,3), (1,4), (1,5)
(2,3), (2,4), (2,5)
(3,4), (3,5)
(4, 5) are inversions.

Hence, maximum number of inversions =(n-1)+(n-2)+......+1 $= \frac{n(n-1)}{2}$

51. Algorithm steps:
1. Use merge sort to sort A & store the output in B.
2. Consider an element from A, starting From 1st index
3. Find the position of A[1] in B using binary-search.
4. The (position-1) will give no. of inversions w.r.t A[1] in A.
5. Remove A[1] from A & B
6. Repeat 2 to 5 for all elements. (steps)
This requires $\theta(n.\log n)$ time.

52. If $X = Y = 0$, available will be $(0,0,2,0)$ with this P_4 then P_2 can be executed then any of the remaining processes can be executed

53.

	Allocation	Max	Need	Available
	A B C D	A B C D	A B C D	
P_1	0 2 1 4	1 2 1 4	1 0 0 0	0 0 2 0
P_2	1 3 5 4	1 6 5 5	0 3 0 1	
P_3	2 0 6 4	3 0 6 4	1 0 0 0	
P_4	0 6 3 2	0 6 5 2	0 0 2 0	
P_5	1 0 1 4	2 0 1 5	1 0 0 1	

With (0, 0, 2, 0) only P_4 can be executed then only P_2 can be executed then any of the remaining processes can be executed, so number of sequences $= \underline{P_4}\ \underline{P_2}\ \underline{3} \times \underline{2} \times \underline{1} = 6$

54. Disk size $= 16 * 1024 * 1024 * 1$ kB

$= 16 * 2^{30}$ byte

$= 16$ GB.

55. Initial time $= 300 * \frac{1}{600 * 10^6} = 0.5\mu s$

$\text{ter min ate time} = 900 * \frac{1}{600 * 10^6} = 1.5\mu s$

time for 1 revolution $= \frac{60}{3000}$ sec

In 1 revolution or in $\frac{60}{3000}$ sec, data transfer is $\longrightarrow 1024$ kB

so in 1 sec data transfer is $\rightarrow \frac{1024 * 3000}{60}$ kB $= 50$MB / sec(data transfer rate)

Data transfer time for 20kB $= \frac{20kB}{50MB}$ sec $= 0.4 * 10^{-3}$ s $= 400\mu s$

% CPU consumed $= \frac{\text{Initial time} + \text{term in ation time}}{\text{total time}} * 100$

$= \frac{0.5\mu s + 1.5\mu s}{(0.5\mu s + 1.5\mu s + 400\mu s)} \Rightarrow \frac{2\mu s}{402\mu s} * 100 = 0.49\%$

59. If the same noun is repeated after preposition, the noun will be singular

60. Let the smaller number be x

Then largest number $= (x + 4245)$

$\therefore x + 4245 = 8x + 45 \Rightarrow 7x = 4200 = x = 600$

$\therefore$ smaller number $= 600$

62. Anshu 1 day work = 1/16

Satish 1 day work = 1/20

Anshu+Satish's 1 day work $= \left(\frac{1}{16} + \frac{1}{20}\right) = \left(\frac{5+4}{80}\right) = \frac{9}{80}$

$\therefore$ Gulshan 1 day work = (Anshu + Satish + Gulshan)

= 1 day work – (Anshu + satish 1 day work)

$= \frac{1}{5} - \frac{9}{80} = \frac{7}{80}$

$\therefore$ Gulsan can finish the work in 80/7 days.

63. Possible cases =

$2B \ \& \ 2G = {}^6C_2 \times {}^4C_2 \quad ---(i)$

$3B \ \& \ 1G = {}^6C_3 \times {}^4C_1 \quad ---(ii)$

$4B \quad = {}^6C_4 \quad ---(iii)$

Adding (i),(ii),(iii)

$90 + 80 + 15 = 185$

64. We need to find out no. of students who take at least one of 3 subjects & subtract from 120.

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

$= 60 + 24 + 17 - (A \cap B + B \cap C + C \cap A) + (A \cap B \cap C)$

$A \cap B = ?$

10th, 20th, 30th, no. of students opted both physics & chemistry

$= 120 / 10 = 12$

$C \cap A = 120/14 = 8 \qquad B \cap C = 120/35 = 3$

$A \cap B \cap C = 120/70 = 1$

$A \cup B \cup C = 60 + 24 + 17 - (12 + 3 + 8) + 1 = 79$

None of 3 subjects opted by students = 120-79=41.

65. Required ratio =

$(272 + 240 + 236 + 256 + 288) : (280 + 179 + 148 + 160 + 193)$

$= 1292 : 960 = 323:240$