2 Digital Logic

Practice Questions

Number System

Q.1 4-bit 2's complement representation of a decimal number is 1000. The number is

(A) +8 (B) 0

(C) – 7 (D) – 8

Q.2 Decimal 43 in Hexadecimal and BCD number system is respectively

(A) B2, 01000011

(B) 2B, 01000011

(C) 2B, 0011 0100

(D) B2, 01000100

Q.3 X = 01110 and Y = 11001 are two 5-bit binary numbers represented in two's complement format. The sum of X and Y represented in 2's complement format using 6 bits is

(A) 100111 (B) 001000

(C) 000111 (D) 101001

Q.4 The two numbers represented in signed 2's complement form are

P = 11101101 and Q = 11100110

If Q is subtracted from P, the value obtained in signed 2's complement form is

(A) 100000111 (B) 00000111

(C) 11111001 (D) 111111001

Q.5 What is the gray code word for the binary number 101011?

(A) 110101 (B) 111110

(C) 101011 (D) 011111

Q.6 Consider the equation $(123)_5 = (x8)_y$ with x and y as unknown. The number of possible solutions are _____.

Q.7 If $(101)_b + (D2)_{16} = (467)_{10}$. Then the value of radix 'b' is _____.

(A) 13 (B) 14

(C) 18 (D) 16

Q.8 The number $(A72E)_{16}$ is equivalent to

(A) $(1010001100101110)_2$ and $(123456)_8$

(B) $(1010011100111111)_2$ and $(123456)_8$

(C) $(1010011100101110)_2$ and $(123456)_8$

(D) None of these

Boolean Algebra

Q.9 The K-map for a Boolean function is shown below. The number of essential prime implicants for this function is

CD \ AB	00	01	11	10
00	1	1	0	1
01	0	0	0	1
11	1	0	0	0
10	1	0	0	1

(A) 4 (B) 5
(C) 6 (D) 8

Q.10 The logical expression $y = A + \overline{A}B$ is equivalent to

(A) $y = AB$ (B) $y = \overline{A}B$

(C) $y = \overline{A} + B$ (D) $y = A + B$

Q.11 The minimized form of the logical expression $(\overline{A}\,\overline{B}\,\overline{C} + \overline{A}B\overline{C} + \overline{A}BC + AB\overline{C})$ is

(A) $\overline{A}\,\overline{C} + B\overline{C} + \overline{A}B$

(B) $A\overline{C} + \overline{B}C + \overline{A}B$

(C) $\overline{A}C + \overline{B}C + \overline{A}B$

(D) $A\overline{C} + \overline{B}C + A\overline{B}$

Q.12 The number of distinct Boolean expression of 4 variables is

(A) 16 (B) 256
(C) 1024 (D) 65536

Q.13 The Boolean expression $Y = \overline{A}\,\overline{B}\,\overline{C}D + \overline{A}BC\overline{D} + A\overline{B}\,\overline{C}D + AB\overline{C}\,\overline{D}$ can be minimized to

(A) $Y = \overline{A}\,\overline{B}\,\overline{C}D + \overline{A}B\overline{C} + A\overline{C}D$

(B) $Y = \overline{A}\,\overline{B}\,\overline{C}D + BC\overline{D} + A\overline{B}\,\overline{C}D$

(C) $Y = \overline{A}BC\overline{D} + \overline{B}\,\overline{C}D + A\overline{B}\,\overline{C}D$

(D) $Y = \overline{A}BC\overline{D} + \overline{B}\,\overline{C}D + AB\overline{C}\,\overline{D}$

Q.14 The number of essential prime implicates in the function

$f(a, b, c, d) = \Sigma(1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 15)$

is _____.

Q.15 The Boolean expression

$(X + Y)\,(X + \overline{Y}) + \overline{(X\,\overline{Y}) + \overline{X}}$

simplifies to

(A) X (B) Y
(C) XY (D) $X+Y$

Q.16 Consider the Boolean function,

$F(w, x, y, z) = wy + xy + \overline{w}xyz + \overline{w}\,\overline{x}\,y + xz + \overline{x}\,\overline{y}\,\overline{z}$

Which one of the following is the complete set of essential prime implicants?

(A) $w, y, xz, \overline{x}\,\overline{z}$ (B) w, y, xz

(C) $y, \overline{x}\,\overline{y}\,\overline{z}$ (D) $y, xz, \overline{x}\,\overline{z}$

Q.17 Find how many number of literals are there in given K-map by using all possible type K-map?

AB \ CD				
		1		
		1	1	1
	1	1	1	
			1	1

(A) 4 (B) 14
(C) 17 (D) 8

Q.18 A function of Boolean variables X, Y and Z is expressed in terms of the minterms as $F(X, Y, Z) = \sum m(1, 2, 5, 6, 7)$

Which one of the product of sums given below is equal to the function $F(X, Y, Z)$?

(A) $(\overline{X} + \overline{Y} + \overline{Z})(\overline{X} + Y + Z)(X + \overline{Y} + \overline{Z})$

(B) $(X + Y + Z)(X + \overline{Y} + \overline{Z})(\overline{X} + Y + Z)$

(C) $(\overline{X} + \overline{Y} + Z)(\overline{X} + Y + \overline{Z})$
$(X + \overline{Y} + Z)\,(X + Y + \overline{Z})(X + Y + Z)$

(D) $(X + Y + \overline{Z})(\overline{X} + Y + Z)$
$(\overline{X} + Y + \overline{Z})\,(\overline{X} + \overline{Y} + Z)(\overline{X} + \overline{Y} + \overline{Z})$

Q.19 Consider the following expression :

$f(A, B, C, D) = AD + ABCD + ACD + \overline{A}B + A\overline{C}D + \overline{A}\overline{B} + \overline{A}(\overline{B} + A)$

The minimized expression of $f(A, B, C, D)$ is equal to

(A) AD (B) $\overline{A}+D$

(C) $A+B\overline{C}$ (D) $A\overline{D}+B\overline{C}$

Q.20 Consider the function

$$f(A,B,C,D)=\Sigma m(1,5,7,12,13,14)+d(0,3,11,15)$$

After implementing the given function in minimal SOP form, what is the output for the inputs $ABCD=$ 0011, 1011 and 1111 respectively?

(A) 0, 0 and 1 (B) 0, 1 and 0

(C) 1, 0 and 1 (D) 1, 1 and 1

Logic Gates

Q.21 Consider the Karnaugh map given below, where X represents "don't care" and blank represents 0.

dc \ ba	00	01	11	10
00		x	x	
01	1			x
11	1			1
10		x	x	

Assume for all input (a, b, c, d), the respective complements $(\overline{a}, b, \overline{c}, \overline{d})$ are also available. The above logic is implemented using 2-input NOR gates only.

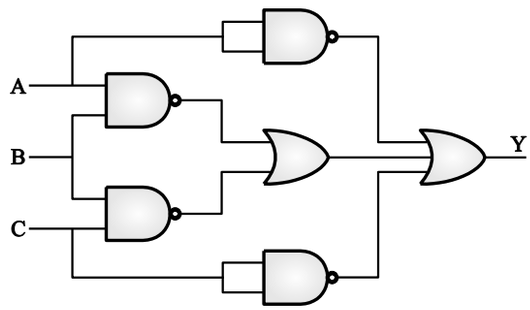
The minimum number of gates required is _____.

Q.22 Minimum number of 2-input NAND gates required to implement the function, $F=(\overline{X}+\overline{Y})(Z+W)$ is

(A) 3 (B) 4

(C) 5 (D) 6

Q.23 For the logic circuit shown in figure, the output is equal to **[MSQ]**



(A) $\overline{ABC}$

(B) $\overline{A}+\overline{B}+\overline{C}$

(C) $\overline{AB}+\overline{BC}+\overline{A}+\overline{C}$

(D) $\overline{AB}+\overline{BC}$

Q.24 The output of a logic gate is '1' when all its inputs are at logic '0'. The gate is either

(A) a NAND or an EX-OR gate.

(B) a NOR or an EX-NOR gate.

(C) an OR or an EX-NOR gate.

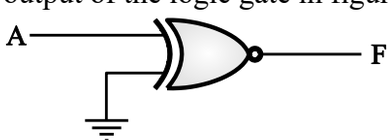
(D) an AND or an EX-OR gate.

Q.25 The minimum number of NAND gates required to implement the Boolean function $A+A\overline{B}+A\overline{B}C$ is equal to

(A) Zero (B) 1

(C) 4 (D) 7

Q.26 The output of the logic gate in figure is



(A) 0 (B) 1

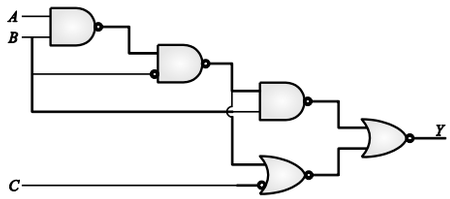
(C) $\overline{A}$ (D) A

Q.27 The minimum number of 2-input NAND gates required to implement the Boolean function $Z=A\overline{B}C$, assuming that A, B and C are available is

(A) two (B) three

(C) five (D) six

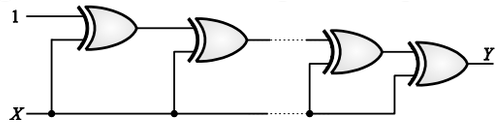
Q.28 For the logic circuit shown in figure, the simplified Boolean expression for the output Y is



(A) $A + B + C$ (B) A

(C) B (D) C

Q.29 If the input to the digital circuit consisting of a cascade of 20 X-OR gates is X, then the output Y is equal to



(A) 0 (B) 1

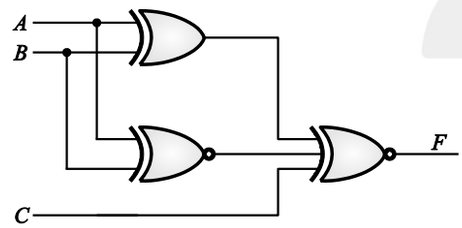
(C) $\bar{X}$ (D) X

Q.30 The Boolean function $Y = AB + CD$ is to be realized using only 2-input NAND gates. The minimum number of gates required is

(A) 2 (B) 3

(C) 4 (D) 5

Q.31 For the output F to be 1 in the logic circuit shown, the input combination should be



(A) $A = 1, B = 1, C = 0$

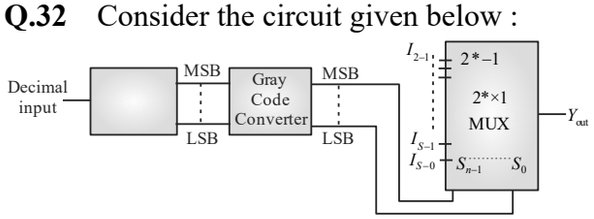
(B) $A = 1, B = 0, C = 0$

(C) $A = 0, B = 1, C = 0$

(D) $A = 0, B = 0, C = 1$

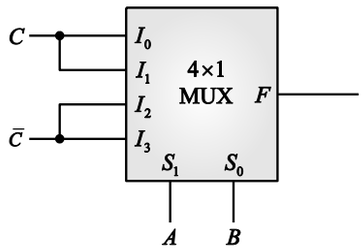
Combinational Circuits

Q.32 Consider the circuit given below :



If the decimal input is 92 then Y_{out} corresponds to l_{gv} then value of m is___.

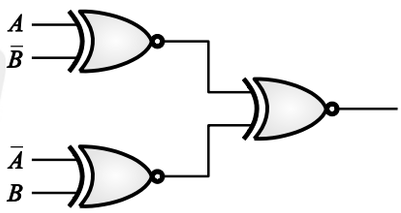
Q.33 The logic realized by the circuit shown in figure is



(A) $F = A \odot C$ (B) $F = A \oplus C$

(C) $F = B \odot C$ (D) $F = B \oplus C$

Q.34 The output of the circuit shown in figure is equal to



(A) 0

(B) 1

(C) $\bar{A}B + A\bar{B}$

(D) $(\overline{A \oplus B}) \oplus (\overline{A \oplus B})$

Q.35 A 2-bit binary multiplier can be implemented using

(A) 2 input AND gates only.

(B) Six 2-input AND gates and two XOR gates.

(C) Two 2-input NORs and one XNOR gate.

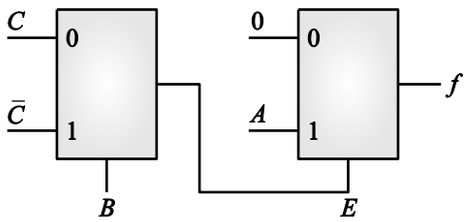
(D) XOR gates and shift registers.

Q.36 The minimum number of 2 to 1 multiplexers required to realize a 4 to 1 multiplexer is

(A) 1 (B) 2

(C) 3 (D) 4

Q.37 The Boolean function 'f' implemented in the figure using two input multiplexers is



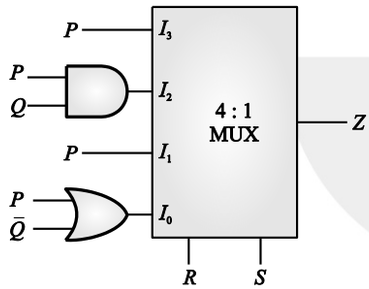
(A) $A\bar{B}C + AB\bar{C}$

(B) $ABC + A\bar{B}\bar{C}$

(C) $\bar{A}BC + \bar{A}\bar{B}\bar{C}$

(D) $\bar{A}\bar{B}C + \bar{A}B\bar{C}$

Q.38 For the circuit shown in the following figure, I_0 - I_3 are inputs to the 4 : 1 multiplexer. R (MSB) and S are control bits.



The output Z can be represented by,

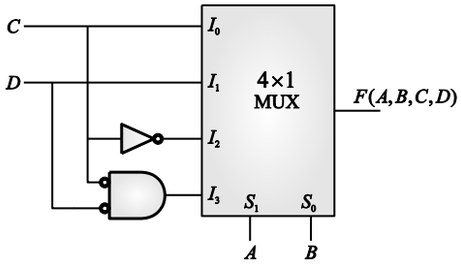
(A) $PQ + PS + \bar{Q}\bar{R}\bar{S}$

(B) $P\bar{Q} + PQ\bar{R} + \bar{P}\bar{Q}\bar{S}$

(C) $P\bar{Q}\bar{R} + \bar{P}QR + PQRS + \bar{Q}\bar{R}\bar{S}$

(D) $PQ\bar{R} + PQR\bar{S} + P\bar{Q}\bar{R}S + \bar{Q}\bar{R}\bar{S}$

Q.39 The Boolean function realized by the logic circuit shown is



(A) $F = \Sigma m(0,1,3,5,9,10,14)$

(B) $F = \Sigma m(2,3,5,7,8,12,13)$

(C) $F = \Sigma m(1,2,4,5,11,14,15)$

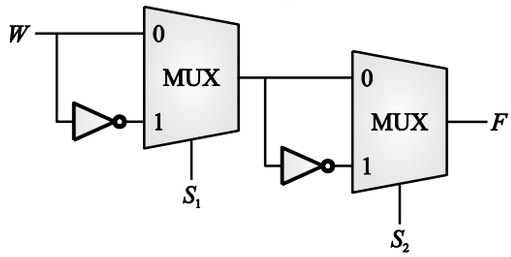
(D) $F = \Sigma m(2,3,5,7,8,9,12)$

Q.40 The output Y of a 2-bit comparator is logic 1 whenever the 2-bit input A is greater than the 2-bit input B. The number of combinations for which the output is logic 1, is

(A) 4 (B) 6

(C) 8 (D) 10

Q.41 Consider the multiplexer based logic circuit shown in the figure.



Which one of the following Boolean functions is realized by the circuit?

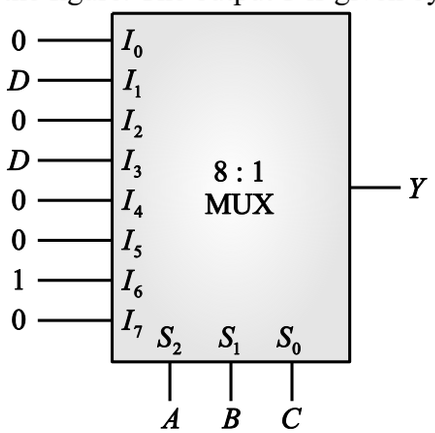
(A) $F = W\bar{S}_1\bar{S}_2$

(B) $F = WS_1 + WS_2 + S_1S_2$

(C) $F = \bar{W} + S_1 + S_2$

(D) $F = W \oplus S_1 \oplus S_2$

Q.42 An 8 to 1 multiplexer is used to implement a logical function Y as shown in the figure. The output Y is given by



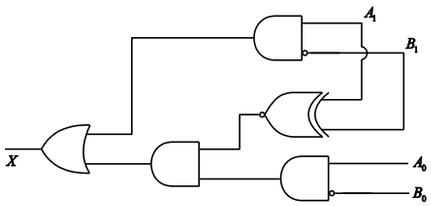
(A) $Y = A\bar{B}C + A\bar{C}D$

(B) $Y = \bar{A}BC + A\bar{B}D$

(C) $Y = AB\bar{C} + \bar{A}CD$

(D) $Y = \bar{A}\bar{B}C + A\bar{B}C$

Q.43 Consider the given circuit



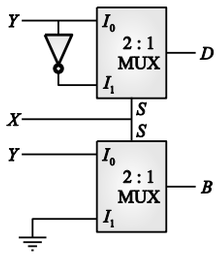
The logic circuit above is used to compare two unsigned 2-bit number. Where $A = A_1A_0$ and $B = B_1B_0$, where A_1 and B_1 represent MSB and A_0 and B_0 represent LSB. Which of the following will make output $X = 1$ always.

(A) $A > B$ (B) $A < B$

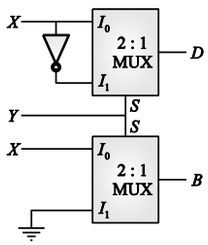
(C) $A \pm B$ (D) $A \geq B$

Q.44 If X and Y are inputs and the Difference ($D = X–Y$) and the Borrow (B) are the outputs, which one of the following diagrams implements a half-subtractor?

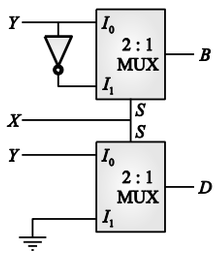
(A)



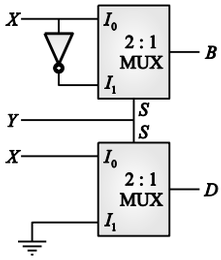
(B)



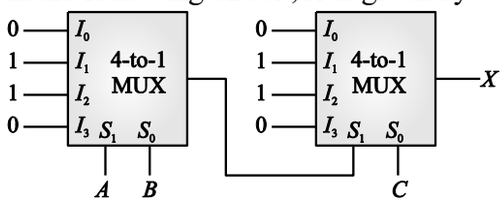
(C)



(D)



Q.45 In the following circuit, X is given by



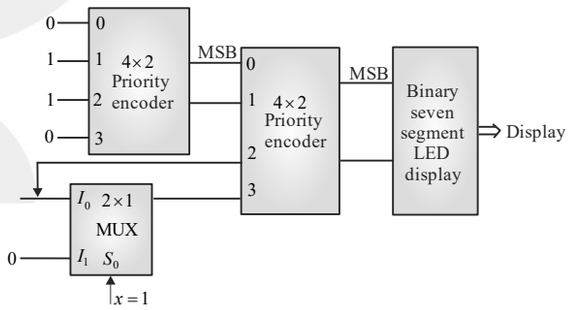
(A) $X = A\bar{B}\bar{C} + \bar{A}B\bar{C} + \bar{A}\bar{B}C + ABC$

(B) $X = \bar{A}BC + A\bar{B}C + AB\bar{C} + \bar{A}\bar{B}\bar{C}$

(C) $X = AB + BC + AC$

(D) $X = \bar{A}\bar{B} + \bar{B}\bar{C} + \bar{A}\bar{C}$

Q.46 Consider the combinational circuit below :



What is the output of the combinational circuit?

(A) 1 (B) 2

(C) 3 (D) 4

Sequential Circuit

Q.47 A-S-R flip flop with a clock input can be converted to a 'D' flip flop using :

(A) Two inverters

(B) The flip flop outputs (Q & $\bar{Q}$) connected to its inputs (S & R)

(C) One inverter

(D) Not possible

Q.48 For one of the following conditions, clocked JK flip-flop can be used as divided by 2 circuit where the pulse train to be divided is applied at clock input :

(A) J = 1, K = 1 and the flip-flop should have active HIGH inputs.

(B) J = 1, K = 1 and the flip-flop should have active LOW inputs.

(C) J = 0, K = 0 and the flip-flop should have active HIGH inputs.

(D) J = 1, K = 1 and the flip-flop should be a negative edge triggered one.

Q.49 The mod number of a Johnson counter will be always equal to the number of flip flops used :

(A) Same

(B) Twice

(C) 2N where N is the number of flip flops.

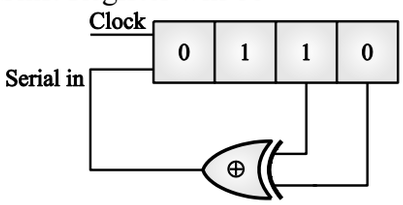
(D) None of the these

Q.50 A 4-bit presentable UP counter has preset input 0101. The preset operation takes place as soon as the counter reaches 1111. The modulus of the counter is

(A) 5 (B) 10

(C) 11 (D) 15

Q.51 The initial contents of the 4-bit serial-in-parallel-out, right-shift, Shift Register shown in the figure is 0110. After three clock pulses are applied, the contents of the Shift Register will be

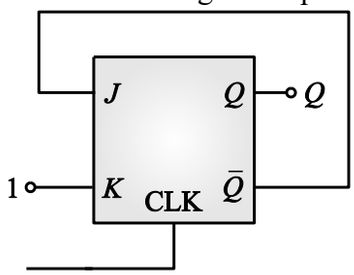


(A) 0000 (B) 0101

(C) 1010 (D) 1111

Q.52 A pulse train with a frequency of 1 MHz is counted using a modulo-1024 ripple-counter built with *J-K* flip flops. For proper operation of the counter, the maximum permissible propagation delay per flip flop stage is_____ nsec.

Q.53 Consider the following *J-K* flip-flop

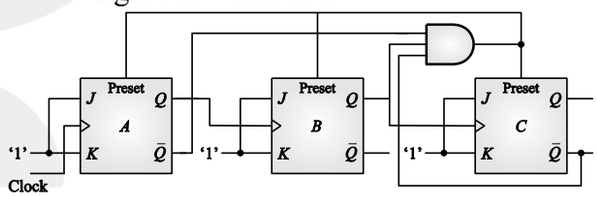


In the above *J-K* flip-flop, $J = \bar{Q}$ and $K = 1$. Assume that the flip-flop was initially cleared and then clocked for 6 pulses. What is the sequence at the Q output?

(A) 010000 (B) 011001

(C) 010010 (D) 010101

Q.54 The ripple counter shown in the given figure is works as a



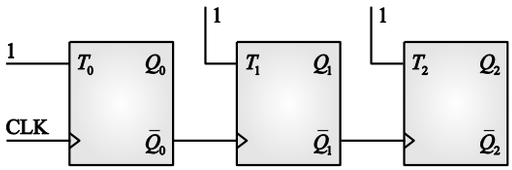
(A) MOD-3 up counter.

(B) MOD-5 up counter.

(C) MOD-3 down counter.

(D) MOD-5 down counter.

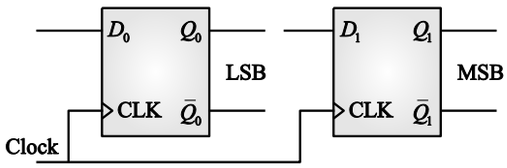
Q.55 The given figure shows a ripple counter using positive edge triggered Flip-Flops. If the present state of the counter is $Q_2Q_1Q_0 = 011$ then its next state $Q_2Q_1Q_0$ will be



(A) 010 (B) 100

(C) 111 (D) 101

Q.56 Two D flip-flops, as shown below, are to be connected as a synchronous counter that goes through the following $Q_1 Q_0$ sequence $00 \rightarrow 01 \rightarrow 11 \rightarrow 10 \rightarrow 00 \rightarrow \ldots$



The inputs D_0 and D_1 respectively should be connected as

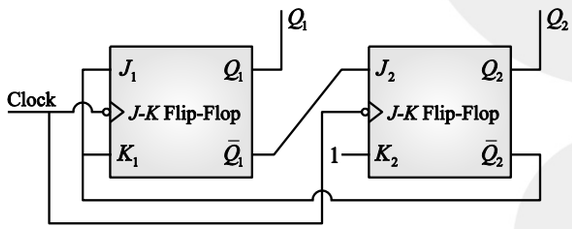
(A) $\bar{Q}_1$ and Q_0

(B) $\bar{Q}_0$ and Q_1

(C) $\bar{Q}_1 Q_0$ and $\bar{Q}_1 Q_0$

(D) $\bar{Q}_1 \bar{Q}_0$ and $Q_1 Q_0$

Q.57 What are the counting state (Q_1, Q_2) for the counter shown in the figure below?



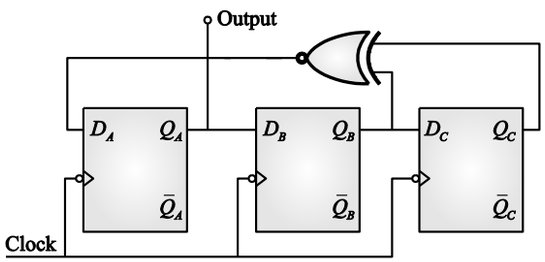
(A) 11, 10, 00, 11, 10,…

(B) 01, 10, 11, 00, 01,…

(C) 00, 11, 01, 10, 00,…

(D) 01, 10, 00, 01, 10,…

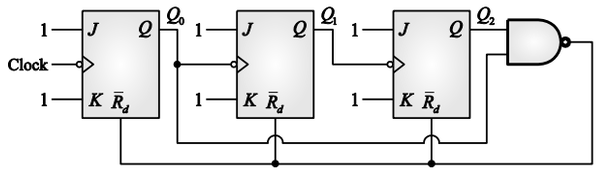
Q.58 Assuming that all flip-flops are in reset condition initially, the count sequence observed at Q_A in the circuit shown is



(A) 0010111… (B) 0001011…

(C) 0101111… (D) 0110100…

Q.59 The circuit shown consists of J-K flip-flops, each with an active low asynchronous reset ($\bar{R}_d$ input). The counter corresponding to this circuit is



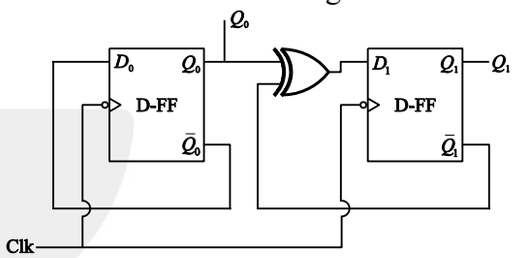
(A) a modulo-5 binary up counter.

(B) a modulo-6 binary down counter.

(C) a modulo-5 binary down counter.

(D) a modulo-6 binary up counter.

Q.60 Consider the following circuit :



Each state of output is designated as a two bit strings $Q_0 Q_1$. If the initial state of flip-flops is 00, then the state transition sequence is

(A) $00 \rightarrow 10 \rightarrow 01 \rightarrow 11$

(B) $00 \rightarrow 11 \rightarrow 10 \rightarrow 01$

(C) $00 \rightarrow 11 \rightarrow 01 \rightarrow 10$

(D) $00 \rightarrow 11$

Q.61 Which of the following functions are self dual? **[MSQ]**

(A) $F(A,B,C) = \Sigma\{0,2,3\}$

(B) $F(A,B,C) = \Sigma\{0,1,6,7\}$

(C) $F(A,B,C) = \Sigma\{0,1,2,4\}$

(D) $F(A,B,C) = \Sigma\{3,5,6,7\}$

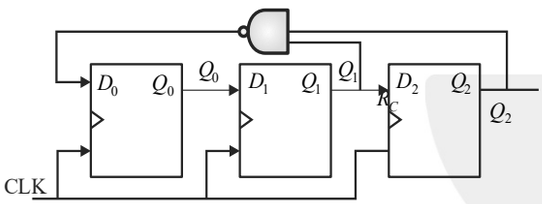
Q.62 A is a 9 bit singed integer the 2's complement representation of A is $(765)_8$ the 2's complement representation of $6\times A$ is?

(A) $(202)_8$ (B) $(676)_8$

(C) $(457)_8$ (D) $(675)_8$

Q.63 Consider the equation $(57)_X=(Y7)_{10}$ where $X\&Y$ are unknown then find the number of possible solution.

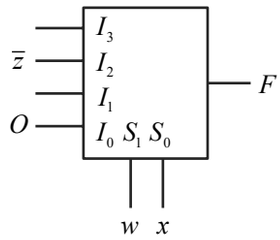
Q.64 For the circuit shown in figure below what is the output $Q_2Q_1Q_0$ as per four clock pulse. Initially all flip flop are reset.



(A) 100 (B) 110

(C) 101 (D) 010

Q.65 The 4 to 1 multiplexer shown below implements the Boolean expression



If $F(w,x,y,z)=\Sigma m(4,5,7,8,10,12,15)$

The input to I_1 & I_3 will be

(A) $yz, y'+z'$ (B) $y+z', y\oplus z$

(C) y'+z, y⊙z (D) $y'+z, y\oplus z$

Answers Digital Logic

1.	D	2.	B	3.	C	4.	B	5.	B
6.	3	7.	D	8.	C	9.	A	10.	D
11.	A	12.	D	13.	D	14.	2	15.	A
16.	D	17.	B	18.	B	19.	B	20.	C
21.	1	22.	B	23.	B, C	24.	B	25.	A
26.	C	27.	C	28.	C	29.	B	30	B
31.	D	32.	219	33.	B	34.	B	35.	B
36.	C	37.	A	38.	A	39.	D	40	B
41.	D	42.	C	43.	A	44.	A	45.	A
46.	B	47.	C	48.	D	49.	C	50.	B
51.	C	52.	100	53.	D	54.	D	55.	B
56.	A	57.	A	58.	D	59.	A	60.	C
61.	C,D	62.	B	63.	6	64.	B	65.	C

3 Computer Organization & Architecture

Practice Questions

Q.1 Consider a system with byte addressable main memory and size of all instructions are 32 bit.

Consider following instructions:

ADD R_1, A // $R_1 = R_1 + \text{Mem}[A]$

Where R_1 is register and A is a memory address and Mem[A] is reading value of memory address A. This instruction stored at memory location 2460 H and A is a memory location with address 4408 H, both are in hexadecimal notation.

What are the values of Program Counter (PC) and Memory Address Register (MAR) during execution of this instruction but after calculating effective address?

(A) PC = 2464 H, MAR = 4408 H

(B) PC = 2460 H, MAR = 440C H

(C) PC = 2464 H, MAR = 440C H

(D) PC = 2460 H, MAR = 4408 H

Q.2 Consider the following table for two systems A and B :

	Word size	**Main Memory (MM)**	**Addressability**
System A	4 bytes	4 GB	Byte addressability
System B	4 bytes	16 GB	Word addressable

x and y are number of bits used to represent address of a memory location in system A and B respectively. Value of x and y are

(A) $x = 32, y = 32$

(B) $x = 32, y = 34$

(C) $x = 30, y = 32$

(D) $x = 34, y = 34$

Q.3 What is the use of Program Counter (PC) in a system?

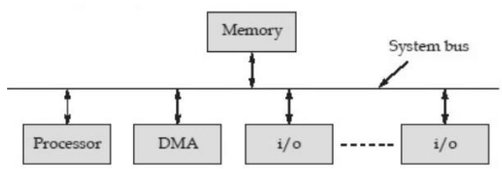
(A) PC contains address of the next instruction to be executed.

(B) PC contains address of current instruction that is being executed.

(C) PC is number of processes running in a system at a particular instance.

(D) PC contains effective address that calculated for operand of current executing instruction.

Q.4 Below diagram shows single bus detached DMA configuration of a system. How many times system bus used for a single data transfer using DMA (consider only data transfer, not command or status transfer).



(A) 1 (B) 2
(C) 3 (D) 0

Q.5 Consider a system with 4 GB main memory with word size of 32 bits. Main memory is half word addressable. Then size of Memory Address Register (MAR) and Memory Data Register (MDR) for this system are respectively.

(A) 32 bits, 30 bits
(B) 31 bits, 32 bits
(C) 32 bits, 31 bits
(D) 30 bits, 32 bits

Q.6 A hard disk has 32 recording surfaces, 256 cylinders, 512 sectors per track and sector size is 1 KB. Find the total size of this hard disk in GB _____.

(Rounded of upto 1 decimal place)

Q.7 Consider a system with 32 bit physical address has data cache of size 16 Kbytes. Cache block size is 256 bytes. Cache is using fully associative mapping. x is tag field length in bits and y is set field length in bits for this cache system. Find value of $x - y$ _____.

Q.8 Which input/output uses interrupts to take attention of CPU/processor?

[MSQ]

(A) Programmed input/output
(B) Interrupt driven input/output
(C) Direct memory access (DMA)
(D) None of the above

Q.9 For a cache memory system, if we change the cache block size then in which of the following cache mapping method the tag field length cannot change.

[MSQ]

Assume, after change in the block size the number of sets in direct mapped and k associative cache must be greater than 1.

(A) Direct mapped cache
(B) k associative cache
(C) Fully associated cache
(D) None of the above

Q.10 A hard disk has 100 cylinders, 16 recording surfaces, 32 sectors per track and 512 bytes per sector. Address of a byte is represented by <c, s, r, b>, where c is cylinder number, s is surface, r is sector number and b is byte number. Thus, 0th byte represented as <0, 0, 0, 0>. 1st byte represented as <0, 0, 0, 1 > and so on. The head of disk starts reading the disk sequentially from <0, 0, 0, 0> and reached at <8, 8, 16, 127>. How many bytes have the head read, including the byte with address <8, 8, 16, 127>.

(A) $2^{21} + 2^{16} + 2^{13} + 128$ bytes
(B) $2^{21} + 2^{17} + 2^{12} + 127$ bytes
(C) $2^{20} + 2^{17} + 2^{12} + 128$ bytes
(D) $2^{21} + 2^{17} + 2^{13} + 128$ bytes

Q.11 A system has 4 GB byte-addressable main-memory and 128 Kbytes data cache memory with block size of 64 bytes. Tag field length is 16 bits in cache. Which of the following cache mapping used in this system?

(A) Direct mapped
(B) 2-way set associative
(C) 4-way set associative
(D) Fully associative

Q.12 Let R_1, R_2 and R_3 are 4 bit registers in a system. $R_1 - 0011$ and $R_2 - 0101$ in 2's complement binary format. System execute following instruction

SLT R_3, R_1, R_2

where SLT is 'set less than' operation in which $R_3 = 0001$ if $R_1 < R_2$ else $R_3 = 0000$, values in 2's complement binary number. What are the values of states bits overflow (V), zero (Z), negative (N) and half carry (H) after executive above instruction? Assume system uses 2's complement addition and subtraction.

(A) $V = 0, Z = 0, N = 1, H = 0$

(B) $V = 0, Z = 1, N = 1, H = 0$

(C) $V = 1, Z = 1, N = 0, H = 1$

(D) $V = 1, Z = 0, N = 1, H = 0$

Q.13 Consider 4 ns CLK cycle processor which consumes 6 cycles for data transfer, 8 cycles for ALU and 4 cycles for branch instructions. Relative frequencies of these instructions are 40%, 30% and 30% respectively. What is the average instruction execution time?

(A) 20 ns (B) 6 ns

(C) 4 ns (D) 24 ns

Q.14 A system has L_1 and L_2 cache with access time of 10 ns and 100 ns respectively. Main memory access time is 1 μs. Miss rates of L_1 and L_2 are $\frac{1}{100}$.

Find average memory access time for this system in ns. (Rounded upto one decimal place)

Q.15 A disk has seek time of 50 ms, 64 sectors per track, 512 bytes per sector and rotate at 600 rounds per minute. A file of size 48 Kbytes sequentially stored in two consecutive adjacent tracks, but starting point of file on both tracks can be anywhere on tracks. Negligible time spend on moving from one track to its adjacent track. Find the average time required to access and read the whole file in ms?

Q.16 Consider two systems A and B, each system contains byte addressable main memory of size 4 GB and "2-way set associative" cache memory of size 128 KBytes. System A has cache block of size 128 bytes and system B has cache block of size 256 bytes. x is difference of tag field lengths of system A and B. y is difference of set field lengths of system A and B. Find value of x and y?

[MSQ]

(A) $x = 0$ (B) $y = 1$

(C) $x = 1$ (D) $y = 0$

Q.17 A system with 8 blocks of cache memory which is 2 way set associative mapped. Cache memory using LRU replacement algorithm. A process referencing following main memory blocks in given order :

[MSQ]

10, 11, 12, 18, 5, 11, 6, 7, 10, 15, 11, 5

Assume cache is initially empty. Which of the following is/are true?

(A) 4 conflict misses

(B) 8 compulsory misses

(C) 0 capacity misses

(D) 2 hits

Q.18 Which of the following is/are correct?

[MSQ]

(A) Little-endian versus big-endian comes into play when the memory is word-addressable and an integer sits completely in one byte.

(B) Little-endian versus big-endian comes into play when the memory is byte-addressable and an integer spans multiple bytes.

(C) The issue of which "endian" type(big or little) the computer uses becomes critical when the memory assigns a separate address to each byte.

(D) The issue of which "endian" type(bog or little) the computer uses becomes critical when the memory assigns a separate address to each word.

Q.19 Consider the following PC-relative addressing mode instruction of RISC instruction set architecture.

I_1 :

$1000 : \text{BEQ } R_1, R_2, \text{label}$

I_2 :

$1004 : \text{ADD } R_1, R_2, R_3$

Where the label is used as an offset and 1000 is the memory location from where instruction I_1 is fetched. $R_1, R_2,$ and R_3 are general purpose registers.

The BEQ instruction branches the PC if the first source register's contents and the second register's contents are equal.

If $R_1 = 0; R_2 = 0$ and label $= 20,$ what is the memory address of the next instruction to be executed?

Q.20 A digital computer has a memory unit with 32 bits per word. The instruction set consists of 110 different operations. All instructions have an operation code part (opcode) and two address fields: one for a memory address and one for a register address. This particular system includes eight general-purpose, user-addressable registers. Registers may be loaded directly from memory, and memory may be updated directly from the registers. Direct memory-to-memory data movement operations are not supported. Each instruction is stored in one word of memory, If X, Y, Z represent the number of bits that are needed for the opcode, for the register field, and bits that are left for the memory address part of the instruction, respectively, then $XY + YZ$ is

_____

Q.21 The unsigned integer 3, 505, 468, 161 can be written in 32-bit binary as 11010000 11110001 00110011 00000001. Putting it into four bytes of memory beginning at address 98370 in little-endian fashion would give which picture?

(A)

98370	98371	98372	98373
11010000	11110001	00110011	00000001

(B)

98370	98371	98372	98373
00000001	11110001	00110011	11010000

(C)

98370	98371	98372	98373
00000001	00110011	11110001	11010000

(D)

98370	98371	98372	98373
00110011	00000001	11010000	11110001

Q.22 When performing hardware integer arithmetic, we say that overflow has occurred when the mathematically correct result of a computation cannot be represented in the number of bits available for the type being used. Obviously, it is important to be able to detect when an overflow error has occurred. **[MSQ]**

For the following options, the bit-sequences are 16-bit 2's complement representations of (signed) integer values. For which of the following an overflow occurs when the given two integers are added?

(A) 0111 1001 1011 1011 + 0011 1011 1110 1110

(B) 1111 0111 0110 1001 + 1000 0001 0110 0100

(C) 0001 1100 0110 1111 + 1111 0111 1110 1101

(D) 1100 1011 1010 1101 + 0111 1111 0010 1111

Q.23 A CPU has an arithmetic unit that adds bytes and then sets its *V*, *C*, and *Z* flag bits as follows. The *V*-bit is set if arithmetic overflow occurs (in two's complement arithmetic). The *C*-bit is set if a carry-out is generated from the most significant bit during an operation.

The *Z*-bit is set if the result is zero.

What are the values of the *V*, *C*, and *Z* flag bits (in that order) after the 8-bit bytes 1100 1100 and 1000 1111 are added?

(A) 000 (B) 110

(C) 111 (D) 001

Q.24 Consider the following :

Consider the instruction Load $R_5, X(R_7)$ which uses the Index addressing mode to load a word of data from memory location $X + [R_7]$ into register R_5.

Execution of this instruction involves the following actions :

- (I_1) Fetch the instruction from the memory.
- (I_2) Decode the instruction to determine the operation to be performed.
- (I_3) Add the immediate value X to the contents of R_7.
- (I_4) Read register R_7.
- (I_5) Use the sum $X + [R_7]$ as the effective address of the source operand, and read the contents of that location in the memory.
- (I_6) Increment the program counter.
- (I_7) Load the data received from the memory into the destination register, R_5.

Which of the following is the most preferred order of execution of the above instruction?

(A) $I_1 \rightarrow I_2 \rightarrow I_3 \rightarrow I_4 \rightarrow I_5 \rightarrow I_6 \rightarrow I_7$

(B) $I_1 \rightarrow I_2 \rightarrow I_6 \rightarrow I_3 \rightarrow I_4 \rightarrow I_5 \rightarrow I_7$

(C) $I_1 \rightarrow I_6 \rightarrow I_2 \rightarrow I_4 \rightarrow I_3 \rightarrow I_5 \rightarrow I_7$

(D) $I_1 \rightarrow I_6 \rightarrow I_2 \rightarrow I_5 \rightarrow I_4 \rightarrow I_3 \rightarrow I_7$

Q.25

	Micro-operations	Active Control Signals
	t_1 : MAR ← (PC)	C_2
Fetch :	t_2 : MBR ← Memory	C_5, C_R
	PC ← (PC) + 1	
	t_3 : IR ← (MBR)	C_4
	t_1 : MAR ← (IR (Address))	C_8
Indirect :	t_2 : MBR ← Memory	C_5, C_R
	t_3 : IR (Address) ← (MBR(Address))	C_4
	t_1 : MBR ← (PC)	C_1
Interrupt :	t_2 : MAR ← Save-address	
	PC ← Routine-address	
	t_3 : Memory ← (MBR)	C_{12}, C_W

$C_R =$ Read control signal to system bus.

$C_W =$ Write control signal to system bus.

Let us define control signals, P and Q, that have the following interpretation

- $PQ = 00$ Fetch cycle
- $PQ = 01$ Indirect cycle
- $PQ = 10$ Execute cycle
- $PQ = 11$ Interrupt cycle

Which of the following expression boolean expression defines C_4 ?

(A) $P't_3$

(B) $Pt_3^{'} + Q't_3$

(C) $P'Q't_3 + PQ't_3$

(D) $P'Q't_3 + PQt_3$

Q.26 The 8-bit registers M, N, O and P initially have the following values.

M = 10001111; N = 01100010; O = 01001001; P = 01110010

The following assembly code is executed :

- $M \leftarrow M \oplus N$
- $M \leftarrow CSL\, M$
- $N \leftarrow M + N$
- $O \leftarrow O \wedge N$
- $O \leftarrow CSR\, O$
- $P \leftarrow P + 1$
- $P \leftarrow P + 0$

Determine the 8-bit values in each register after the execution of the above sequence of micro-operations.

CSL : Circular shift left: CSR : Circular shift right; A : logical AND; + : Arithmetic addition 0 : logical Ex-or.

(A) M = 11101101; N = 00111101; O = 10000100; P = 11110111

(B) M = 11011011; N = 00111101; O = 10000100; P = 11110111

(C) M = 11011011; N = 10111101; O = 10000100; P = 11110111

(D) M = 11011011; N = 00111101; O = 00001001; P = 01110011

Q.27 A particular parallel program computation requires 100 seconds when executed on a single processor. If 40 percent of this computation is "inherently sequential" (i.e., will not benefit from additional processors), then the theoretically best possible elapsed times for this program running with 2 and 4 processors, respectively, are

(A) 20 seconds and 10 seconds

(B) 50 seconds and 25 seconds

(C) 70 seconds and 55 seconds

(D) 80 seconds and 70 seconds

Q.28 A 64-bit processor has 64 registers and uses a 20-bit instruction format. It has two types of instructions: M-type and R-type. Each M-type instruction contains an opcode and a memory address. Each R-type instruction contains an opcode and two register names. Main memory is 8K words, and it is byte addressable. If there are 10 distinct M-type opcodes, then the maximum number of distinct R-type opcodes is _____

Q.29 Amdahl's Law pertains to the speedup achieved when running a program on parallel processors versus using a single serial processor. In this context, the speedup is the ratio of original running time to improved running time. According to Amdahl's Law, approximately how much speedup could we expect for an unlimited number of processors if 10 percent of a program is sequential i.e., will not benefit from additional processors) and the remaining part is ideally parallel?

(A) $10X$ (B) $20X$

(C) $40X$ (D) Infinite

Q.30 Following is a definition of a widget and a declaration of an array A that contains 10 widgets. The sizes of a byte, short, int, and long are 1, 2, 4 and 8 byte, respectively. Alignment is restricted so that an *n*-byte field must be located at an address divisible by *n*.

The fields in a struct are not rearranged; padding is used to ensure alignment. All widgets in A must have the same size.

1. struct widget
2. short *s*
3. byte *b*
4. long *l*
5. int *I*
6. end widget
7. widget *A*[10]

Assuming that *A* is located at a memory address divisible by 8, what is the total size of *A*, in bytes?

(A) 150 (B) 160

(C) 2001 (D) 240

Q.31 Consider two different design enhancements of ALU as follows :

i. A part of a bigger task is improved twenty times than it was before. The other part of the same task constitutes 60% of the overall task time, and it remains unchanged.

ii. The designer can make changes to improve 20% of the task 100% faster, 35% of the task 4 times faster, and 10% of the task 100 times faster, but it causes the remaining part of the task to perform as bad as 50% slower than before.

Which of the following value is the best approximate difference between the two speedups achieved in those two improvements :

(A) 0.3567 (B) 0.2667

(C) 0.4875 (D) 0.4325

Q.32 Big-Endian(BE) and Little-Endian(LE) change the order in which the bytes of a word are stored in RAM. We typically show the contents of a word, especially if it's an integer, as four hexadecimal pairs of characters. For example, the hex string $0\times abcdef12$ contains four bytes: "*ab*" is the first, which have the binary value of 1010 and 1011. So the first 8 bits are 10101011. BE/LE specifies whether this byte goes into RAM as the first of the four bytes in the word or as the last. Suppose Byte 0 in RAM contains the value 0×00. Subsequent bytes contain $0\times01, 0\times40$ and 0×70. On a Big-Endian system with a 32-bit word, what's the decimal value of the word?

Q.33 Consider the control unit that adopts the single address field branch control logic. Assume that the control memory is 24 bits wide. The control portion of the micro-instruction format is divided into two fields. A micro-operation field of 13 bits specifies the micro operations to be performed. An address selection field specifies 8 conditions that will cause a micro-instruction branch.

[MSQ]

Which of the following is true?

(A) 8 bits are in the address field

(B) 8 bytes are in the address field

(C) the size of the control memory is 768 Bytes

(D) the size of the control memory is 4096 bits.

Q.34 Let x and y are represented in singed 2's complement notation with 8 bit. The correct statement in the given below is/are **[MSQ]**

(A) Overflow occurs after adding $x=(94)_{16}$ and $=(79)_{16}$

(B) Overflow does not occurs after adding $x=(94)_{16}$ and $y=(79)_{16}$

(C) Overflow occurs after subtracting $x=(79)_{16}$ from $y=(94)_{16}$

(D) Overflow does not occur after subtracting $x=(79)_{16}$ from $y=(94)_{16}$

Q.35 For adding 2 number of singed data with the available size, let first data size is m bits and second data size in n bits, $(m>n)$ to get the target result

[MSQ]

(A) Size of m and n should be same

(B) The longest result size is $(m+n)$ bits

(C) The longest result is $m+1$ bits

(D) The longest result size is $n+1$ bits

Q.36 Consider a disk pack with a average seek time of 3 millisecond and rotational speed of 12000 RPM. It has 100 sectors/track and 1K Bytes/sector. A file contains 20 sectors stored in the disk. Assume that every sector access requires one average seek time, one average rotational delay and data transfer (RD/WR) time. The total time needed to read entire file is _____ milliseconds.

Q.37 A cache memory access time is 10 ns and main memory access time is 100 ns. The hit rate for read operation is 90%. In total memory references, 70% are used for read operations with write through technique. The average memory access time is _____ns.

Q.38 A system is designed with direct mapped cache wit capacity of 128 KB and each block size is 512 Bytes. The processor generates 24 bit physical address (Note word size = one byte)

[MSQ]

(A) Tag field size in each cache line is 7 bits

(B) Total Tag directory size is 1792 bits

(C) No. of blocks available in cache memory is 256

(D) IN this conflict miss does not occur when the CPU requires the same words repeatedly

Q.39 Let the given data in variable format and it is in signed 2's complement notation; the decimal value of n bit size 'x' value is p $\left(x_{n-1}x_{n-2}.....x_2x_1x_0\right)_2 = P$

The decimal value of 'P' is

(A) $\sum_{i=0}^{n-1} a_i \times 2^i$

(B) $\sum_{i=0}^{n-2} a_i \times 2^i + \left\{(-1)\left[x_{n-1}\right] \times \left(2^{n-1}\right)\right\}$

(C) $\sum_{i=0}^{n-2} a_i \times 2^i + \left\{(-1)\, x_{n-1} \times 2^{n-1}\right\}$

(D) $\sum_{i=0}^{n-2} a_i \times 2^i + \left\{(-1) * \left(x_{n-1}\right) \times \left(2^{n-2}\right)\right\}$

Q.40 A 16 bit resister is used to represent floating data with biasing value of 64, one bit (MSB) in the resister is reserved for representing the sign of the mantissa; next field to MSB in used to represent Biased exponent and last field is used to represent the mantissa in signed magnitude form. The no. of bits needed to represent Biased exponent field and mantissa field respectively are

(A) 7, 8 (B) 8, 7

(C) 6, 9 (D) 9, 6

Q.41 A magnetic hard disk is having 16 surface, 1024 Track/surface; 256 sectors/track and 64 Bytes/sector. It is operated with the RPM of 'x' average latency is 5 milliseconds, the 'x' value is_____.

Q.42 In the given below, the single conflict miss does not occur in

(A) Fully associative mapped cache

(B) Direct mapped cache

(C) 4 way block set associative

(D) 16 way block set associative mapped cache

Q.43 A direct mapped cache size is 64 KB and each cache line size is 256 byte and CPU generates 20 bit memory address. The 2049 addressed work of main memory maps to the cache line of

(A) CL_a (cache line 8)

(B) CL_1 (cache line 1)

(C) CL_{255} (cache line 255)

(D) None of the above

Q.44 One magnetic surface is having 1024 tracks $\left(T_0 \text{ to } T_{1023}\right)$, each track has 64, $\left(S_0 \text{ to } S_{63}\right)$ sectors with 16 bytes $\left(B_0 \text{ to } B_{15}\right)$ in each sector. Let starting word address in the surface is (00000) H and last word address is (FFFFF) h. Find the correct statement in the given below

[MSQ]

(A) $(\text{FFC0F})_{16}$ Address byte is in S_{63} sector

(B) $(\text{FFC0F})_{16}$ Address byte is in S_0 sector

(C) $(003F2)_{16}$ Addressed byte in S_0 sector

(D) $(003F2)_{16}$ Addressed byte is in S_{63} sector

Q.45 The size of the ROM required for storing the truth table for 16 for squarer operation is____ kilo bytes.

Q.46 Let 0 X F F F E 0 0 0 0 is represented in IEEE single precision notation with biasing value of 127. It represents

(A) Decimal value –17.725

(B) Decimal value –29.775

(C) Not a number (special value)

(D) ± Infinitive (special value)

Q.47 Consider the three floating point number P, Q and R stored in Registers R_P, R_Q, R_R respectively as per IEEE – 754 single precision floating point format. The 32 bit contact stored in these registers (in Hexa decimal) are as follows.

$R_P = \text{C1D00000}$, $R_Q = \text{C1600000}$,

$R_R = 41\text{D00000}$

Which one of the following is false?

(A) $R = P + Q$ (B) $R > Q$

(C) $P + R = 0$ (D) $R + Q = 12$

Q.48 To implement a $64\text{ K} \times 8$ bit memory with $16\text{ K} \times 4$ bit chips

[MSQ]

(A) Total no. of 16×4 bit chips needed is '4'

(B) Total no. of $16\text{ K} \times 4$ bit chips needed is '8'

(C) 2×4 size row chip select decoder is needed

(D) 3×8 size row chip select decoder is needed

Q.49 In the given below, the correct statements is/are

[MSQ]

(A) Index register addressing mode instruction is faster than immediate addressing mode instruction

(B) Memory cycle is not needed for operand reading while executing the register addressing mode instruction. Memory indirect addressing mode instruction requires more

(C) No. of memory clock cycle than register indirect addressing mode instruction

(D) Position independent addressing mode instruction is used in the place of short jump instructions.

Q.50 Match the following

P:	Compact Disk driven	1.	Interrupt
Q:	Printer controller	2.	DMA
R:	Non mask able interrupt	3.	A. L. U
S:	Carry flag	4.	Power failure

	P	Q	R	S
(A)	2	1	4	3
(B)	1	2	3	4
(C)	4	3	2	1
(D)	4	1	2	3

Q.51 The main memory is byte addressable and count register fabricated in IO processor is having 16 bits length. IN burst DMA operation, the IO processor requests the CPU for bus services 16 times. The maximum size of the data that can be transferred from secondary memory to main memory is_____.

Kilo bytes (Note: 1 KB = 1024 Bytes)

Q.52 P.C Relative addressing mode instruction is

[MSQ]

(A) Used only for forward jump but not for backward jumping instructions

(B) Used for both forward and backward jump instructions

(C) Generally used in the place of short jump instructions

(D) Used for array implementation

Q.53 The given below program is executed on 2GHZ CPU

Memory Address	Instruction	No. of clock cycles required
1600 (I_1)	MOV C # 06	1
1601 (I_2)	MOV B # 00	1
1602 (I_3)	ADD C	1
1603 (I_4)	DCR C	1
1604 (I_5)	JNZ: 1602	2
1605 (I_6)	(Jump on Non zero) HLT	1

The amount of time required to execute the above program is_____ ns.

Q.54 Consider a one word machine instruction ADD $R_2 @ R_1$ executed on hypothetical CPU, R_1 and R_2 are processing registers. Fetching operation takes 2 clock cycles, operand read takes 2 clock cycles and any ALU operation takes one clock cycles and extra clock is not required for storing the result in destination register.

No. of memory cycles needed to complete the instruction cycle of the above ADD $R_1 @ R_2$ $\{R_2 \leftarrow R_2 + (R_1)\}$ is _____.

Q.55 Certain CPU permits only one address and two address instructions and address field size is 6 bit and CPU word size is 16 bits. Let it used 'X' no. of two address instruction and 448 no. of one address instructions, the value of 'X' is _____

Q.56 Horizontal microprogram control word technique

[MSQ]

(A) Is used to reduce the control memory space

(B) Provide higher degree of parallelism

(C) Requires larger size control word

(D) Does not require signal encoders and decoders

Q.57 Let the processor word size is 16 bit and all processing registers size also 16 bits including program counter, stack pointer and program status word. While executing RET, Let the memory is word addressable and present SP content is $(5926)_{10}$. **[MSQ]**

(A) The SP content becomes 5928 if system used stack grows upward technique

(B) The SP content becomes 5924 if system uses stack grows upward technique.

(C) The SP content becomes 5928 if the system used stack goes down technique

(D) The SP content becomes 5924 if system used stack goes down technique

Q.58 CPU generates 72 control signals and these are divided into three unique groups, $G_1 = 40$, $G_2 = 25$ and $G_3 = 7$

[exclude the bits required for recognizing group number]

The no. of control bits that can be saved when it used vertical microprogram control word over Horizontal micro program control word is_____.

Q.59 A pipelined processor (without branch prediction unit)

[MSQ]

(A) While executing a conditional branch instruction, the CPU comes to know the status of the condition after completing the execute stage only.

(B) Requires longer execution time for arithmetical instruction then conditional branch instruction

(C) CPU finds the target instruction address immediately after fetching the conditional branch instruction

(D) Generally flags are used for writing the conditional branch instructions.

Q.60 A CPU has 6 stage pipeline and runs at 2 GHz frequency. The CPU finds the target address for the conditional branch outcome is known. While executing the largest size program CPU find 25% instructions are conditional branch related. The average instruction time is _____ns

Q.61 A system used memory mapped IO technique for connecting IO devices and CPU address bus size is 16 bits. Let system used 56594 memory register for storing the program and data, the maximum no. of IO devices to be addressed is_____.

(Note: One memory address permits only one IO device connection)

Q.62 While using memory mapped IO technique for connecting IO devices

[MSQ]

(A) Load and store instruction are used for addressing input and output devices respectively

(B) IO Read and IO write control signals are used

(C) Maximum no. of IO devices to be connected is 65536 when memory address size is 16 bits

(D) Memory space is blocked by the IO devices connection

Q.63 Consider a processor with 1 GHz clock frequency. The stack memory addressing instruction POP R_1 requires one clock cycle for memory read operation and 2 clock cycle for instruction fetch and decode (R_1 is the processing register). The amount of time needed for the instruction cycle of POP R_1 is _____micro seconds.

Q.64 Which of the following is incorrect for interrupt driven I/O implementation?

(A) Every word of data that goes from memory to I/O module or vice-versa must pass through the processor.

(B) Need to implement a mechanism such that processor can determine which device issued the interrupt.

(C) In Daisy chain implementation, for interrupt, all I/O modulus share a common interrupt request line.

(D) If interrupt occurred, processor save only current program counter (PC) in control/interrupt stack and then start execution of interrupt handler.

Q.65 Which of the following statements is false for data organized on a hard disk?

(A) Sector is the smallest unit of data that can be transferred.

(B) A collection of sectors is called tracks.

(C) A collection of tracks on various surfaces is called cylinder.

(D) None of the above

Q.66 A program runs separately on system S_1 and S_2 System S_1 execute 30% of program parallely using 6 processors. System S_2 execute 20% of program parallely using 20 processors. Find the ratio of speedup of system S_1 over speedup of system S_2 ? Consider speedup of S_1 and S_2 with respect to sequential execution of program.

Q.67 What is maximum speedup that can be achieved (approximately) by a k-stage pipeline?

(A) 2k

(B) k

(C) k^2

(D) None of the above

Q.68 Consider a system uses DMA transfer with size of word count register of DMA controller is 16 bits. The processor need to transfer 1630 KB size file from disk to main memory. The memory is byte addressable. The minimum number of times the DMA controller needs to get the control of the system bus from the processor to transfer the file from disk to main memory is _____

Q.69 A system uses programmed I/O mode of transfer. Width of bus is 16 bits. Assume CPU need to read 4000 bytes from a I/O device. Each word I/O transfer (16 bits) takes 2 microseconds. Minimum CPU time required to I/O transfer of required data is _____ milliseconds.

Q.70 Consider a system with following content of memory addresses at this instance:

Memory address	Content in address
2000	20
2030	25
3000	30
3020	40
5000	50

Let system execute following instructions in order:

LOAD	$R_1, 3000$	//immediate mode
ADD	$R_2, R_1, (2000)$	//direct mode
ADD	$R_3, (R_2), 0$	//register indirect mode

Left most registers in above instructions are destination registers and other fields are operands for instruction. The value of R_3 after above execution is

(A) 40 (B) 50

(C) 3020 (D) 25

Q.71 Which of the following is/are correct?

(A) Data forwarding in data path reduces impact of data hazards.

(B) Splitting the memory into separate data memory and instruction memory reduces impact of data hazards.

(C) In delayed branching technique, a pipeline stall created by control/branch hazard can always be filled by an instruction of same program.

(D) Register renaming reduces the impact of control hazard.

Q.72 Which of the following sequence of microinstructions adding an immediate value in instruction with accumulator

register (AC) and storing result in AC? (IR_{imm} is bits is immediate field of instruction).

(A) MAR $\leftarrow IR_{imm}$
MBR $\leftarrow$ Mem[MBR]
$R_1 \leftarrow$ MBR
$Z \leftarrow AC + R_1$
$AC \leftarrow Z$

(B) MAR $\leftarrow IR_{imm}$
MBR $\leftarrow$ Mem[MBR]
$Z \leftarrow AC + MBR$
$AC \leftarrow Z$

(C) $R_1 \leftarrow IR_{imm}$
$Z \leftarrow AC + R_1$
$AC \leftarrow Z$

(D) None of the above

Q.73 Consider a system with 24 bits wide control memory. Every microinstruction is 24 bits long and divided into two parts, control and address. Control part is further divided in to two parts, micro-opcode and flag selection.
Micro-opcode field is 11 bits long and specifies the micro-operation to be performed. Flag selection field used to select a flag for the purpose of finding next address depend on value of one selected flag. There are 16 flags. Consider following statements for above control memory:
S_1 : Maximum size of control memory is 1536 bytes.
S_2 : Flag selection field is 4 bits long.
Which of the following is true?
(A) Only S_1 is correct
(B) Only S_2 is correct
(C) Both S_1 and S_2 are correct
(D) Neither S_1 and S_2 is correct

Q.74 Consider the following pipelines with specified stage delays in nanoseconds. Assume zero latency for inter stage pipeline registers. Which of the following pipeline have the highest clock frequency?
(A) 6 stage pipeline with stage delays 3, 5,4, 3,4, 4.5
(B) 5 stage pipeline with stage delays 4, 3,4.5, 4, 3.5
(C) 4 stage pipeline with stage delays 4,4.5, 5, 5.5
(D) 4 stage pipeline with stage delays 3.5, 5, 6, 4

Q.75 Consider a 4 way set associative cache memory with 32 cache blocks. The main memory consists 128 blocks numbered from 0 to 127. Assume, initially cache is empty. A program request following memory blocks in order:
7,13, 2,18, 5, 87, 45, 53, 50, 98, 87, 53, 34, 33, 69,122,13, 2, 39, 50
Cache uses LRU replacement algorithm. The number of cache block replacements occurred on above sequence of requests is _____.
[Replacement means remove of already filled cache block]

Q.76 Assertion (A): The DMA technique is more efficient than the interrupt-driven technique for high volume I/O data transfer.
Reason (R): The DMA technique does not make use of the interrupt mechanism.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is NOT the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

Q.77 Match List-I (Characteristic) with List II (Processor Architecture) and select the correct answering the code given below the lists:

List-I

A. Write through protocol
B. Write back protocol
C. RISC
D. CISC

List-II

1. Relatively few addressing modes
2. Inclusion
3. Coherence
4. Variable length instruction format

Codes:

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

(A) A (B) B
(C) C (D) D

Q.78 Consider the following statements:

(i) In a uniform delay pipeline execution time for a single instruction is less than the execution time in non-pipelined processor.

(ii) Execution time for single instruction on six stage pipelined CPU is less than or equal to identical non-pipelined CPU.

Which of the above statements are correct?

(A) Only (i)
(B) Only (ii)
(C) Both (i) and (ii)
(D) Neither (i) and (ii)

Q.79 Consider following instruction sequence with their meaning given below:

Instruction

I_0 : DIV R_1, R_2, R_1

I_1: MUL R_2, R_3, R_5

I_2 : ADD R_5, R_4, R_2

I_3 : SUB R_1, R_3, R_7

Meaning of instruction

$R_1 \leftarrow R_2 / R_1$

$R_2 \leftarrow R_3 * R_5$

$R_5 \leftarrow R_4 + R_2$

$R_1 \leftarrow R_3 - R_7$

What is the number of Write After Read (WAR) and Write After Write (WAW) hazards for the above instruction sequence?

(A) 0.2 (B) 2.2
(C) 3.1 (D) 1.3

Q.80 Consider the following statement:

S_1 : The main disadvantage of write through technique is that it generates substantial memory traffic and may create a bottleneck.

S_1 : In write back, when an update occurs a dirty bit associated with the line is set, after that if a block is replaced. It is written back to main memory irrespective of dirty bit.

Which of the following is correct?

(A) Neither S_1 nor S_2 is true
(B) Only S_1 true
(C) Only S_2 true
(D) Both S_1 and S_2 true

Q.81 Consider the following booths multiplication:
Multiplicand: 10010011011
Multiplier: 10100101
The number of addition operations required in the multiplication will be_____

(A) 2 (B) 3
(C) 4 (D) 1

Q.82 Match List-I (Instructions) with List II (Addressing modes) and select the correct answer using the codes given below the lists:

List I

A. ADD R_0[[2000]]

B. MOVR_1, 10

C. ADD R_1, R_2

D. ADD R_0, (100)

List II

1. Direct addressing mode
2. Immediate addressing mode
3. Register addressing mode
4. Indirect addressing mode

Codes:

	A	B	C	D
(A)	4	2	3	1
(B)	4	3	1	2
(C)	3	1	2	4
(D)	3	1	4	2

(A) A (B) B
(C) C (D) D

Q.83 Consider the instruction ADD [[2000]] where ADD stands for addition. The number of memory cycles required to execute the instruction is

(A) 1 (B) 2
(C) 3 (D) 4

Q.84 Consider a DRAM that must be given a refresh cycle of 64 times per msec. Each refresh operation requires 100 ns and a memory cycle requires 200nsec. The percentage of the memory's total operating time must be given to refresh is_____. (Up to 2 decimal places)

Q.85 A set-associative cache consists of 64 lines, or slots, divided into four-line sets. Main memory contains 4 K blocks of 128 words each. Find the value of X + 5Y where X is number of bits for tag and Y is number of bits for set?

Q.86 Consider a micro-programmed control unit which supports 360 instructions. Each instruction takes 10 micro operations, 15 flags are supported and 62 control signal vertical micro-programmed is used then the size of 4 control word is _____ bytes.

Q.87 5 stage pipeline has the stage delay 100,140,170,180 and 200 ns respectively. Registers that are used between the stages have a delay of 2 ns each. Assuming constant clock rate, the total time taken to process 580 data items on this pipeline will be_____ (in micro seconds).

Q.88 Consider a task that makes extensive use of floating point operations with 40% of the time is consumed by floating point operations with a new hardware design. If the floating point module is speeded by a factor of 4. What is overall speed up_____? (Up to 2 decimal places)

Q.89 The access time of a cache memory is 100 ns and that of main memory is 1 micro-seconds. 80% of the memory requests are for read and others are for write. Hit ratio for read only accesses is 0.9. A write through procedure is used. The average access time of the system for both read and write requests is_____ (in ns).

Q.90 Which of the following is true about horizontal micro-instruction?

[MSQ]

(A) It has high degree of parallelism.
(B) Slower execution than vertical micro-instruction.
(C) Longer control word than vertical micro-instruction.
(D) Control signal is expressed in decoded binary format.

Q.91 Which of the following is/are true?

[MSQ]

(A) I/O mapped I/O is most widely used communication for connecting I/O devices as compared to memory mapped I/O.
(B) Internal Interrupts are given priority over external interrupts for service.
(C) In Interleaving DMA mode, the waiting time of CPU is almost zero.
(D) Arithmetic left shift is exactly same as logical left shift.

Q.92 Consider a hypothetical CPU which supports 16 bit instruction, 62 registers and 1 KB memory space. If there exist 12 two address instructions which uses register reference and 14 one address memory reference instructions. How many 0-address instructions are possible?

(A) 1024 (B) 2448
(C) 4096 (D) 8192

Q.93 Consider a direct mapped cache with 16 blocks with block size of 16 bytes. Initially the cache is empty. The following sequence of access of memory addresses: 0x80000, 0x80008, 0x80010, 0x80018, 0x30010

Is repeated 10 times. Which of the following represents number of compulsory and conflict misses?

(A) Compulsory = 2 and conflict = 18
(B) Compulsory = 3 and conflict = 18
(C) Compulsory = 4 and conflict = 16
(D) Compulsory = 2 and conflict = 20

Q.94 The speed gained by an '*rl* segment pipeline executing 'm' tasks is

(A) $\frac{(n+m-1)}{mn}$ (B) $\frac{mn}{(n+m-1)}$

(C) $\frac{n+m}{(nm-1)}$ (D) $\frac{n+m}{(nm+1)}$

Q.95 A particular parallel program computation require 200 seconds when it is executed on a single processor. If 40% of this computation is "inherently sequential" then what are the theoretically best elapsed time for this program running with 2 and 4 processors respectively?

(A) 80 and 120 seconds
(B) 90 and 60 seconds
(C) 140 and 110 seconds
(D) 100 and 80 seconds

Q.96 Consider the following floating point format:

Sign	Exponent	Mantissa
19	18 11	10 0

What is the representation of 0.625×8^{12} in hexadecimal without normalization?

(A) Ox545D0 (B) OC58700
(C) OX51D00 (D) Ox5AC00

Q.97 Consider the following code:

$I_1 : \text{ADD}\, r_1, r_2$	$r_1 \leftarrow r_1 + r_2$
$I_2 : \text{Load}\, r_1, (r_0)$	$r_1 \leftarrow M[[r_0]]$
$I_3 : \text{SUB}\, r_3, r_4$	$r_3 \leftarrow r_3 - r_4$
$I_4 : \text{Load}\, (r_0), r_3$	$M[[r_0]] \leftarrow r_3$
$I_5 : \text{ADD}\, r_1, r_3$	$r_1 \leftarrow r_1 + r_3$
$I_5 : \text{Halt}$	Halts

The data transfer instruction size is 64 bit, ALU operation instruction size is 32

bit and branch instruction size is 16 bit. Assume program has been loaded in the memory starling from the location 5000 decimal onwards. If an interrupt occurs during the execution of I_6,the return address pushed on to the stack is.

(A) 5030 (B) 2024

(C) 5028 (D) 5016

Q.98 Consider 4 stage instruction pipeline where different instructions are spending different cycles at different stage shown below:

	S_1	S_2	S_3	S_4
I_1	1	3	2	1
I_2	1	1	3	2
I_3	3	1	1	1
I_4	1	2	1	1

The following loop is executed in the pipeline

For (i=1;i<=2;i++)

{

I_1;

I_2;

I_3;

I_4;

}

The number of cycles saved using the loop level parallelism over without loop level parallelism to executed the above program is ____(in cycles).

(A) 1 (B) 2

(C) 3 (D) 4

Q.99 Consider the machine with a byte addressable main memory of 216 byte, block size of 16 byte and a 2 way set associate mapped cache having 210 lines Suppose there are two bytes in main memory i.e. first byte $[E01F]_{16}$ and second byte $[E208]_{16}$ respectively then the difference of the set value (in decimal) between given two bytes i.e. (SET value of second byte - SET value of 1st byte) is

(A) 21 (B) 31

(C) 40 (D) 51

Q.100 Consider a system with two level cache hierarchies with L_1 and L_2 cache. Program refers memory 2000 times, out of which 30 misses are in L_1 cache and 20 misses are in L_2 cache If miss penalty of L_2 is 400 clock cycles, hit time of L_2 is 12 clock cycle and hit time of L_1 is 1 clock cycle, the average memory access time is _____ clock cycles (Upto 2 decimal places).

Q.101 A hypothetical 6 stage pipeline processor is designed in which branch is predicted at 4th stage and each stage takes 1 cycle to compute its task. If f is a the probability of an instruction being a branch instruction then the value of f such that speed up is at least 5 is (Up to 3 decimal places)

Q.102 A 5 stage pipeline has instruction Fetch (IF), Instruction decode (ID), Operand fetch (OF), Process data (PD) and Write back (WB) stages. The IF, ID, OF takes 1 clock cycles each for any instruction. The process data lakes 1 dock cycle for ADD and SUB instruction. 2 clock cycles for MUL instruction and 4 clock cycles for DIV instruction respectively. The number of dock cycles needed to execute the following sequence of

instruction where operand forwarding from WB to PO and PO to of is used

Instruction Meaning of Instruction

$I_0 = \text{SUB } R_2, R_0, R_1$

$R_2 \leftarrow R_0 - R_1$

$I_1 : \text{MUL } R_5, R_3, R_4$

$R_5 \leftarrow R_3 * R_4$

$I_2 : \text{ADD } R_2 \leftarrow R_5, R_2$

$R_2 \leftarrow R_5 + R_2$

$I_3 : \text{DIV } R_5, R_2, R_6$

$R_5 \leftarrow R_2 / R_6$

Q.103 Consider a disk that rotates at 60000 rotations per minute and has a transfer rate of 80 MBps If the average seek time of the disk is twice the average rotational delay and the controller's transfer time is 8 times the Ask transfer time, the average time to read or write a 128 byte sector of the disk is___msec.(Upto 4 decimal places)

Q.104 Consider a machine with 8 way set associative data cache of size 64 Kbytes and block size 8 byte. The cache is managed using 32 bit virtual address and page size is 4 Kbytes. What Is the total size of the tags in the cache directory____(K bits)?

Q.105 Consider a two- way set associative cache with total of 8 cache blocks and the following sequence of memory block requests arrived:

20,17,21, 32, 20, 16, 27, 7, 16, 32

If LRU replacement policy is used then the hit ratio will be____(Upto 2 decimal places)

Q.106 A hypothetical DMA is designed to transfer the data from I/O device to main memory under burst transfer mode. The count register size Is 34 bit and gets the control of the system buses 4 times then the maximum size of the data transferred by controller in Giga byte is____.

Q.107 Consider the following addressing modes:

[MSQ]

(a) Indirect addressing mode

(b) Indexed addressing mode

(c) Relative addressing mode

(d) Based addressing mode

In which of the following addressing mode's, effective address is calculated by adding the constant value to some register content.

(A) a (B) b

(C) c (D) d

Q.108 Which of the following is correct regarding data hazard to pipeline?

[MSQ]

(A) Read after read causes no hazards for the processor.

(B) When the output register of an instruction is used to write after read by a previous instruction, hazards occur due to write After read dependency (anti- dependency).

(C) When the value produced by an instruction is required by a subsequent instruction, then hazards occur due to output data dependency.

(D) Code reordering mechanism can be used to handle data hazards.

Q.109 The method of accessing the I/O devise by repeatedly checking the status flags is

(A) Program controlled I/O

(B) Memory mapped I/O

(C) I/O mapped

(D) None of these

Q.110 Which of the following statements about synchronous and asynchronous I/O is False?

(A) An ISR is invoked on completion of I/O in synchronous I/O but not in asynchronous I/O

(B) In both synchronous and asynchronous I/O, an ISR (Interrupt Service Routine) is invoked after completion of the I/O

(C) A process making a synchronous I/O call waits until I/O is complete, but a process making an asynchronous I/O call does not wait for completion of the I/O

(D) In the case of synchronous I/O, the process waiting for the completion of I/O is woken up by the ISR that is invoked alter the completion of I/O

Answers **Computer Organization & Architecture**

1.	A	2.	A	3.	A	4.	B	5.	B
6.	4	7.	24	8.	B,C	9.	A,B	10.	D
11.	B	12.	A	13.	D	14.	11.1	15.	300
16.	A,B	17.	B,C,D	18.	B,C	19.	1024	20.	87
21.	C	22.	A,B	23.	B	24.	C	25.	A
26.	B	27.	C	28.	96	29.	A	30	D
31.	C	32.	82032	33.	A,C	34.	B,C	35.	A,C
36.	111	37.	43.3	38.	A,B,C	39.	B	40	A
41.	6000	42.	A	43.	A	44.	B,D	45.	256
46.	C	47.	A	48.	B,C	49.	B,C,D	50.	A
51.	1024	52.	B,C	53.	13.5	54.	5	55.	9
56.	B,C,D	57.	B,C	58.	58	59.	A,D	60.	0.87
61.	8942	62.	A,C,D	63.	0.003	64.	D	65.	D
66.	1.08	67.	B	68.	26	69.	4	70.	A
71.	A	72.	C	73.	C	74.	B	75.	6
76.	A	77.	C	78.	D	79.	C	80.	B
81.	B	82.	A	83.	C	84.	0.64	85.	28
86.	11	87.	116.8	88.	1.42	89.	253	90.	A,C,D
91.	A,B,C,D	92.	B	93.	B	94.	B	95.	C
96.	C	97.	C	98.	C	99.	B	100.	5.14
101.	0.066	102.	12	103.	1.5128	104.	152	105.	0.18
106.	64	107.	B,C,D	108.	A,B,D	109.	A	110.	B

1. (A)

Just before fetching given instruction $PC = 2460$ H

Just after fetching given instruction $PC = PC + 4 = 2460 + 4 = 2464$ H because instruction size is 4 bytes (32 bits).

Mem [A] is using direct addressing mode.

So, Effective address $= A = 4408$ H

Now to read value of location A system has to make MAR $= A = 4408$ H.

2. (A)

System A :

It is byte addressable and 4 GB in size of memory.

So number of addressable locations in memory

$$= \frac{\text{Memory size}}{\text{Addressable size}}$$

$$= \frac{4\text{ GB}}{1\text{ byte}} = 4\text{ GB} = 2^{32}$$

Number of bits required for 2^{32} locations $= \log_2(2^{32}) = 32$ bits

So, $x = 32$

System B :

It is word addressable, word size is 4 bytes and 16 GB in size of memory, so number of addressable locations in memory

So, number of addressable locations in memory

$$= \frac{16\text{ GB}}{4\text{ bytes}} = 4\text{ GB} = 2^{32}$$

Number of bits required for 2^{32} locations $= \log_2(2^{32}) = 32$ bits

So, $y = 32$

3. (A)

4. (B)

One access of system bus for data transfer from input/output to DMA and other for data transfer from DMA to memory.

5. (B)

Word size is 32 bit, so MDR size is 32 bits.

$$\text{Size of MAR} = \log_2\left(\frac{\text{Main memory size}}{\text{Addressable size}}\right)$$

$$= \log_2\left(\frac{4\text{ GB}}{16\text{ bits}}\right)$$

$\{\because$ Here half word $= 16$ bits$\}$

$$= \log_2\left(\frac{4 \times 2^{30} \times 8}{16}\right) = \log_2(2^{31}) = 31\text{ bits}$$

6. 4

Number of tracks = Number of cylinders

Total size = (Number of surfaces) × (Number of tracks per surface) (Number of sectors per track) × (Size of a sector)

$= 32 \times 256 \times 512 \times 1024$ bytes

$= 2^5 \times 2^8 \times 2^9 \times 2^{10}$ bytes $= 2^{32}$ bytes $=$ 4 GB

7. 24

Block size (BS) $= 256$ bytes $= 2^8$ B

Block offset (BO) $= \log_2(2^8) = 8$ bits

In fully associative mapping physical address divided into tag field and block offset, so set field length $= 0$ bits.

Tag field length = Physical address length – Block offset

$= 32 - 8 = 24$ bits

So, $x = 24, y = 0$

$x - y = 24$

8. B,C

In interrupt driven input/output, device interrupt CPU before data transfer. And DMA interrupt CPU at the end of input/output operation.

9. A,B

Fully associative cache contains only tag field and block offset, so if we change block size then it will effect tag field.

Direct mapped and k associative cache have tag field, set field and block offset. Here block offset will affect only set field, but not tag field.

10. (D)

Current address of head <8, 8, 16, 127>.
Head have read 8 cylinders from 0 to 7, so
Bytes for 8 cylinders = (Number of cylinders) × (Number of surfaces) × (Number of sectors per track) × (Bytes per sector)

$$= 8 \times 16 \times 32 \times 512 \text{ bytes}$$

$$= 2^3 \times 2^4 \times 2^5 \times 2^9 = 2^{21} \text{ bytes} \quad \ldots \text{(i)}$$

On 8th cylinder, head completed 8 surfaces from 0 to 7, so
Bytes for 8 surfaces = (Number of surfaces) × (Number of sectors per track) × (Bytes per sector)

$$= 8 \times 32 \times 512$$

$$= 2^3 \times 2^5 \times 2^9 = 2^{17} \text{ bytes} \quad \ldots \text{(ii)}$$

On 8th surface of 8th cylinder, head completed 16 sectors from 0 to 15, so
Bytes for 16 sectors = (Number of sectors) × (Bytes per sector)

$$= 16 \times 512 = 2^4 \times 2^9 = 2^{13} \text{ bytes} \quad \ldots \text{(iii)}$$

On 16th sector of 8th surface on 8th cylinder, head completed 128 bytes from 0 to 127, so
On this sector bytes read = 128 bytes … (iv)
From (i), (ii), (iii) and (iv) total bytes read by head.

$$= 2^{21} + 2^{17} + 2^{13} + 128 \text{ bytes}$$

11. (B)

$4 \text{ GB} = 2^{32}$ bytes and memory is byte addressable, so address length is 32 bit

Block size (BS) $= 64 \text{ bytes} = 2^6$ B

Block offset (BO) $= \log_2(2^6) = 6$ bit

Number of cache blocks

$$= \left(\frac{\text{Cache size}}{\text{Block size}}\right) = \frac{128 \text{ KB}}{2^6 \text{ B}} = 2^{11} \text{ blocks}$$

Length of set field = Address length – Block offset – Tag length $= 32 - 6 - 16 = 10$ bit

Length of set field

$$= \log_2\left(\frac{\text{Number of cache blocks}}{\text{Associativity}}\right)$$

$$10 = \log_2\left(\frac{2^{11}}{x}\right)$$

$$\frac{2^{11}}{x} = 2^{10}$$

$$x = 2$$

So, cache is 2 way set associative.

12. (A)

SLT operation actually implemented using subtraction, as shown below :
For SLT a, b, c

$$a = \begin{cases} 0, & \text{if } b - c > 0 \\ 1, & \text{if } b - c < 0 \end{cases}$$

So, here use $R_1 - R_2$

$$R_2 = 0101$$

$-R_2 = 2\text{'s}$ complement of $R_2 = 1011$

$$R_1 - R_2 = R_1 + (-R_2)$$

$$= 0011 + 1011 = 1110$$

1110 is negative number in 2's complement.
So, $N = 1$
1110 is non zero
So, $Z = 0$
No overflow in above operation
So, $V = 0$
No half carry
So, $H = 0$

13. (D)

Average instruction execution time $= \sum(\text{IC} \times \text{CPI}) \times \text{Cycle time}$

$$= \big((0.4 \times 6) + (0.3 \times 8) + (0.3 \times 4)\big) \text{ 4 ns}$$

$$= 24 \text{ ns}$$

14. 11.1

Average memory access time (AMAT)

$$= (L_1 \text{ access time}) + \text{Miss rate of } L_1$$

$$\times \begin{bmatrix} L_2 \text{ access time} + \text{Miss rate} \\ L_2 \times \text{Memory access time} \end{bmatrix}$$

$$= 10 \text{ ns} + \frac{1}{100} \times \left[100 \text{ ns} + \frac{1}{100} \times 1000 \text{ ns} \right]$$

$$= 11.1 \text{ ns}$$

15. 300

600 rounds in $= 1$ minute $= 60$ sec

1 round in $= \frac{60}{600} = \frac{1}{10} = 100 \text{ ms} -$ rotation time

Bytes read in 1 round = Bytes in a track

= (Number of sectors per track) × (Bytes per sector)

$$= 64 \times 512 = 2^6 \times 2^9 = 2^{15} \text{ bytes}$$

Time to access 1st track of file = Seek time

$$= 50 \text{ ms} \quad \ldots \text{(i)}$$

Time to access starting point of file on 1st track = Average rotational latency

$$= \frac{\text{Rotation time}}{2} = \frac{100}{2} = 50 \text{ ms} \quad \ldots \text{(ii)}$$

Let x bytes of file stored on 1st track, then

$$\text{Time to record } x \text{ bytes} = x \times \frac{\text{Rotation time}}{\text{Bytes in 1 rotation}}$$

$$= x \cdot \frac{100}{2^{15}} \cdot \text{ms} \quad \ldots \text{(iii)}$$

Negligible time on moving from 1st track to its adjacent track which contain other part of file.

Time to access starting point of file on 2nd track = Average rotational latency

$$= \frac{\text{Rotation time}}{2} = \frac{100}{2} = 50 \text{ ms} \quad \ldots \text{(iv)}$$

1st track has x bytes of file, so 2nd track has $(48 \text{ KB} - x)$ bytes.

Time to read $(48 \text{ KB} - x)$ bytes from 2nd track

$$= (48 \text{ KB} - x \text{ bytes}) \times \frac{\text{Rotation time}}{\text{Bytes in 1 rotation}}$$

$$= (48 \text{ KB} - x \text{ bytes}) \frac{100}{2^{15}} \text{ ms} \quad \ldots \text{(v)}$$

Add (i), (ii), (iii), (iv) and (v) for total time to access and read given file.

Total time

$$= 50 \text{ ms} + 50 \text{ ms} + x \cdot \frac{100}{2^{15}} \text{ ms}$$

$$+ 50 \text{ ms} + (48 \text{ KB} - x) \frac{100}{2^{15}} \text{ ms}$$

$$= 100 \text{ ms} + \frac{100}{2^{15}} (x + 48 \text{ KB} - x) + 50 \text{ ms}$$

$$= 150 \text{ ms} + \frac{100}{2^{15}} \times 48 \times 2^{10}$$

$$= 150 \text{ ms} + \frac{100}{32} \times 48$$

$$= 150 \text{ ms} + 150 \text{ ms} = 300 \text{ ms}$$

16. A,B

Main memory (MM) address length

$$= \log_2 (\text{MM size}) = \log_2 (4 \text{ GB})$$

$$= \log_2 (2^{32}) = 32 \text{ bits}$$

System A :

Number of cache blocks

$$= \frac{\text{Cache size}}{\text{Block size}} = \frac{128 \text{ KB}}{128 \text{ B}} = 1 \text{ K} = 2^{10}$$

$$\text{Set numbers} = \frac{\text{Block}}{\text{Associativity}} = \frac{2^{10}}{2} = 2^9$$

Set field length $= \log_2$ (Set numbers)

$$= \log_2 (2^9) = 9 \text{ bits}$$

Block offset $= \log_2$ (Block size)

$$= \log_2 (2^7) = 7 \text{ bits}$$

Tag field length = Address length – Set length – Block offset

$$= 32 - 9 - 7 = 16 \text{ bits}$$

System B :

$$\text{Number of cache blocks} = \frac{128 \text{ KB}}{256 \text{ B}} = 2^9$$

$$\text{Set numbers} = \frac{2^9}{2} = 2^8$$

Set field length $= \log_2 (2^8) = 8$ bits

Block offset $= \log_2(256) = \log_2(2^8) = 8$ bits

Tag field length $= 32 - 8 - 8 = 16$ bits

$x =$ Tag length of $A -$ Tag length of B

$= 16 - 16 = 0$

$y =$ Set length of $A -$ Set length of B

$= 9 - 8 = 1$

17. B,C,D

$C_1 \rightarrow$ Conflict miss

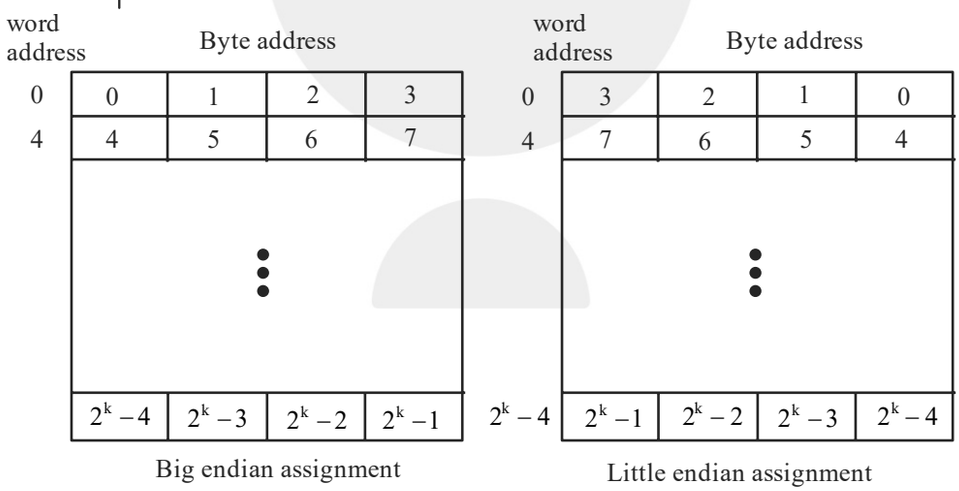
$C_2 \rightarrow$ Compulsory miss

$C_3 \rightarrow$ Capacity miss

$H \rightarrow$ Hit

10	11	12	18	5	11	6	7	10	15	11
C_1	C_2	C_2	C_2	C_2	H	C_2	C_2	C_1	C_2	C_1	H

0	12			
1	5			
2	~~10~~	~~15~~	6	10
3	~~11~~	~~7~~	15	11



Big endian assignment

Little endian assignment

19. 1024

Branch is checking equality R_1 and R_2. PC relative mode is used. Before adding the offset the PC is already incremented by 4.

Therefore mem address of next instruction must be

$1004 + \text{label} = 1004 + 20 = 1024$

20. 87

X (opcode bits) = ceil $(\log_2 110) = 7$ (because the instruction set consists of 110 different)

Number of $C_1 = 2$

Number of $C_2 = 8$

Number of $C_3 = 0$

Number of $H = 2$

18. B,C

Byte addresses can be assigned across words in two ways

Big endian and little endian

Big endian: the most significant byte has the lowest address, and the least significant byte has the highest address $(1-2-3-4)$.

Little endian: the least significant byte has the lowest address, and the most significant byte has the highest address $(4-3-2-1)$

Bits for register address $(Y) = \log 8 = 3$ (because there are registers)

Total size of the instruction = 32 bits

Therefore bits for mem address

$(Z) = 32 - 7 - 3 = 22$

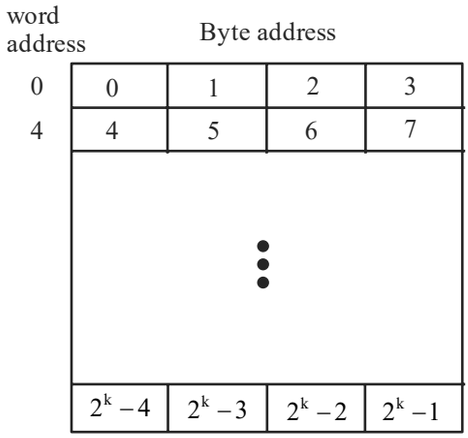
$XY + YZ = 21 + 66 = 87$

21. (C)

Byte addresses can be assigned across words in two ways:

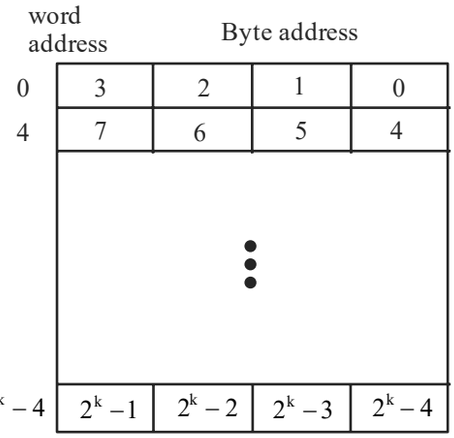
Big Endian and little endian

Big Endian the most significant byte has the lowest address, and the least significant byte has the highest addresses $(1-2-3-4)$



Big endian assignment

Little Endian the least significant byte has the lowest address, add the most significant byte has the highest address $(4-3-2-1)$



Little endian assignment

22. A,B

If 2 Two's Complement numbers are added, and they both have the same sign (both positive and both negative), then overflow occurs if and only if the result has the opposite sign. Overflow never occurs when adding operands with different signs.

i.e. Adding two positive number must give a positive result

Adding two negative number must give a negative result

$$\begin{array}{l} 0111\ \ 1001\ \ 1011\ \ 1011 \\ +\,0011\ \ 1011\ \ 1110\ \ 1110 \\ =1011\ \ 0101\ \ 1010\ \ 1001 \\ 1111\ \ 0111\ \ 0110\ \ 1001 \\ +\,1000\ \ 0001\ \ 0110\ \ 0100 \\ =1011\ \ 1100\ \ 01100\ \ 1101 \end{array}$$

Overflow never occurs when adding operands with different signs, so, in option C, and D, we don't have any overflow.

23. (B)

$$\begin{array}{r} 1100\ \ 1100 \\ 1000\ \ 1111 \\ \hline 1\ \ 0101\ \ 1011 \end{array}$$

There is a carry out is generated from the most significant bit during an operation, so C =1

To check overflow, we can check the MSB bits of the two number being added. Since both are 1 but the result is 0 hence, an overflow has occurred (Or we can check by seeing that there is out carry from MSB, but there is No in carry into MSB). Hence, V = 1.

Result is not zero, hence, Z = 0.

24. (C)

Very first step = fetch the inst^n = I1

After fetching we can increment the PC = I6

Now we have the inst in the IR let's decode it = I2

After decoding read the operand value from R7 = I2

We have the immediate value add it to R7 = I3

Now calculate the EA using I4 and I3 and fetch the source operand = I5

Load the data = I7

Therefore ans should be C.

25. (A)

C_4 CS is there in fetch cycle as well as in indirect cycle section

Boolean Expression for C_4

$$C_4 = P'Q't_3 + P'Qt_3$$

Since No option is matching. Let's simplify

$$C_4 = P't_3(Q'+Q) = P't_3$$

Therefore answer should be A.

26. (B)

Initially

$M = 10001111$
$N = 01100010$
$O = 01001001$
$P = 01110010$

Now, program execution begins:

$1: M \leftarrow M \oplus N :: / / M = 11101101$
$2: M \leftarrow CSLM :: / / M = 11011011$
$3: N \leftarrow M + N :: / / N = 00111101$
$4: O \leftarrow O \wedge N :: / / \mathrm{O} = 00001001$
$5: O \leftarrow CSRO :: / / \mathrm{O} = 10000100$
$6: P \leftarrow P + 1 :: / / P = 01110011$
$7: P \leftarrow P + O :: / / P = 11110111$

Hence, answer is options B.

27. (C)

When the program is executed on a single processor i.e. All instructions are executed sequentially, then the time taken is 100 units. The assumed program has 100 instruction. So, each instruction takes 1 unit of time.

Program running with 2 processors:

40 percent of computation is "inherently sequential" (i.e. will not benefit from additional processors), So, 40 units of time will be required for these 40 instruction. The remaining 60 instruction can be executed parallelly on the two processors, so 30 units of time more required. Hence a total 70 units of time 70 seconds.

Program running with 4 processors:

40 percent of computation is "inherently sequential" (i.e. will not benefit from additional processors), so 40 units of time will be required for these 40 instruction. The remaining 60 instructions can be executed parallelly on the four processors, so 15 units of time more required hence a total 55 units of time 55 seconds.

28. 96

Instruction length is 20, so, maximum possible encodings $= 2^{20}$

It is given that there are 10 M – type instruction. Let's assume the maximum R-Type instructions to be *x*.

$$2^{20} \geq (10 \times 2^{16}) + (x \times 2^6 \times 2^6)$$
$$\Rightarrow x \leq 96$$

So, maximum 96 R type instructions possible.

29. (A)

Say the program takes 100 units time when executed sequentially

Now, on the parallel processors, 10 of the program is executed sequentially, so the time needed for that is 10 units.

The remaining 90 of the program is run parallelly using an unlimited no of processors, then execution time is negligible.

So, speed up = 100 unit/10 unit = 10.

Speed up is approximately 10 times.

30. (D)

As Alignment is mentioned in the question and no rearrangement of fields of a widget can be done memory layout:

1. Short *s*, byte *b* (2+1)+5 (padding to make the sum = 8 bytes)
2. Long *l* (8 bytes, no need of padding)
3. int *I* (4+4(padding) = 8)

Therefore each element in the widget array occupies 3 words $= 3 * 8 = 24$ bytes

The answer is D.

31. (C)

Design 1:

A part of a bigger task is improved twenty times than it was before. The other part of the same task constitutes 60 of the overall task time and it remains unchanged.

Let, this task be T, and let's assume this task takes 100 units of time before enhancement. Let

it have two part: part A (40 units of time) and part B (60 units of time)

After enhancement, part A is improved twenty times than it was before, so now part A will take time : $40/20 = 2$ unit of time

After enhancement, Part B remains unchanged so, Now part B will take time 60 unit of time.

So, after enhancement, the task T will take $2+60 = 62$ unit of time

So, speedup achieved is = (execution time before enhancement)/ (execution time after enhancement)

$= 100/62 = 1.61290323$

Design 2:

The designer can make changes to improve 20 of the task 100 faster, 35 of the task 4 times faster and 10 of the task 100 times faster but it causes faster, but it causes the remaining part of the task to perform as bad as 50 slower than before.

Let this task be S, and let's assume this task takes 100 units of time before enchantment. Let it have four part: Part 1 (20 unit of time), Part 2 (35 unit of time), Part 3 (10 units of time) and part 4 (remaining 35 unit of time)

After enhancement, Part 1 is improved to be made 100 faster than it was before, so, now part 1 will take time: 20/2 = 10 unit of time

After enhancement, part 2 is improved to be made 4 times faster than it was before, so, now part 3 will take time: 10/100 = 0.1 unit of time

After enhancement part 4 becomes 50 slower than it was before, so, now part 4 will take time: 35*2 = 70 units of time.

So, after enchantment, the task S will take 10 + (35/4) + 0.1 + 70 = 88.85 unit of time

So, speedup achieved is = (execution time before enhancement) / (execution time after enhancement) = 100/88.85 = 1.1254924

So, difference in speedup is 1.61290323

– 1.1254924 = 0.4875 (approx.).

32. 82032

Big endian: the most significant byte has the lowest address and the least significant byte has the highest address $(1-2-3-4)$

Little endian: the least significant byte has the lowest address and the most significant byte has the highest address $(4-3-2-1)$

So the given word is 0×00014070 which in decimal is 82032

33. A,C

Here, no of flags = 8

Therefore, no of bits required in the address selection field = 3

No of bits in address field $= 24-13-3 = 8$

Size of control memory

$= 2^8 = 256$ word $= 256*24$ bits

$= 6144$ bits

34. B,C

Since data is 8 bit the OVEL occurs, when the result is between

$(-128)_{10}$ and $(+127)$

94_{16} = 1 0 0 1 0 1 0 0 = $-(108)$

−128 16 4

79_{16} = 0 1 1 1 1 0 0 1 = +121

64 32 16 8 1

Option (A) is False, $-108+121 = -13$ No OVEL

Option (B) is True, $-108+121 = -13$ No OVEL

Option (C) is True, $-108-79 = -187$ OVEL

Option (D) is False, $-108-79 = -187$ OVEL

35. A,C

While adding 2 number of signed data the of both operands is same and longest result size of $m+1$ bits

36. 111

RPM = 12000, RPS = 200,

One rotation time $= \frac{1}{200}\text{sec} = 5$ ms

Avg. latency = 2.5 msec

Access time of ac sector $= T_{\text{seek}} + T_{\text{AvgRot}} + T_{\text{RD/WR}}$

$T_{\text{track}} = 5$ ms, one sector data

RD/WR time $\left(T_{\text{sec tor}}\right) = \frac{5 \text{ ms}}{100} = 0.5$ m.sec

One sector access time $= 3 + 2.5$ ms $== 5.55$ ms

$T_{20\text{sector}} = 20 \times 5.55 \text{ ms} = 111$

37. 43.3

$T_{cm} = 10$ ns, $T_{mm} = 100$ ns

$H_{RD} = 90\% = 0.9$

Read frequency $f_{RD} = 70\%$

Write frequency $f_{WR} = 30\%$

$T_{Avg} = f_{RD} * T_{\text{Read}} + f_{\text{WRAvg}}$

$T_{\text{readAvg}} = \left(T_{em} * H_{RD}\right) + \left(1 - H_{RD}\right) \times T_{MM}$

$= (10 \times 0.9) + 0.1 \times 100 = 19$ ns

$T_{\text{WRAvg}} =$ lostgest delay in $T_{cm}. T_{mm}$

$= 1000$ ns(write through)

$T_{Avg} = \left(0.7 * 19 \text{ ns}\right) + \left(0.3 \times 100 \text{ ns}\right)$

13.3 ns + 30 ns = 43.3 ns

38. A,B,C

$MMW = 2^{24}$ word $= 16$ M word

$CMW = 2^{17}$ word $= 128$ K word

$BW = 9; PA = 24; CA = 17;$

Tag size $= PA - CA$

$= 24 - 17 = 7$ bits

$$CL = \frac{CMW}{BW} = \frac{2^{17}\text{B}}{2^{9}\text{B}} = 2^{8} = 256$$

Tag directory size $=$ Tag $\times CL$

$= 7 \times 256 = 1792$ bits

When CPU requires the same word repeatedly, then there are more no. of chances for occurring conflict miss.

39. (B)

Given data is in singed 2's complement notation, its decimal value is

$$\underset{}{x_{n-1}} \quad \underset{}{x_{n-2}} \quad \underset{}{-x_4} \; \underset{}{x_3} \; \underset{}{x_2} \; \underset{}{x_1} \; \underset{}{x_0}$$

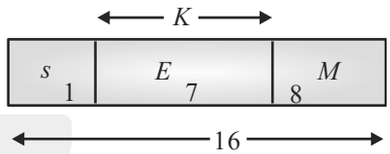
$$\underbrace{-(2^{n-1})}_{-ve\ value} \quad \underbrace{2^{n-2} \quad 2^4 \; 2^3 \; 2^2 \; 2^1 \; 2^0}_{-vev\ alue}$$

$$\left\{(-1)\left(x_{n-1}\right) \times \left(2^{n-1}\right)\right\} + \sum_{i=0}^{n-2} a_i \times 2^i$$

40. (A)

Biasing value $= 64 = 2^6$

Hence $K - 1 = 6, \; K = 7$



E size = 7 bit and

M size = 8 bits

41. 6000

Average latency is equal to the half Rotation time $= \frac{T_{\text{track}}}{2} = 5$ m sec

$T_{track} = 10$ msec (One track reading time)

One rotation time = 10 msec

$$\text{RPS} \frac{1}{T_{\text{track}}} = \frac{1}{10 \times 10^{-3}} = 100$$

Hence RPM $= 60 \times 100 = 6000$

42. (A)

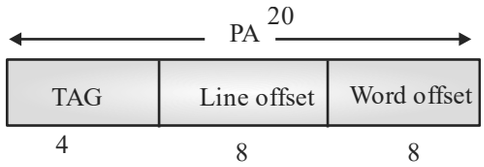
Conflict miss occurred, when a word is accessed 2nd time on words and the word is not available in cache memory address. In fully associative mapped cache only compulsory and capacity misses will occur.

43. (A)

PA = 20 bit, direct map CM size = 64 KB,

CMW $= 2^{16}$, BW $= 2^8$

$$CL = \frac{CMW}{BW} = \frac{2^{16}}{2^8} = 2^8$$
$$= 256(CL\ 0 \text{ to } CL\ 255)$$



$$W_{2049} = 100000000001$$

$$= 0000 \left| \begin{array}{c} 128\ 64\ 32\ 16\ 8\ 4\ 2\ 1 \\ 0\ 0\ \ 0\ 0\ 1\ 0\ 0\ 0 \\ \text{Cache line offset} \\ = \text{CL}_8 \end{array} \right| \begin{array}{c} 00000001 \\ \text{word address} \end{array}$$

44. B,D

$$T = 1024 = 2^{10},\ S = 64 = 2^6,\ B = 16 = 2^4$$

Hence word address format $\langle T\ S\ B \rangle$

$$= 10 + 6 + 4 = 20 \text{ bits}$$

$$\rightarrow FFC.F_{16} = \begin{array}{c} 1111\,111111 \\ \text{Track address} \\ T_{1023} \end{array} \left| \begin{array}{c} 000000 \\ \text{Sector} \\ \text{Address} \\ S_0 \end{array} \right| \begin{array}{c} 1111_2 \\ \text{Byte address} \\ B_{15} \end{array}$$

It is in sector S_0, hence option (A) is false and option (B) is True.

$$(003F2)_{16} = \begin{array}{c} 0000\ 0000\ 00 \\ \text{Track address} \\ T_0 \end{array} \left| \begin{array}{c} 111111 \\ \text{Sector} \\ \text{Address} \\ S_{63} \end{array} \right| \begin{array}{c} 0010 \\ \text{Byte address} \\ B_2 \end{array}$$

It is in sector S_{63}, hence (C) is wrong and (D) is True.

45. 256

Operand size = 16 bit
Operation is squarer
Address size = 16 bit
Longest result size = 32 bit (data size)

$$\text{ROM size} = 2^{16} \times 32 \text{ bits}$$
$$= 64\text{K} \times 4 \text{ bytes} = 256 \text{ KB}$$

46. (C)

$$(FFFE0000)_{16}$$

$$\begin{array}{c|c|c} 1 & 111\ \ 11111 & 111\,1110\ 0000\ 0000\ 0000\ 0000_2 \\ S & E = \ \ 255 & M \end{array}$$

Let, E = 255, $M \neq 0$, it is reserved for special value (NAN)

Note: Let E = 255, M = 0; it is used to represent $\pm$ infinitive

47. (A)

$$R_P = \text{C1D00000} =$$

$$\begin{array}{c|c|c} 1 & 100\ 0011 & 1010000000....0(32 \text{ bits}) \\ S & E = 131 & M \end{array}$$

$$\text{Value} = (-1)^S * 1.M \times 2^{E-127} = (-1) * 1.1010 \times 2^4$$
$$= (-1)11010 \times 2^0 = (-)11010_2 = -26$$

$$R_R = 41\text{D}00000 = 0 \left| \begin{array}{c} 10000011 \\ S \\ E = 131 \end{array} \right| \begin{array}{c} 10100000....0 \\ M \end{array}$$

$$= (-1)11010 \times 2^4 = +11010 = +26$$

Hence P + R = 0 True

R = P +Q = False

26 = –26 – 14 False

$$R_Q = C1600000 = 1 \left| \begin{array}{c} 10000010 \\ S \\ E = 130 \end{array} \right| \begin{array}{c} 1100000....0(32 \text{ bits}) \\ M \end{array}$$

$$\text{Value} = (-1)^s * 1.M \times 2^{E-127}$$
$$= (-1)^1 * 1.1100 \times 2^{130-127}$$
$$= (-)1110 \times 2^0 = -14 = Q$$

$R > Q$ = True; $R + Q = 26 - 14 = +12$ True

48. B,C

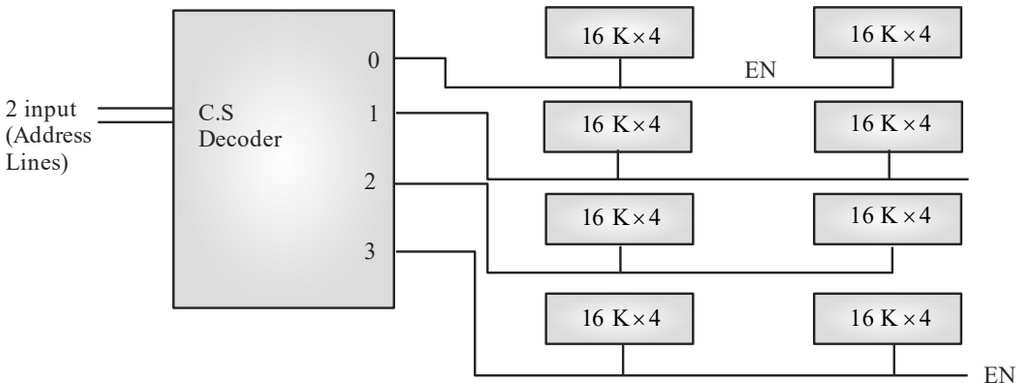
$$\text{Target size} = 64\text{ K} \times 8 = 2^{16} \times 8$$

$$\text{Basic size} = 16\text{ K} \times 4 = 2^{14} \times 4$$

$$\text{Total no. of chips needed} = \frac{64\text{ K} \times 8}{16\text{ K} \times 4} = 4 \times 2 = 8$$

These '8' chips are arranged in 4 rows and 2 columns.

No. of free address lines $= 16 - 14 = 2$



49. B,C,D

Option (A) is false because Index register addressing mode instruction requires one operand read from memory but it is not needed for immediate addressing mode instruction.

Option (B) and (C) are True. Option (D) is true because PC Relative addressing mode is also known as position independent addressing mode.

50. (A)

P = 2 because generally DMAC is used to transfer the data from secondary memories

Q = 1 because interrupt driven IO used for connecting printer and monitor.

R = 4 CPU used NMI for checking the power failure case

S = 3 Flag register is connected to the output of the ALU.

51. 1024

Since count register size is 16 bits one bus request is used to transfer 2^{16} Bytes $= 64$ KB

Maximum size of the data to be transferred for 16 request

$$= 16 \times 64 \text{ KB} = 1024 \text{ KB}$$

52. B,C

Option (A) is false because PC Relative addressing mode is used for both forward and backward jump that is specified by the MSB of the displacement.

Option (D) is false because indexed addressing mode is used for array implementation

53. 13.5

I_1, I_2 and I_6 are executed for only one time but I_3, I_4 I_5 are executed for 6 times.

(Count = 6).

Total no. of clock cycles required

$$I_1 = 1,\ I_2 = 1,\ I_3 = 6,\ I_4 = 6$$

$$I_5 = 12,\ I_6 = 1 = 27$$

$$f_{clk} = 2 \text{ GHz},\ T = 0.5 \text{ ns}$$

$$\text{Total time} = 27 \times 0.5 \text{ ns} = 13.5 \text{ ns}$$

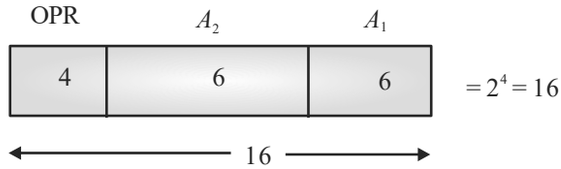
54. 5

Instruction cycle is the combination of both Fetch cycle and execute cycle.

Fetching requires 2 clocks. @ R_1 is register indirect addressing mode i.e. CPU reads the operand from memory that address is given by R_1 hence it requires 2 clocks and for adding operation one more clock is needed. Hence total no. of clocks needed is $2 + 2 + 1 = 5$

55. 9

Maximum no. of two address instruction is



But it used 'X' only, the no. of free combinations $= (16 - X)$, each one free

combination produces 2^6 one address instructions.

i.e. $(16-X)\times 2^6 = 448$

$$16-X = \frac{448}{64} = 7$$

$$X = 9$$

56. B,C,D

Horizontal microprogram control word required longer size control word hence it requires larger size control space. Option (A) is false it is used to generate more no. of control signals in parallel hence degree of parallelism is high.

It does not require signal encoders and decoders option (B), (C) & (D) are true.

57. B,C

SP = 5926

Memory is word addressable i.e. CPU access one memory location for reading PC and 2nd memory location content.

Hence RET requires POP operations; the SP content is incremented for stack going downward method and decremented fir stack going upward method.

Stack	Stack
Goes upward	Goes down ward
5926 –2	5926 + 2
= 5924	= 5928

58. 58

Total number of control signals = 72

Hence 72 bits are needed for horizontal microprogram control word but for vertical microprogram control word Log_2n bits are sufficient for 'N' signals, Hence vertical system needs $6+5+3=14$

Hence, it saves 58 bits.

59. A,D

Option (A) is true and option (C) is false because when there is no branch prediction, CPU stops the fetching of new instruction until completion of branch instruction execute stage option (B) is false arithmetical instruction takes shorter time than conditional branch instruction option (D) is True because conditional code resister is also known as flag register.

60. 0.87

$$f_{clk} = 2 \text{ GHz}; T_{CLK} = 0.5 \text{ ns} = T_{\text{seg}}$$

Hence for executing the non branch instruction, only 0.5 ns time is sufficient, non branch instructions = 75% and branch instructions = 25% CPU finds the target address for the branch instruction means, it requires 3 stalls (3 segment delays)

Average time

$$= \left(0.75(1+0)\times T_{\text{seg}}\right) + \left(0.25\times(1+3)*T_{\text{seg}}\right)$$

$$= (0..75\times 0.5)\text{ns} + \left(1\times 0.5 \text{ ns}\right) = 0.875 \text{ ns}$$

61. 8942

Address bus size = 16 bit, hence maximum no. of memory registers to be addressed

$= 2^{16} = 64 \text{ K} = 65536$; but 56594 memory locations are used for programs and data storage, the no. of IO devices permitted.

$= 65536 - 56594 = 8942$

62. A,C,D

Option (A) is true, input and output have load and store instructions respectively.

Options (B) is false because IO RD and IO WR control signals are used in IO mapped IO only

Options (C) is true because since memory address size is 16 bit maximum no. of IO devices to be addressed

$$= 2^{16} = 64 \text{ K} = 64\times 1024 = 65536$$

Option (D) is True because, it is not possible to use the memory register after connecting IO device.

63. 0.003

$$f_{clk} = 1 \text{ GHz}; T = 1 \text{ ns}$$

POP R_1 instruction cycle requires instruction fetch (fetch + decode) and operand read form

stack to R_1 in execute cycle. Hence it requires 3 clock. Total instruction cycle time

$$= 3 \times 1 \text{ ns} = 3 \text{ ns} = 0.003 \ \mu\text{sec}.$$

64. (D)

On interrupt, processor save PC, processor status word (PSW) and other required thing, PC is not only thing which saved.

65. (D)

A sector is the smallest physical storage unit on a disk and is almost always 512 bytes (0.5 kB) in size.

Collection of sectors are called tracks and collection of tracks are called cylinder.

Hence, all the option are true.

Therefore option (D) is incorrect.

66. 1.08

Using Amdahl's law

$$\text{Speedup}(S_1) = \frac{1}{0.7 + \frac{0.3}{6}} = \frac{1}{0.7 + 0.05}$$

$$= \frac{1}{0.75} = \frac{4}{3}$$

$$\text{Speedup}(S_2) = \frac{1}{0.8 + \frac{0.2}{20}} = \frac{1}{0.8 + 01}$$

$$= \frac{1}{0.81} = \frac{100}{81}$$

$$\frac{\text{Speedup}(S_1)}{\text{Speedup}(S_2)} = \frac{\frac{4}{3}}{\frac{100}{81}} = \frac{4 \times 81}{3 \times 100} = 1.08$$

67. (B)

Speedup of K stage pipeline is K **.**

68. 26

Maximum value of word count register

$$= 2^{16} - 1 = 65535$$

DMA can transfer 65535 bytes maximum at a time.

Number of tunes DMA controller needs to be invoked

$$= \left\lceil \frac{1630 \times 1024}{65535} \right\rceil = [25.469] = 26$$

69. 4

2 bytes (16 bits) require time to transfer $= 2\mu s$

4000 bytes will take minimum time $4000\,\mu s = 4$ ms

70. (A)

LOAD	$R_1, 3000$	$// R_1 = 3000$
ADD	$R_2, R_1, (2000)$	$// R_2 = R_1 + M[2000]$
ADD	$R_3, (R_2), 0$	$// R_3 = M[R_2] + 0$ $= 40 + 0 = 40$

71. (A)

(b) Splitting reduces structural hazards.

(c) Stall filling possible, but not always.

(d) Register renaming reduces data hazards.

72. (C)

(A) and (B) adding AC using direct addressing, not immediate

73. (C)

16 flags, and one flag need to select, so $\lceil \log_2(16) \rceil = 4$ bits required

Address field length = 24 – (opcode) – (flag)

$$= 24 - 11 - 4 = 9 \text{ bits}$$

Instruction length = 24 bits

Memory size = Number of addresses × Instruction length $= 2^6 \times 24$ bits

$$= \frac{512 \times 24}{8} \text{ Bytes} = 1536 \text{ Bytes}$$

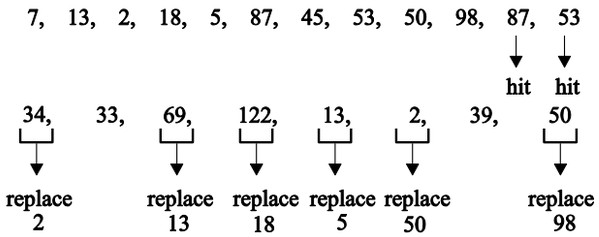
μ – opcode	Flag	Address
11	4	9

74. (B)

Maximum clock frequency is limited by the slowest pipeline stage. In (b), slowest pipeline delay is 4.5 ns and it is smallest among given options.

75. 6

$$\text{Number of sets} = \frac{\text{Number of blocks}}{\text{Associativity}} = \frac{32}{4} = 8$$



Set	
0	
1	33
2	~~2~~, ~~15~~, ~~50~~, ~~98~~, 34, 122, 2, 50
3	
4	
5	~~13~~, ~~5~~, 45, 53, 69, 13
6	
7	7, 87, 39

76. (A)

The DMA technique does not make use of the interrupt mechanism, that's why it is more efficient than the interrupt-driven technique for high volume I/O data transfer.

77. (C)

Write through protocol – Inclusion
Write back protocol – Coherence
RISC – Relatively few addressing modes
CISC –Variable length instruction format

78. (D)

When all stages of pipeline having same delay and buffer latency is zero then, for a single instruction execution time of pipeline CPU is equal to the execution time of non-pipelined CPU.

For a single instruction time taken on pipelined CPU is greater than or equal to the identical non-pipeline.

79. C)

WAR

$$I_1(R_2) - I_0(R_2)$$
$$I_2(R_5) - I_1(R_5)$$
$$I_3(R_3) - I_0(R_1)$$

WAW

$$I_3(R_1) - I_0(R_1)$$

WAR = 3 and WAW = 1

80. (B)

S_1 is correct, in write through all write operations are made to main memory as well as to the cache ensuring the main memory is always valid, thus it generates substantial memory traffic.

S_2 is false, in write back updates are made to main memory on the basis of dirty bit.

81. (B)

Multiplier	Pair with (q - 1)	Operation
1	0	SUB
0	1	ADD
1	0	SUB
0	1	ADD
0	0	Shift only
1	0	SUB
0	1	ADD
1	0	SUB

Total 3 ADD required

82. (A)

MOV R_1, 10 is immediate addressing mode.

83. (C)

For execution of the instruction, we have to consider the instruction fetch and operand fetch.
Instruction fetch = 1 cycle
Operand fetch = 2 cycles (due to indirect addressing mode)
So total 3 cycle required.

84. 0.64

0.64 [0.63 – 0.65]
Refreshments done in 1msec = 64
Refreshments done in

$$10^6 n\sec = 64 (\because 1n\sec = 10^6 n\sec)$$

Now refreshments done in

$$200n\sec = \frac{64\times 200}{10^6} = \frac{128}{10^4}$$

In 1 memory cycle, $\frac{128}{10^4}$ refreshes could be done

Time spent in doing $\frac{128}{10^4}$ refreshes

$$= 100n\sec \times \frac{128}{10^4} = 1.28n\sec$$

Out of 200nsec is spent in doing refreshments
Percentage of CPU time spent in refreshments

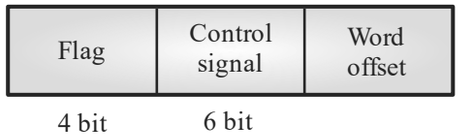
$$= \frac{1.28n\sec}{200n\sec}\times 100 = 0.64\%$$

85. 28

Cache is divided into 16 sets of 4 lines each, therefore 4 bits are needed to identify the set number.
Main memory consist of 2^{12} blocks. Therefore set + Tag length must be 12 bits.
So, Tag = 12 – 4 =8

Block size = 128 words = 7 bit
Thus, X = 8 bit, Y = 4
So, $X + 5Y = 8 + 4\times 5 = 8 + 20 = 28$

86. 11



Number of bits for flag $= \lceil \log_2 15 \rceil = 4$ bit
Number of bits for control signal $= \lceil \log_2 62 \rceil = 6$ bit
Length of control word = Flag + Control signals + Address
Also, number of the operations for 360 instructions $= 360\times 10 = 3600$
So, Address field $= \lceil \log_2 3600 \rceil = 12$ bits
So, Size of 1 control word = 12 + 4 + 6 = 22 bit
For 4 control words $= 4\times 22$ bits $= 88$ bits
i.e. $\frac{88}{8} = 11$ bits

87. 116.8

116.8 [116.8 – 119.9]
$t_p = 200$ ns $\quad n = 580$
$k = 5$
$\Rightarrow \quad (k+n-1)t_p$
$\Rightarrow \quad (5+580-1)\times 200$ ns
$\Rightarrow \quad 1165800$ ns $= 116.8$ ns

88. 1.42

By using Amdhal's law
$s = 4; f = 40\%$

$$s_{\text{overall}} = \left[(1-f) + \frac{f}{s}\right]^{-1}$$

Here f is most frequency used operation frequency and s is speed up factor.

$$s_{\text{overall}} = \left[(1-f) + \frac{0.4}{4}\right]^{-1}$$
$$= [0.6 + 0.1]^{-1} = 1.42$$

89. 352

Read access time $= HT + (1-H)(T_w)$

$= 0.9\times100 + 0.1\times(1000)\,n\text{sec}$

$= 190n\,\text{sec}$

Total Access time

$= (0.8\times190 + 0.2\times1000)\,n\text{sec}$

$= 352n\,\text{sec}$

90. A,C,D

High degree of parallelism (more than 1 control signal enabled at a time).

Little encoding (faster).

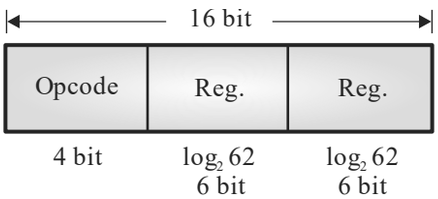
1 bit/control signal (longer control word).

91. A,B,C,D

In I/O mapped I/O mapping, the I/O devise are given a separate addressing region separate from the memory. These separate address spaces are known as 'Ports'

Interleaved DMA is a more complex type of DMA operation using this technique, the DMA controller takes over the system bus when the microprocessor is not using it.

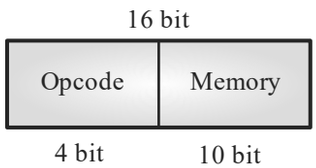
92. (B)



Number of 2 address instructions $= 2^4 = 16$

Number of free opcodes $= 16 - 12 = 4$

Number of 1 address memory reference instructions $= 4\times2^2 = 16$



Number of free opcodes $= 16 - 14 = 2$

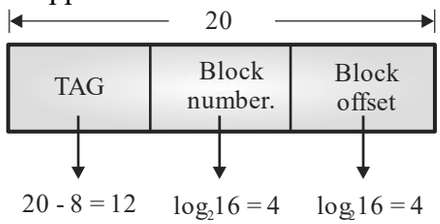
Number of 0 address instruction

$= 2\times2^{10} = 2^{11} = 2048$

93. (B)

Main memory address size $= 5\times4 = 20$ bits

Direct mapped cache:



1st pass

1. $O\times80000 =$ Compulsory misses
2. $O\times80008 =$ Hit
3. $O\times80010 =$ Compulsory misses
4. $O\times80018 =$ Hit
5. $O\times30010 =$ Compulsory

2nd pass

1. $O\times80000 =$ Hit
2. $O\times80008 =$ Hit
3. $O\times80018 =$ conflict misses
4. $O\times80018 =$ Hit
5. $O\times30010 =$ Conflict misses

So, for 10 passes

Compulsory misses = 3

Conflict misses $= 2\times9 = 18$

94. (B)

Tasks $\rightarrow m$

Stages in pipeline = n

Without pipelining number of cycles required to execute m tasks = n m.

(Each task required n cycle)

When we pipeline the tasks for I s t task it requires n cycles and for next (m - 1) 1 cycle for each

(m – 1) tasks

So total cycles required with pipelining

$= n + (m-1) \times 1$

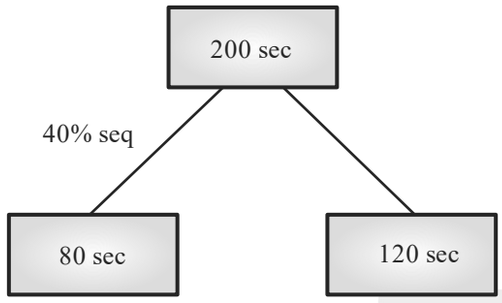
$= (n + m - 1)$

Speed gained by pipeline

$$= \frac{\text{Number of cycles without pipelining}}{\text{Number of cycles with pipeline}}$$

$$= \frac{mn}{(n+m-1)}$$

95. (C)

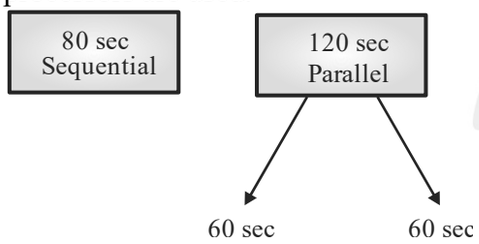


A single processor which requires 200 ns for computation.

It's 40 % computation is serial i.e. 80 s.

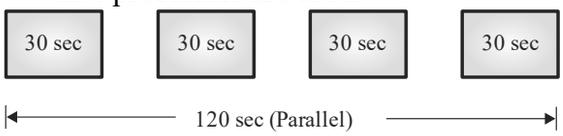
Then 60% will be parallel i.e. 120 s.

If 2 processors are used.



Here maximum elapsed time = (80 + 60) sec = 140 sec

If 4 processors are used.



Here maximum elapsed time = (80 + 30) = 110 sec

96. (C)

Bias $= 2^{8-1} = 127$

Biased exponent (B.E.)= Actual exponent +Bias

Also 8^{12} can be written as $= (2^3)^{12} = 2^{36}$

Now, B.E. $= 36 + 127 = 163$

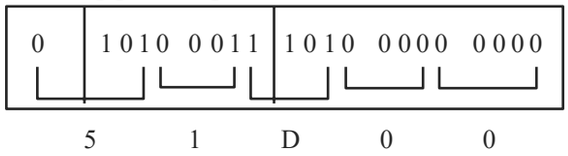
Representing exponent in binary

$$(163)_2 = (10100011)_2$$

Representing mantissa in binary

$$(0.625)_2 = (0.10100000000)_2$$

Floating point representation will be



= Ox51D00

97. (C)

$I_1 : 5000 - 5003$

$I_2 : 5004 - 5011$

$I_3 : 5012 - 5015$

$I_4 : 5016 - 5023$

$I_5 : 5024 - 5027$

$I_6 : 5028 - 5029 \rightarrow$ Interrupt

$I_7 : 5030 - 5033$

Return address 5028 is pushed on to stack due to halt.

98. (C)

With loop level // ^{sm}:23 cycles

Without loop level// ^{sm}:26 cycles

Number of cycle saved = (26–23) = 3

99. (B)

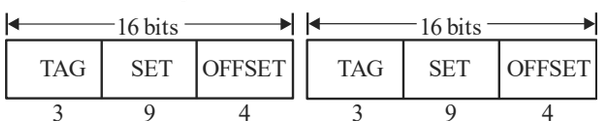
Block size = 16 byte = 2^4 byte =4 bits

Blocks in main memory = 2^{10}

So number of sets $= \frac{2^{10}}{2^1} = 2^9 \Rightarrow 9$ bits

Number of bits in physical address

$= 2^{16}$ byte $\Rightarrow 16$ bits



$$\underbrace{111}_{[E\ 0\ 1\ F]}\underbrace{0000000001}_{\text{SET}}\underbrace{1111}_{}$$

$$\underbrace{111}_{[E\ 2\ 0\ 8]}\underbrace{0001000001}_{\text{SET}}\underbrace{1000}_{}$$

SET value$_1$= 000000001

= Decimal value $= (1)_{10}$

SET value$_2$= 000100001

= Decimal value $= (32)_{10}$

Difference $= \text{SET}_2 - \text{SET}_1$

$= 32 - 1 = (31)_{10}$

100. 5.14

L_1 miss rate $= \dfrac{30}{2000} = 0.015$

L_2 miss rate (we need to take local miss rate)

$= \dfrac{20}{30} = 0.66$

Average memory access time= Hit time (L_1) + miss rate (L_1) [Hit time (L_2) + Miss rate $L_2 \times$ Miss penalty]

$= 1 + 0.015[12 + 0.66 \times 400]$

$= 1 + 4.14 \Rightarrow 5.14$ clock cycles

101. 0.066

$$\text{Sepeedup} = \frac{\text{Pipe line depth}}{1 + \text{Branch freqency} \times \text{Branch penalty}} \geq 5$$

$$\Rightarrow \quad \frac{6}{1 + f \times 3} \geq 5$$

[$\because$ Branch penalty = Branch predicted stage –1]

$5 + 15f \leq 6$

$15f \leq 6 - 5$

$15f \leq 1$

$f \leq \dfrac{1}{15}$

$f \leq 0.066$

102. 12

Since operand forwarding is not maintained, so wait till instruction finish.

	IF	ID	OF	PD	WB
SUB	1	1	1	1	1
MUL	1	1	1	2	1
ADD	1	1	1	1	1
DIV	1	1	1	4	1

	1	2	3	4	5	6	7	8	9	10	11	12	13
I_0	IF	ID	OF	PD	WB								
I_1		IF	ID	OF	PD	PD	WB						
I_2			IF	ID	OF	OF	PD	WB					
I_3			IF	ID	-	-	OF	PD	PD	PD	PD	WB	

So, total 12 cycles required.

103. 1.5128

Average time to read/ write = Seek time + Rotational delay + Effective transfer time

Rotational delay $= \dfrac{1}{2}\left(\dfrac{60}{60000}\right) = 0.5$ msec

Seek time $= 2 \times 0.5$ msec $= 1$ msec

Disk transfer time $= \dfrac{128}{80 \times 10^6} = 0.0016$ msec

Effective transfer time =

8×0.0016 msec $= 0.0128$ msec

So, average time to read/write = 1 msec + 0.5 msec+ 0.0128 =1.5128

104. 152

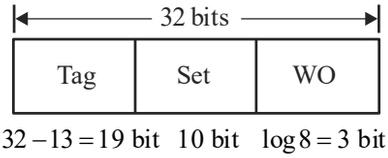
8 – way set associative cache

Cache memory size = 64 KB

Block size = 8 bytes

$$\text{Number of lines} = \frac{64\ \text{KB}}{8\,\text{B}} = 8\text{K} = 2^{13}$$

32 bit virtual address



Tag memory size = Number of lines of cache × Number of tag bits

$$= 2^{13} \times 19 = 152\,\text{K bits}$$

105. 0.18

$$\text{Number of sets} = \frac{8}{2} = 4$$

20 mod 4 = 0 → miss
17 mod 4 = 1 → miss
21 mod 4 = 1 → miss
32 mod 4 = 0 → miss
20 mod 4 = 0 → miss
16 mod 4 = 0 → miss
27 mod 4 = 3 → miss
22 mod 4 = 2 → miss
7 mod 4 = 3 → miss
16 mod 4 = 0 → hit
32 mod 4 = 0 → miss

$$\text{Hit ratio} = \frac{\text{Total hit}}{\text{Total reference}} = \frac{2}{11} = 0.18$$

0	~~20~~ 32	~~32~~ 16
1	17	21
2	22	7
3	27	7

106. 64

Count register size =34 bit

So, it can transfer 2^{34} bytes of data in 1 time.

∴ Total data transferred in 4 times.

$$= 4 \times 2^{34}$$

$$= 16 \times 4 \times 2^{30} = 64\ \text{GB}$$

107. B,C,D

- In indexed addressing mode, effective address is calculated by adding index value to the register content.
- In relative addressing mode effective address is calculated by adding relative value to the register content.
- In based addressing mode effective address is calculated by adding constant value to the base register content.

108. A,B,D

There is no conflict between two read so there is no hazard.

- Option (b) is case of anti data dependency.
- Option (c) is true data dependency because of subsequent write and read
- Code reordering, forwarding, stall insertion are the methods used to handle data hazards.

109. (A)

In Program controlled I/O method, the processor constantly checks the status flags, and when it finds that the flag is set it performs the appropriate operation.

Hence, the correct option is (A).

110. (B)

In synchronous I/O process performing I/O operation will be placed in blocked state till the I/O operation is completed. An ISR will be invoked after the completion of I/O operation and it will place process from block state to ready state

In asynchronous I/O, a process need not stay in the blocked state until the I/O is complete. It can place a request for I/O to the kernel, and resume with the execution. After the I/O operation is

completed, a signal is directed to the process notifying the completion
Hence, the correct option is (B).

❖❖❖❖

5 Algorithm

Practice Questions

Q.1 Consider a job scheduling problem with 6 jobs J_1, J_2, J_3, J_4, J_5 and J_6 with corresponding deadlines $(d_1, d_2, d_3, d_4, d_5, d_6) = (6, 4, 3, 5, 4, 3)$.

Which of the following schedules are feasible without violating any job schedule? **[MSQ]**

(A) $J_1, J_2, J_3, J_4, J_5, J_6$

(B) $J_3, J_6, J_2, J_5, J_4, J_1$

(C) $J_6, J_5, J_3, J_2, J_4, J_1$

(D) $J_6, J_5, J_4, J_3, J_2, J_1$

Q.2 A edTech Company uses a compression technique to encode the message before transmitting over the network. Suppose the message contains the following string. Message $=$"gate academy"

Each character in input message takes 1 byte. If the compression technique used is Huffman coding. The number of bits saved in the message is_____.

Q.3 Which of the following pair of algorithms are Greedy algorithms? **[MSQ]**

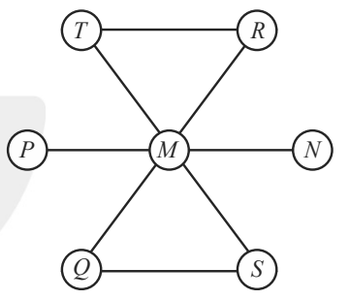
(A) Prism's and Kruskal's

(B) Huffman coding and optimal merge pattern.

(C) Dijkshtra and Bellman ford

(D) Dijkshtra and floyd warshall.

Q.4 Breath First Search (BFS) has been implemented using queue data structure. **[MSQ]**



Which of the following is/are not possible sequence of BFS.

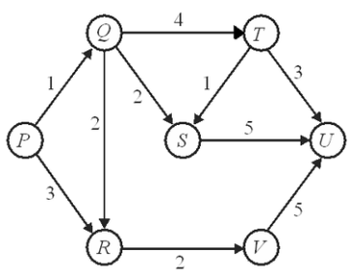
(A) M, N, P, R, T, Q, S

(B) N, M, P, Q, S, T, R

(C) Q, S, N, M, P, T, R

(D) R, T, Q, P, N, M, S

Q.5 Suppose we run Dijkstra's single source shortest-path algorithm on the following edge weighted directed graph with Vertex. *P* as the source. In what order do the nodes get included into the set of vertices to reach '*U*' Vetex. For which the shortest path distances are finalized?



(A) P, Q, S, T, U

(B) P, Q, S, U

(C) P, Q, T, U

(D) P, Q, R, V, U

Q.6 Consider the above question the shortest path selected by the Dijkstra algorithm having minimum cost of _____.

Q.7 Consider the string *pqrrrqqpsppeerep* each letter in the string must be assigned a binary code.

Satisfying the following properties:

I. For any two letters, the code assigned to one letter must not be prefix of the code assigned to the other letter.

II. For any two letter of the same frequency, the letter which occurs earlier in the dictionary order is assigned a code whose length is at most the length of the code assigned to the other letter

The minimum length of encoded string "peers" is _____.

Q.8 Consider the question 7, which of the following is the binary encoded code for "Peers". **[MSQ]**

(A) 11 101 101 01 100

(B) 11 100 100 101 01

(C) 00 100 100 11 01

(D) 00 0100 10 100 11

Q.9 Consider the following two sequences :

$P = < M, N, O, N, R, M, N >$

$Q = < N, R, O, M, N, M >$

The length of longest common subsequence of P and Q is _____.

Q.10 Consider the following two sequences.

$P = < M, N, O, N, R, M, N >$

$Q = < N, R, O, M, N, M >$

The number of largest common length subsequence is 'a',

The number of smallest common two length subsequences is 'b'.

Then $b + a =$ _____.

Q.11 What is the time complexity f following code

```
gateacademy()
{
  int i = 1, s =1
  while (s <= n)
{
  i++j
  s = s + i;
  printf ("gate academy");
}
}
```

Q.12 What is complexity of following recurrence relation?

$T(n) = \sqrt{n}T\left(\sqrt{n}\right) + 100n$

(A) $\theta(n \log\log n)$

(B) $\theta(n \log n \log n)$

(C) $\theta(n)$

(D) $\theta(n \log n)$

Q.13 Gate Academy contains 500 employees whose monthly salary is stored in the form of array and assume every employees salary is based on performance means each employee has distinct salary. Now Gate Academy wants to find min and max salary crediting to employee for which minimum number of salary comparisions needed is _____.

Q.14 A array contains elements which can be changed dynamically (periodic) then which of the following algorithm gives

surety that time complexity of sorting array element will never change?

(A) Insertion sort (B) Bubble sort

(C) Merge sort (D) Quick sort

Q.15 Let $f(n)=n^{1+\cos x}$ and $g(n)=n^{1+\sin x}$ where n is a positive number. Which of the following is/are correct

(I) $f(n)=0(g(n))$

(II) $f(n)=\Omega(g(n))$

(III) $f(n)=0(g(n))$

(IV) $f(n)=\Omega(g(n))$

(A) I and II

(B) III and IV

(C) All are correct

(D) All are incorrect

Q.16 Consider the equality **[MSQ]**

$X=\sum_{i=0}^{n^2} i^2+i$ and the choices for X are,

I. $0(n^6)$ II. $0(n^5)$

III. $\Omega(n^4)$ IV. $\Omega(n^6)$

(A) I (B) II

(C) III (D) IV

Q.17 An unordered list contains n distinct elements which is stored in array. The number of minimum comparisions required to find element in array is not a minimax is_____.

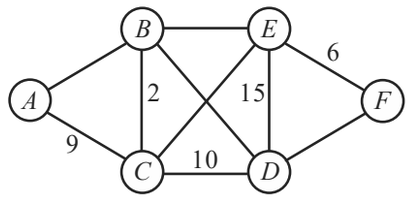
(A) $\theta(\log n)$ (B) $\theta(n\log n)$

(C) $\theta(n)$ (D) $\theta(1)$

Q.18 The graph shown below 8 edges with distinct integer edge weight. The minimum spanning tree (MST) is of weight 42 and contains the edges $\{(A,C),(B,C),(C,D),(D,E),(E,F)\}$.

The edge weights of only those edges which are in the MST are given in the figure shown.

The minimum possible sum of weights of remaining edges (other than MST edges) is _____.



Q.19 A BST contains n elements in the tree if further n elements are inserted in the BST then worst case complexity is _____

(A) $\theta(n\log n)$ (B) $0(n^2)$

(C) $0(n)$ (D) $0(n^2\log n)$

Q.20 Which one of the following is the recurrence equation for the worst case time complexity of Quick sort algorithm for sorting n elements. Consider pivoted element is last element of array.

(A) $T(n)=2T\left(\frac{n}{2}\right)+C\cdot n$

(B) $T(n)=2T(n-2)+C\cdot n$

(C) $T(n)=T\left(\frac{n}{2}\right)+C\cdot n$

(D) $T(n)=T(n-1)+C\cdot n$

Q.21 The minimum number of scalar multiplication required for parenthesized of a matrix chain product whose sequence of dimensions for four matrices is :

$<5,7,4,10,12>$

Q.22 For the above given matrix chain multiplication which of the following parenthesis is selected for the minimum number of scalar multiplications?

(A) $(A(B(CD)))$ (B) $(((AB)C)D)$

(C) $((AB)(CD))$ (D) $(A(BC)D)$

Q.23 Let $T(n)$ be the function defined by $T(1)=1,\ T(n)=2T(\lfloor n/2 \rfloor)+\sqrt{n}$ for $n \geq 2$.

Which of the following statements is true?

(A) $T(n)=O(\sqrt{n})$ (B) $T(n)=O(n)$

(C) $T(n)=O(\log n)$ (D) None of these

Q.24 Consider a given array, 8, 3, 4, 6, 7, 2, 1, 9,5 performed quick sort to sort array by considering last element as pivot. Which of the following will be the correct array after performing pivoting on 5?

(A) 1, 2, 3, 4, 5, 6, 7, 8, 9

(B) 1, 2, 3, 4, 5, 6, 9, 8, 7

(C) 3, 4, 2, 1, 5, 8, 6, 9, 7

(D) 1, 3, 2, 4, 5, 6, 7, 9, 8

Q.25 Which of the following sorting algorithm is used to sort largest element of the unsorted array or to find next largest element in each iteration?

Note : We need to arrange elements in increasing order.

(A) Bubble sort (B) Selection sort

(C) Insertion sort (D) Quick sort

Q.26 Which of the following is the correct pair of the time complexity with algorithm in undirected graph with given weight to find shortest path.

Algorithm	**Time Complexity**
1. Bellman ford	a. $E \log V$
2. Floyd warshall	b. EV
3. Dijkshtra	c. V^3
4. Breadth first search	d. V^2
	e. $(E+V)$

(A) 1-b, 2-c, 3-a, 4-d

(B) 1-d, 2-c, 3-a, 4-e

(C) 1-c, 2-b, 3-a, 4-e

(D) 1-a, 2-c, 3-b, 4-d

Q.27 Optimal merge pattern algorithm used then minimum number of comparisons is_____.

Files	*a*	*b*	*c*	*d*	*e*	*f*
Records	30	5	10	8	15	20

Q.28 Consider the 15×15 upper triangular matrix whose elements are stored in an array having starting index '0'. The position of array (7, 9) is _____.

Q.29 Match the following

A. Prims

B. Quick sort

C. Bellman ford

D. Subset sum problem

1. Divide and conquer
2. Dynamic programming
3. Recursion
4. Greedy algorithm
5. Backtracking

(A) A-4, B-1, C-2, D-4

(B) A-4, B-1, C-2, D-2

(C) A-3, B-1, C-4, D-4

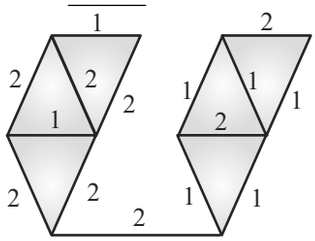
(D) A-2, B-3, C-4, D-2

Q.30 Let G be connected undirected graph of 50 vertices and 150 edges. The weight of a minimum spanning tree of G is 250. When the weight of each edge of G is increased by five, the weight of a minimum spanning tree becomes _____.

Q.31 Consider a complete undirected graph with vertex set {1, 2, 3, 4, 5}. Entry W_{ij} in the matrix W below is the weight of the edge $\{i, j\}$. The minimum possible weight of a spanning tree T in this graph such that vertex 1 is a leaf node in the tree T is _____.

$$W = \begin{bmatrix} 0 & 1 & 6 & 1 & 3 \\ 1 & 0 & 10 & 4 & 7 \\ 6 & 10 & 0 & 5 & 2 \\ 1 & 4 & 5 & 0 & 2 \\ 4 & 7 & 3 & 2 & 0 \end{bmatrix}$$

Q.32 The number of distinct minimum spanning tree for the weighted graph below is _____.



Q.33 An undirected graph G has n nodes. Its adjacency matrix is given by an $n \times n$ square matrix whose (i) diagonal elements are 0's and (ii) non-diagonal elements are distinct. Let e_{max} be the edge with maximum weight and e_{min} be the edge with minimum weight. Which of the following is/are correct?

[MSQ]

(A) Graph G has multiple minimum spanning trees of same cost $(n-1)$

(B) Every minimum spanning tree of G must contain e_{min}.

(C) If e_{max} is in a minimum spanning tree, then its removal must disconnect G.

(D) No minimum spanning tree contains e_{max}.

Q.34 $G = (V, E)$ is an undirected graph with distinct positive edge weights. If every edge weight is increased by same value, and e be the particular edge of G which of the following statement is/are True regarding minimum spanning tree.

[MSQ]

(A) Minimum spanning tree of G does not change

(B) If e is the minimum weighted edge of some cycle in G then every MST of G includes e.

(C) Shortest path between any pair of vertices does not change.

(D) If e is the maximum weighted edge of some cycle in G then every MST of G excludes e.

Q.35 If algorithm X is having better asymptotic time complexity than algorithm Y, then which of the following is/are TRUE? (Mark all choices which are CORRECT)

(A) X will outperform Y for all inputs

(B) X will outperform Y for all small inputs

(C) X will outperform Y for all large inputs

(D) X will outperform Y for all inputs above 1 million in size

Q.36 Suppose you are given the following set of keys to insert into a hash table that holds exactly 10 values: 13,107,49,50,64,98,16,33. Which of the following best demonstrates the contents of the hash table after all the keys have been inserted using linear probing and mod 10 as hash function

(A) 50….13 64 33 16 107 98 49

(B) 50 33….13 64 ….. 16 107 98 49

(C) 50 …… 33 13 64 …… 16 107 98 49

(D) 50…….33 64 13 16 107 98 49

Q.37 An array of 8 integers is being sorted by the heapsort algorithm. After the initial phase of the algorithm (constructing the heap), which of the following is a

possible ordering for the array? (Mark all the appropriate choices) **[MSQ]**

(A) 2 6 11 13 21 41 43 92
(B) 2 13 6 43 92 11 21 41
(C) 2 6 11 41 92 13 21 43
(D) 2 6 11 21 11 41 43 13

Q.38 Which of the following is/are TRUE about Huffman Coding? (Mark all the appropriate choices) **[MSQ]**

(A) Huffman coding may become lossy in some cases
(B) Huffman Coding does not always have an exact solution
(C) In Huffman coding, no code is prefix of any other code
(D) There exists a greedy algorithm to do Huffman coding

Q.39 Consider the following functions **[MSQ]**

$\log_{10} n, \log_2 n, \lceil \log_2 n \rceil, \lfloor \log_2 n \rfloor$

Which of the following is/are TRUE? (Mark all the appropriate choices)

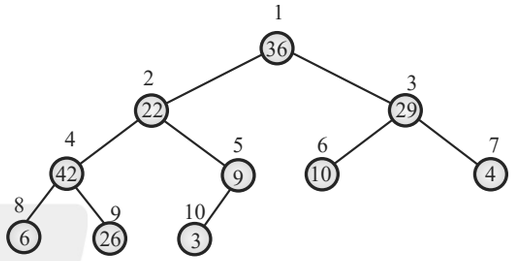
(A) $\log_{10} n = O(\log_2 n)$
(B) $\log_2 n = \Omega \lfloor \log_2 n \rfloor$
(C) $\lceil \log_2 n \rceil = O(\lfloor \log_2 n \rfloor)$
(D) $\lceil \log_2 n \rceil = \Omega(\lfloor \log_2 n \rfloor)$

Q.40 Consider a min heap implemented as an array with the elements 1, 2, 3, 6,7,8, 9,10. The level (starting from 1) in which 7 is stored is _____.

Q.41 It is required to sort a large number large number of records of employee details based on the employee IDs. Assuming the records are already sorted on the basis of employee names and it is required to maintain name as the secondary sort order (similar to order by id name in SQL), which of the following sorting algorithms is/are the most appropriate for this?

(A) Merge Sort
(B) Selection Sort
(C) Quick Sort
(D) Heap Sort

Q.42 Consider the binary tree shown below, which is an almost max-heap with the node 22 violating the max -heap property. Once heapify procedure is applied to it which position will it be in?



Q.43 In a hash table with 20 slots 30 records are inserted with collisions being resolved by chaining what is the expected number of key comparisons in an unsuccessful search assuming uniform hashing?

Q.44 Which of the following is/are the possible array contents after second pass of Quick Sort for the following initial ordering assuming first element is taken as pivot?

34, 8, 64, 51, 32, 21

(A) 8, 21, 32, 34, 51, 64
(B) 8, 8, 32, 34, 51, 64, 21
(C) 8, 34, 51, 64, 32, 21
(D) 8, 34, 64, 51, 32, 21

Q.45 Given an array of n elements, you have to design an algorithm to find the k smallest elements in sorted order. The time complexity of the best algorithm assuming comparison based sorting will be

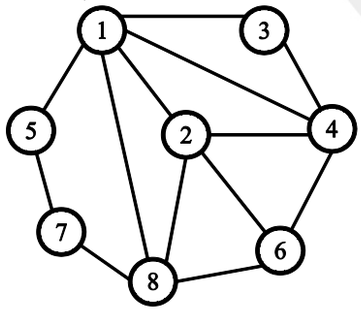
(A) $O(k \log n)$ (B) $\theta(n + k \log k)$
(C) $\theta(n^2)$ (D) $\theta(n \log k)$

Q.46 Suppose that you store 6 records in a hash table of size 8 by chaining, and suppose that you have a good hash function so that the probability that a key is hashed into any of the 8 slots is 1/8. For a particular slat in the hash table, what is the probability that this slot is empty, that is, none of the 6 keys hashes into this slot?

(A) 0.125^6 (B) 0.875^6

(C) 0.166^8 (D) 0.833^8

Q.47 Consider the following graph. If BFS is implemented on the following graph then which of the following set of the nodes are present in the queue after performing 5^{th} dequeue operation? (Root vertex is 1 and consider descending order while visiting the vertices.)



(A) 2, 7, 6 (B) 2, 3, 4

(C) 3, 4, 6 (D) 8, 7, 6

Q.48 Consider the following C function and an input array to it as [1, 4, 10, 12] and len as 4. The return value of the function will be

```
int foo (int arr [], int len)
{
int result = 0 ;
for (int i = 0; i < len; ++)
{
result + = arr [i] * (i+1)* (len – i);
}
return result:
```

Q.49 You are given an empty hash table of size 6 that uses open addressing. The following sequence of keys is to be inserted: **[MSQ]**

32 7 14 22 29 3

If linear probing with $h(x) = x\%6;$ is used, which all elements will cause a collision? (Mark all choices which are CORRECT)

(A) 3 (B) 14

(C) 29 (D) 22

Q.50 Consider the following C function

```
int findme (int n)
{
if (n < = 0) return 1;
return findme (n/2) + findme (n-1)
}
```

What will be the output if the above function is called with argument 12 ?

Q.51 For quick sort pivot selection you are provided with an buggy implementation of Median select which can return any element between $(n/3)^{rd}$ smallest and $(2n/3)^{rd}$ smallest in O(n) time. With this function to choose the pivot, which of the following is/are TRUE for the Quicksort implementation? (Mark all CORRECT choices) **[MSQ]**

(A) In best ease it can run in $O(n)$ time

(B) In worst case it will take $\theta(n^2)$ time

(C) In worst case it will take $\theta(n \log n)$ time

(D) In best case, It will run in $\Omega(n \log n)$ time

Q.52 What is the time complexity of following code if foo(n) takes $\theta(\log n)$ time to execute?

```
int i , j;
for (i = n / 2; I < = n; i++)
{
```

```
for (j = 1; j < = n; j = j * 2)
{
foo (j);
}
}
```

(A) $\theta(n)$ (B) $\theta(n \lg n)^2$

(C) $\theta(n(\lg n)^2)$ (D) $\theta(n^2 \lg n)$

Q.53 The return value, time complexity and space complexity of the following code are

```
int foo (int n)
{
    int a = 0
    while (n > 0)
{
    a + = n;
    n/=2;
}
    return a;
}
```

(A) $\theta(\log n,), \theta(\log n), \theta(\log n)$

(B) $\theta(n), \theta(\log n), O(1)$

(C) $\theta(\log n), \theta(\log n), O(1)$

(D) $\theta(n^2), O(n), O(1)$

Q.54 Suppose you are having 5 notes each with denominations of 2000, 500,300 and 50 and you are asked to make a sum of Rs 4650. For each note you choose you are asked to pay a service charge of Rs. 2.5 which is irrespective of the denomination of the note, what will he the minimum amount in rupees you'll have to pay as service charge?

Q.55 Which of the following statements is/are TRUE? (Mark all CORRECT choices)

(A) The expected number of comparisons in a successful linear search is n

(B) The expected number of comparisons in a successful binary search is $O(\log n)$

(C) The best case runtime of linear search is asymptotically better than binary search

(D) In worst case binary search can lead to $\Omega(n)$ comparisons

Q.56 Suppose the letters *a, b, c, d* have probabilities 1/3, 1/6, 1/6, 3/10 respectively. What is the average length of Huffman codes (correct to 1 decimal point)?

Q.57 You are given an empty hash table of size 7 that uses open addressing. The following sequence of keys is to be inserted:

13 18 25 11 20 29

If hash function $h_1(x)\%7$; and double hashing with $h_2(x) = x/7 + 1$ is followed, which of the inserted elements causes a collision? (Mark all the appropriate choices) **[MSQ]**

(A) 25 (B) 11

(C) 20 (D) 29

Q.58 Which of the following statements is/are TRUE? (Mark all the appropriate choices) **[MSQ]**

(A) The worst case runtime for searching in a binary tree can be O(n).

(B) The minimum number of comparisons to sort 5 elements is 4.

(C) There can be at most $\left\lceil \frac{n}{2^{h-1}} \right\rceil$ nodes of height h (h starting from 1) in any n element heap.

(D) The time to find the maximal element in a min-heap of $2^n - 1$ elements is $\Omega(2^n)$

Q.59 Four matrices M_1, M_2, M_3 and M_4 of dimensions $p \times q, q \times r, r \times s$ and $s \times t$ respectively can be multiplied is several ways with different number of total scalar multination's. For example, when multiplied as $((M_1 \times M_2) \times (M_2 \times M_4))$, the total number of multiplications is $pqr + rst + prt$. When multiplied as $(((M_1 \times M_2) \times M_3) \times M_4)$, the total number of scalar multiplications is $pqr + prs + pst$.

If $p = 20, q = 90, r = 10, s = 15$ and t = 40, then the minimum number of scalar multiplications needed is

Q.60 Maximum Subarray Sum problem is to find the subarray with maximum sum. For example, given an array {12, –13, –5, 25, –20, 30, 10}, the maximum subarray sum is 45. The best possible algorithm to compute the maximum subarray sum will run in

(Mark all the appropriate choices)

(A) $O(n)$ (B) $\Omega(n \log n)$

(C) $O(\log n)$ (D) $O(n^2)$

Q.61 During solution of $T(n)$ recurrence relation we find the following series, solve it and find the value of $T(n)$.

$T(n) = 1.2^1 + 2.2^2 + 3.2^2$

$+4.2^4 + 5.2^5 + 6.2^6$

$+7.2^7 + ...n.2^n$

(A) $O(2^n)$ (B) $O(2^n)$

(C) $O(n.2^n)$ (D) $O(n^2.2^n)$

Q.62 Consider the code given below, which runs insertion sort;

```
void insertion Sort (int arr [], int size)
{
 int i, j, value
for (i = 1; i < size; i++)
{
value = arr [i];
j = i;
while (_________)
{
arr [j] = arr [j - 1];
J = j – 1;
}
arr [j] = value
}
}
```

Which condition will correctly implement the which loop?

(A) (j > 0) || (arr [j – 1] > value)

(B) (j > 0) && (arr [j – 1] > value)

(C) (j>0) && (arr[j+1]) > value)

(D) (j>0)&&(arr[j+1]<value)

Q.63 Consider the following C function for arguments m, n > 1

```
int foo (int n, int m)
{
    While (m! = n)
{
    if (m>n)
    m = m – n;
    else
    n = n – m;
}
    return n;
}
```

Which of the following is/are true about the above function? (Mark all CORRECT choices)

(A) If m = 9 , n = 13 the function returns 1.

(B) The asymptotic time complexity of the function is O(log(max(m,n)))

(C) For any positive integers m, n the function returns the least common multiple of m, n.

(D) The space complexity of the function is $\Omega(1\log)(\min(m,n))$

Q.64 Which of the following statements is/are TRUE? (Mark all CORRECT choices}

(A) When 90% of the input is already in sorted order, insertion sort will do less number of comparisons than merge sort for all sufficiently large inputs

(B) If the number of inversions in an array is O(n), then insertion sort will be having fewer comparisons than quick sort for all inputs

(C) If the number of inversions in an array is O(n), bubble sort will be having fewer number of comparisons than merge sort for all inputs

(D) If the number of inversions in an array is O(n), heap sort will be having fewer number of comparisons than insertion sort for all inputs

Q.65 Consider the following recurrence relation which is applicable on two arrays x and y, x_i and y_i, are the i^{th} elements of x and y array respectively.

$$c(i,j)=\begin{cases}0 \\ c(i-1,j-1)+1 \\ \min(c(i-1,j),c(i,j-1))\end{cases}$$

if $i=0$ or $j=0$

if $i,j>0$ and $x_i=y_i$

if $i,j>0$ and $x_i\neq y_i$

Suppose each array is of n size and time complexity to compute c (n,n) using dynamic programming is $O(n^a(\log n)^b)$ then what will be value of a + b?

Q.66 You're working on a dynamic programming problem that has a recurrence elation

$A(i,j)=F(A(\lfloor i/2\rfloor,j)A,(i,\lfloor j/2\rfloor))$

where F is a known function that can be evaluated in constant time and $A(i,j)=0$ when $i=0$ or $j=0$. To compute $A(m,n)$ for some m and n, you can use either a top – down or a bottom – up method. Which one is more efficient in solving this problem?

(A) Top Down will take asymptotically lesser time than bottom up

(B) Bottom-up will take asymptotically lesser time than Top Down

(C) Both will take the same time

(D) None of them

Q.67 In bottom-up dynamic programming, we need an order to fill m the solution cells m a table, such that all needed subproblems are solved before solving a subproblem. For the following relation, give a valid traversal order.

$A(i,j)=F(A(i,j-1),A(i-1,j-1)$

$A(i-1,j+1))$

$A(0,j)=0$

$A(i,0)=0$

Where F(.) is a function.

(A) Fill values of $A(i,\ j)$ column-wise, i.e., fill the first column then the second column, and so on.

(B) Fill the last column of $A(i,j)$. then the second last column, and so on.

(C) Fill values of $A(i,\ j)$ row-wise i.e. fill the first row then the second row, and so on.

(D) No order is possible as there Is cyclic dependency in subproblems.

Q.68 Consider the following code snippet :

```
int i = 0;
while (i < n)
{
    printf ("computer science batch1");
    while (i < n)
{
    printf ("computer network");
    while (i < n)
{
    printf ("compiler design");
    i++;
}
    i++;
}
    i++;
}
```

What will be the time complexity of above code snippet?

(A) $\theta(n^5)$ (B) $\theta(n^6)$

(C) $\theta(n^4)$ (D) $\theta(n^3)$

Q.69 While walking on the beach one day you find a treasure trove. Inside there are n treasures with weights w_1.., w_n and values v_1....v_n. Unfortunately, you have a knapsack that only holds a total weight M. Fortunately, there is a knife handy so that you can cut treasure if necessary to take home treasure of maximal value: a cut treasure retains its fractional value (so, for example a third of treasure I has weight w_i / 3 and value v_i/3). What is the maximum value that can take home if we have 3 treasures with weights (18, 15, 10) and values (25, 24, 15) and also a knapsack of total weight 20?

Q.70 Consider G (V, E) be a complete undirected graph with 6 edges having a distinct weight from 1, 3, 9, 27, 81 and 243. Which of the following will not be the weight of the minimum spanning tree of G? **[MSQ]**

(A) 121 (B) 13

(C) 40 (D) 31

Q.71 Consider the following 0 -1 knapsack problem with the item's weight and value given in the table

Item	Weight	Value
1	3	Rs 25
2	2	Rs 20
3	1	Rs 15
4	4	Rs 40
5	5	Rs 50

Capacity W = 6

If the capacity of the knapsack (W), is 6 then how many optimal solutions (number of set of items) are possible?

(A) 1 (B) 2

(C) 3 (D) 4

Q.72 For a given sequence of integers $a_1, a_2, ..., a_n$ decreasing subsequence is one for which every integer is strictly smaller than the previous one.

The longest decreasing subsequence is the longest among all decreasing subsequences of a given sequence.

For example, decreasing subsequences of 5, 2, 4, 8,3, 40 are .

- 5, 2
- 5, 4
- 4, 3
- 5, 4, 3 etc

And longest among all possible decreasing subsequences is 5, 4, 3.

For a given sequence of integers $a1, a2, ...a_n$ let L(j) be length of the

longest decreasing subsequence that starts with a_j.

$L(n) = 1$

$$L(j) = \begin{cases} 1 & \text{if } a_j = \min(a_j, a_{j+1}, a_{j+2}, .., a_n) \\ ? & \text{otherwise} \end{cases}$$

Complete the above recurrence relation with the appropriate value of ?

(A) 1 + min{L(k):j < k ≤ n and $a_j > a_k$ }

(B) 1 + max {L(k) : j < k ≤ n and $a_j > a_k$}

(C) 1 + max {L(k) : j < k ≤ n and $a_j < a_k$}

(D) 1+ min {L(k): j < k ≤ n and $a_j > a_k$ }

Q.73 Consider a DAG G = (V, E) which has topological ordering of vertices $v_1, v_2, ..., v_n$. We want to count number of paths from vertex v_1 to vertex v_n. Let Paths(i) represents total number of paths from i to n.

Complete the following recurrence for Paths (i).

$$\text{Paths(i)} = \begin{cases} 1 & \text{if } i = n \\ ? & \text{otherwise} \end{cases}$$

In options, $\Sigma_{j:(i,j)\in E}$ Paths (j) is a quantity which sums Paths (j) for all outgoing edges from i i.e., for edges $i \to j$

(A) $\Sigma_{j:(i,j)\in E}$ (1+Paths (j))

(B) $\Sigma_{j:(i,j)\in E}$ Paths (j)

(C) $1+\Sigma_{j:(i,j)\in E}$ Paths (j)

(D) 1+Paths (j) for some edge $i \to j$

Q.74 Find total number of scalar multiplications of a matrix-chain product of 6 matrices whose sequence of dimensions is 5,10,3, 12,5,50 and 6. That is 5×10 is dimension of first matrix, 10×3 is dimension of second matrix and so on.

Q.75 The number of longest common subsequences for "bacb" and 'abcabc' are:

(A) 2 (B) 3

(C) 4 (D) 5

Q.76 For the given recurrences calculate the tightest bound on time and space that would be required by a dynamic programming algorithm to compute OPT(n).

$$\text{OPT}(i) = \min_{1\le j<i}\{\text{OPT}(j) / j + w(j)\}$$

where OPT(l) = 1

(A) Time = $O(n^2)$, space = $O(n)$

(B) Time = $O(n^3)$, Space = $O(n^2)$

(C) Time = $O(n^2)$, Space = $O(n^2)$

(D) Time = $O(n)$, Space = $O(n)$.

Q.77 Suppose you have a row of coins with values that are positive integers $c_1, ..., c_n$. These values might not be distinct. Your task is to pick up coins that have as much total value as possible, subject to the constraint that you don't ever pick up two coins that lie beside each other. For example - Given c_1 to c_6 as follows- (5, 1, 2, 10, 6, 2), the maximum value is 17 and using coins $\{c_1 = 5, c_1 = 10, c_6 = 2\}$

Let $f(n)$ be maximum total value with n coins with $f(0) = 0$ and $f(1) = c_1$ then what will be correct recurrence for $f(n)$?

(A) $f(n) = \max(c_n + f(n-2), f(n-1))$

(B) $f(n) = \max(c_{n-1} + f(n-2), f(n-1))$

(C) $f(n) = \max(c_{n-1} + f(n-1), f(n-2))$

(D) $f(n) = \max(c_n + f(n-1), f(n-2))$

Q.78 Consider the following code snippet. It accepts a positive integer n as input,

```
int i = 0, j = 0, val = 1;
for (i = 1, i < = n; i++){
        j = n;
       if (i % 2 = = 0){
       while (j >1) {
        val = val * j;
       j = j/2
                    }
   }
}
```

What is the worst-case time complexity of the algorithm?

(A) $O(n)$ (B) $O(n \log n)$

(C) $O(n^2)$ (D) $O(n^2 \log n)$

Q.79 The time required by an efficient algorithm to determine whether an arbitrary array of size n is min-heap or not is

(A) $O(\log n)$ (B) $O(n)$

(C) $O(n \log n)$ (D) None of these

Q.80 What is time complexity of matrix multiplication (Strassen's) using divide and conquer approach?

(A) $O(n^{\log_2 5})$ (B) $O(n^{\log_2 6})$

(C) $O(n^{\log_2 7})$ (D) None of these

Q.81 Consider the following steps :

S_1 : Characterize the structure of an optimal solution.

S_2 : Compute the value of an optimal solution in bottom-up fashion.

Which of the following step (s) is/are common to both dynamic programming and Greedy algorithm?

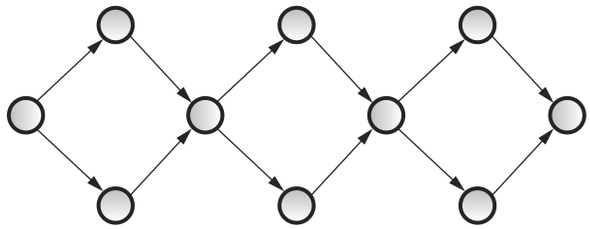
(A) Only S_1

(B) Only S_2

(C) Both S_1 and S_2

(D) Neither S_1 or S_2

Q.82 Consider the directed acyclic graph given below. How many topological ordering are possible for the given graph?



Q.83 Match the following and choose the correct solution for the order A,B,C,D

A	Strassen matrix multiplication	p	Decrease and Conquer
B	Insertion sort	q	Dynamic programming
C	Gaussian Elimination	r	Divide and conquer
D	Floyd shortest path algorithm	s	Transform and Conquer

(A) r,s,p,q (B) r,p,s,q

(C) q,p,s,q (D) s,p,q,r

Q.84 Consider the following functions:

$f(n) = 2^n, g(n) = n!, h(n) = n^{\log n}$

Which of the following statements about the asymptotic behavior of $f(n)$, $g(n)$ and $h(n)$ is true?

(A) $f(n) = O(g(n)); g(n) = O(h(n))$

(B) $f(n) = O(g(n)); g(n) = O(h(n))$

(C) $g(n) = O(f(n)); h(n) = O(f(n))$

(D) $h(n) = O(f(n)); f(n) = O(g(n))$

Q.85 The weight of a sequence $a_0, a_1, ..., a_n$-1 of real numbers is defined as $a_0+a_1/2+...+ a_{a-1}/2^{n-1}$. A subsequence of a sequence is obtained by deleting some elements from the sequence, keeping the order of the remaining elements the same. Let X denote the maximum possible weight of a subsequence of a_0, $a_1, ...,a_{n-1}$ and Y the maximum possible weight of a subsequence of $a_1, a_2, ...,a_{n-1}$. Then X is equal to

(A) max(Y, a_0+Y)
(B) max(Y, a_0+Y/2)
(C) max(Y, a_0+2Y)
(D) a_0+Y/2

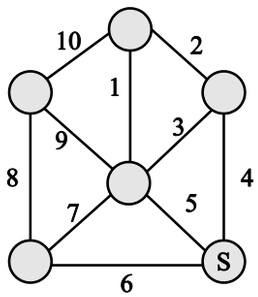
Q.86 Consider the following C code segment:

```
int f(int x)
{
    if (x < 1) return 1;
    else return (f(x − 1) + g(x));
}
int g(int x)
{
 if (x < 2) return 2;
 else return (f(x − 1) + g(x / 2));
 }
```

Of the following, which best describes the growth of $f(x)$ as a function of x?

(A) $K_1x + K_2$ (B) K^x
(C) Kx^2 (D) Kx^3

Q.87 Consider the following graph.



Assume that node 'S' is the starting vertex for prim's algorithm. Which of the following can be the correct order of edges in which they are added to construct the minimal spanning tree?

(A) 4, 2, 1, 6, 8 (B) 4, 1, 2, 6, 8
(C) 4, 2, 1, 7, 10 (D) None of these

Q.88 The minimum number of comparisons required to find maximum element in a min-heap of n elements (assume $n > 1$)?

(A) $n-1$ (B) $\left\lfloor \frac{n}{2} \right\rfloor - 1$
(C) $\left\lceil \frac{n}{2} \right\rceil - 1$ (D) n

Q.89 The running time of an algorithm is given by $T(n) = T(n-1) + T(n-2) - T(n-3), if\ n > 3$,T(n)= n otherwise, then what should be the relation between T(1), T(2) and T(3), so that the order of the algorithm is constant?

(A) T(1) = T(2) = T(3)
(B) T(1) + T(3) = 2*T(2)
(C) T(1) – T(3) = T(2)
(D) T(1) + T(2) = T(3)

Q.90 What is the time complexity for the following C module? Assume that n>0

```
int module (int n)
{
if (n = = 1)
return 1;
else
return (n + module (n-1));
}
```

(A) O(n) (B) O(log n)
(C) O(n^2) (D) O(n!)

Q.91 Match the following:

P.	$T(n)=3T(\lfloor n/4 \rfloor)+O(n^2)$	1.	$O(n\log n)$
Q.	$T(n)=T(n/3)+T(2n/3)+O(n)$	2.	$O(n^2)$
R.	$T(n)=\sum_{n=1}^{\log n}\left(\frac{n}{2}\right)$	3.	$O(n^3)$
S		4.	$O(n)$

Codes:

(A) P-3, Q-2, R-1 (B) P-3, Q-2, R-2

(C) P-2, Q-1, R-1 (D) P-2, Q-1, R-4

Q.92 Let $T(n)=T(n/5)+T(7n/10)+c.n$ where c is a constant. Find running time of $T(n)$.

(A) $\Theta(n)$ (B) $\Theta(n\log n)$

(C) $\Theta(n^2)$ (D) None of these

Q.93 Consider the following two functions :

$$g_1(n)=\begin{cases} n^3 \text{ for } 0\le n\le 10{,}000 \\ n^2 \text{ for } n\ge 10{,}000 \end{cases}$$

$$g_2(n)=\begin{cases} n \text{ for } 0\le n\le 100 \\ n^3 \text{ for } n>100 \end{cases}$$

Which of the following is true?

(A) $g_1(n)$ is $O(g_2(n))$

(B) $g_1(n)$ is $O(n^{\frac{1}{2}})$

(C) $g_2(n)$ is $O(g_1(n))$

(D) $g_2(n)$ is $O(n)$

Q.94 A Priority-Queue is implemented as a Max- Heap. Initially, it has 5 elements. The level- order traversal of the heap is given below:

10, 8, 5, 3, 2

Two new elements '1' and '7' are inserted in the heap in that order. The level- order traversal of the heap after the insertion of the elements is:

(A) 10, 8, 7, 5, 3, 2, 1

(B) 10, 8, 7, 2, 3, 1, 5

(C) 10, 8, 7, 1, 2, 3, 5

(D) 10, 8, 7, 3, 2, 1, 5

Q.95 The characters a to f have set of frequencies as

a : 5, b : 9, c : 12, d : 13, e : 16, f : 55

Huffman coding is used to encode the character what is the average number of bits required for character_____.

Q.96 Find the average number of comparisons in a binary search on sorted array of 7 elements _____.

Q.97 Consider 5 items along their respective weights and values

$I=[I,I_2,I_3,I_4,I_5]$

$W=[5,10,20,30,40]$

$V=[30,20,100,90,160]$

The capacity of knapsack $W=60$. Find the maximum value using fractional knapsack is ____

Q.98 Consider the program

```
gate academy (int n)
{
    int i, j, c = 0
for (i = 1; i <= n/2; i++)
{
for (j = 1; j <= n; j = j * 2)
{
c++;
 }
 }
}
```

The complexity of the program is?

(A) $O(\log n)$

(B) $O(n^2)$

(C) $O(n^2\log n)$

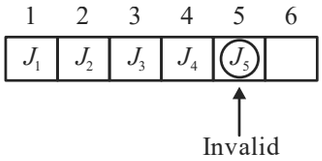
(D) $O(n\log n)$

Answers Algorithm

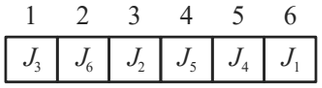
1.	A,B	2.	56	3.	A,B	4.	C,D	5.	B
6.	8	7.	13	8.	A.D	9.	4	10.	13
11.	$0\sqrt{n}$	12.	A	13.	748	14.	C	15.	D
16.	C,D	17.	D	18.	61	19.	B	20.	D
21.	860	22.	C	23.	B	24.	C	25.	A
26.	C	27.	207	28.	77	29.	B	30	495
31.	9	32.	24	33.	B,C	34.	A,D	35.	C
36.	A	37.	A,C	38.	C,D	39.	A,B,C,D	40	3
41.	A	42.	9	43.	1.5	44.	A	45.	B
46.	B	47.	A	48.	136	49.	A,B	50.	94
51.	C,D	52.	C	53.	B	54.	12.5	55.	B
56.	2	57.	A,B,C,D	58.	A,D	59.	32000	60.	A
61.	C	62.	B	63.	A	64.	B	65.	2
66.	A	67.	C	68.	D	69.	28	70.	A,C
71.	A	72.	B	73.	B	74.	1860	75.	C
76.	A	77.	A	78.	B	79.	B	80.	C
81.	A	82.	8	83.	B	84.	D	85.	B
86.	B	87.	D	88.	C	89.	A	90.	A
91.	C	92.	A	93.	A	94.	D	95.	2.12
96.	2.428	97.	270	98.	D				

1. (A,B)

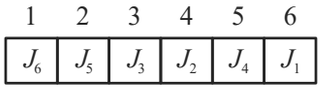
(A)



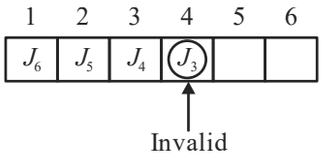
(B)



(C)



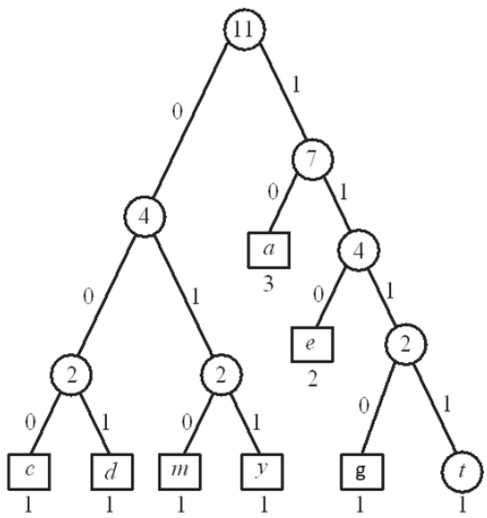
(D)



Hence, the correct option are (A,B).

2. 56

$g-1=1110$
$a-3=10$
$t-1=1111$
$e-2=110$
$c-1=000$
$d-1=001$
$m-1=010$
$y-1=011$



Total bits without compression $=11\times8=88$ bits

Number of bits

$=(1\times4)+(3\times2)+(1\times4)$
$+(2\times3)+(1\times3)+(1\times3)$
$+(1\times3)+(1\times3)$
$=4+6+4+6+3+3+3+3=32$ bits

Number of hits saved $=88-32=56$ bits

Hence, the correct answer is 56.

3. (A,B)

Dijkshtra algorithm is greedy algorithm but Bellman ford and floyd warshall are dynamic programming algorithms.

Hence, the correct option are (A,B).

4. (C,D)

(A) Starting from M which is connected all nodes so any sequence $\Rightarrow$ all valid

(B) $N\rightarrow M \Rightarrow$ all valid

(C) $Q\rightarrow \underbrace{S\rightarrow N}_{\text{Invalid}}$

(D) $R\rightarrow \underbrace{T\rightarrow Q}_{\text{Invalid}}$

Hence, the correct option are (C,D).

5. (B)

P	Q	R
0	1	3

Q	R	S	T
1	3	3	5

R	S	T	V
3	3	5	5

S	T	V	U
3	5	5	8

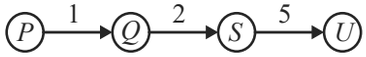
T	V	U
5	5	8

V	U
5	8

U	-
8	-

node	π	distance
P	–	–
Q	1	P
R	3	P
S	Q	3
T	Q	5
U	S	8
V	R	5

Selected shortest path by Dijkstra

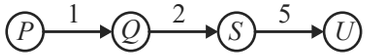


Note : $P \xrightarrow{1} Q \xrightarrow{4} T \xrightarrow{3} U$. This is also shortest path but it will not be selected by Dijkstra.

Hence, the correct option is (B).

6. 8

Selected path by Dijkstra's algorithm,



Cost $= 1+2+5 = 8$

Hence, the correct answer is 8.

7. 13

Frequency

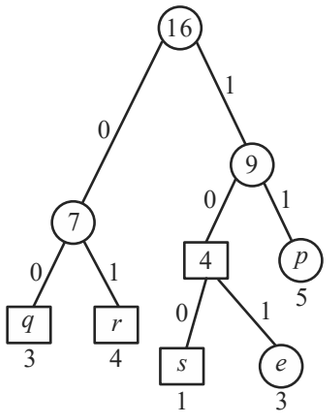
$p-5 \Rightarrow 11$

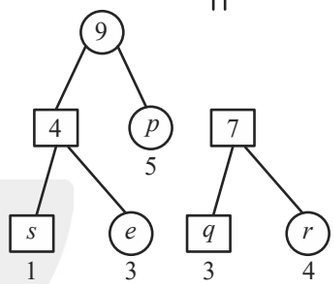
$q-3 \Rightarrow 00$

$r-4 \Rightarrow 01$

$s-1 \Rightarrow 100$

$e-3 \Rightarrow 101$





Peers $\Rightarrow$ $p+e+e+r+s$

$\downarrow$

$2+3+3+2+3 = 13$

Hence, the correct answer is 13.

8. (A,D)

Frequency

$p-5 \Rightarrow 11$

$q-3 \Rightarrow 00$

$r-4 \Rightarrow 01$

$s-1 \Rightarrow 100$

$e-3 \Rightarrow 101$

$\underset{11}{p}\ \underset{101}{e}\ \underset{101}{e}\ \underset{01}{r}\ \underset{100}{s}$

binary code =

11 101 101 01 100

$\Downarrow$ 1's complement

0001001010011 $\Rightarrow$ This is also a binary code (valid)

Hence, the correct option are (A,D).

9. **4**

$P = M, N, O, N, R, M, N$

$Q = N, R, O, M, N, M$

1. $MNM = 3$
2. $NRMN = 4$
3. $RMN = 3$
4. $NONM = 4$
5. $NONM = 4$

Hence, the correct answer is 4.

10. **13**

Longest common length subsequences :

1. $NRMN$
2. $NONM$
3. $NOMN$

$a = 3$

Smallest common length subsequences :

1. MN
2. NM
3. RM
4. RN
5. NR
6. NO
7. ON
8. OM
9. NN
10. MM

$b = 10$

$b + a = 10 + 3 = 13$

Hence, the correct answer is 13.

11. $0\sqrt{n}$

$i = 1, s = 1$

i	1	2	3	4	5
s	1	3	6	10	15

We see that s is the sum of n terms function is

$$s = \frac{k(k+1)}{2}$$

But $s \le n$ must be true

So, the maximum value of s is

$$\frac{k(k+1)}{2} = n \Rightarrow \frac{k^2 + k}{2} = n$$

$$k^2 = \sqrt{2}n$$

$$k = 0\sqrt{n}$$

Hence, the correct answer is $0\sqrt{n}$.

12. **(A)**

$$T(x) = \sqrt{n}T\left(\sqrt{n}\right) + 100n$$

Let, $n = 2^k \Rightarrow k = \log n$

$$T(2k) = (2)^{k/2} T(2^{k/2}) + 200 \times 2^k$$

(dividing by 2^k)

$$\frac{T(2^k)}{2^k} = \frac{2^{k/2} T(2^{k/2})}{2^k} + 100$$

$$\frac{T(2^k)}{2^k} = \frac{T(2^{k/2})}{2^{k/2}} + 100$$

Let, $y(k) = \frac{T(2^k)}{2^k}$, then …(i)

$$y(k) = y\left(\frac{k}{2}\right) + 100$$

Now, applying master theorem $[a = b^k = 1]$

$$y(k) = \log k$$

From (i) we also know that $T(2^k) = 2^k y(k)$, then

$$T(2^k) = 2k \log k = T(n)$$

$= n \log \log n$ (because $n = 2^k$ and $k \log n$)

Finally, $T(n) = \theta(n \log \log n)$

Hence, the correct option is (A).

13. **748**

$n = 500$ (array)

I. linear comparision :

Total comparisons

$= 2n = 2 \times 500 = 1000$

II. Using Divide and Conquer approach :

Total comparisons $= \frac{3n}{2} - 2$ (go through minmax algorithm)

$= \frac{3 \times 500}{2} - 2 = 748$

Min (748, 1000) $= 748$

Hence, the correct answer is 748.

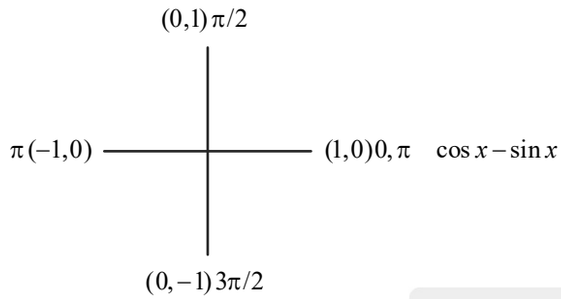
14. **(C)**

Merge sort does not depend on input data but Selection, Bubble and Quick sort depends on input data based on that their time complexity varies.

Hence, the correct option is (C).

15. **(D)**

Note : $\cos x$ and $\sin x$ are periodic functions.



Range of $\cos x$ & $\sin x$ is [–1, 1]

$\Rightarrow \quad f(n) = n^{1+\cos x}$

$\Rightarrow \quad \left(0(1), 0(n), 0(n^2)\right)$ possible values

$g(n) = \left(0(1), 0(n), 0(n^2)\right)$

So, we can't predict or conclude exact relation between $f(n)$ and $g(n)$.

Hence, the correct option is (D).

16. **(C, D)**

$$X = \frac{n^2(n^2+1)(2n^2+1)}{6} + \frac{n^2(n^2+1)}{2}$$

$$= n^2\left[n^4 + n^2 + 1 + n^2 + 1\right]$$

$$= n^6 + n^4 + n^4 + n^2 + n^4 + n^2$$

$$= n^6 + 3n^4 + 2n^2$$

(lower terms neglected)

$$= 0(n^6)$$

Hence, the correct option are (C,D).

17. **(D)**

To find minimax algorithm we can use divide and conquer algorithm with $\frac{3n}{2} - 2$ minimum comparisons. But here we have to find the number which is not minimax so, simply we can pic 3 number and compare them the middle element of three of will be not an minimax, so always required only 2 comparisions

So, $\theta(1)$ time complexity.

Hence, the correct option is (D).

18. **61**

edge $AB = 10$ ($AC = 9$ selected)

$BC = 2$

edge $BE = 16$ ($DE = 15$)

$CE = 17$

edge $BD = 11$ ($CD = 10$)

edge $DF = 7$ ($EF = 6$)

Minimum sum $= AB + BD + BE + CE + DF$

$= 10 + 11 + 16 + 17 + 7 = 61$

Hence, the correct answer is 61.

19. **(B)**

If we consider Left skewed or Right skewed then in worst case we need to traverse n nodes so, its complexity becomes $0(n)$. For 1 insertion, we have to insert n elements,

Time Complexity $= n \cdot 0(n)$

$= 0(n^2)$

Hence, the correct option is (B).

20. **(D)**

Quick sort algorithm Recurrence Relation is,

$$T(n) = T(k) + T(n-k-1) + 0(n)$$

Worst case : $k = 0$ (last element is sorted in its position only).

$$T(n) = T(0) + T(n-0-1) + 0(n)$$

$$T(n) = T(n-1) + 0(n)$$

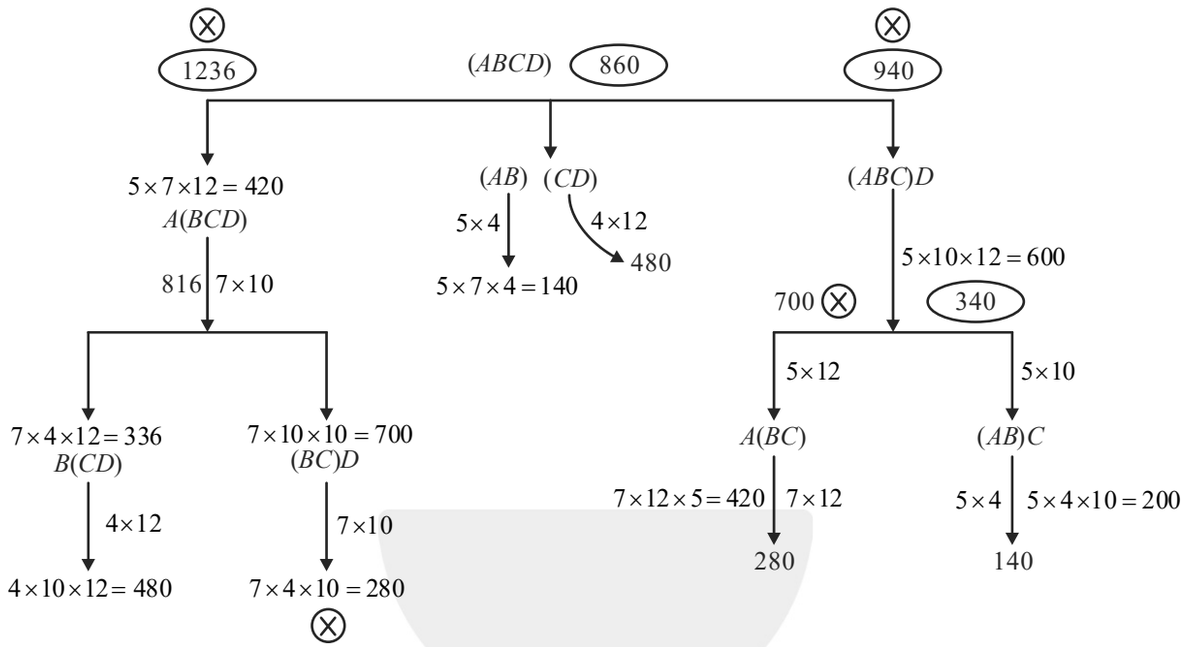
$$T(n) = 1$$

Hence, the correct option is (D).

21. 860

Dimensions of four matrices $ABCD$.

$A = 5\times 7, B = 7\times 4, C = 4\times 10, D = 10\times 12$



Hence, the correct answer is 860.

22. (C)

Settle above multiplication tree $((AB)(CD))$ gives minimal scalar products as 860 with dimension 5×12

Hence, the correct option is (C).

23. (B)

Given : $T(n) = 2T\left(\frac{n}{2}\right) + \sqrt{n}$

As we know by Masters theorem :

For $T(n) = aT\left(\frac{n}{b}\right) + \theta(n^k \log^p n)$

$a > b^k \Rightarrow T(n) = \theta(n^{\log b^a})$

$a = 2, b = 2, k = \frac{1}{2}, p = 0$

$2 > 2^{1/2} \quad \{a > b^k\}$

$T(n) = \theta(n)$

$= \theta(n^{\log_b a}) = \theta(n^1) = \theta(n)$

Hence, the correct option is (B).

24. (C)

8	3	4	6	7	2	1	9	5
$A[1]$	$A[2]$	$A[3]$	$A[4]$	$A[5]$	$A[6]$	$A[7]$	$A[8]$	$A[9]$

5 as pivot

So i is 1 and j is 0 [check $A[i] < 5$]

Check $A[j] < 5$ false $i = i + 1$

Check $A[2] < 5$ true

$j \leftarrow j + 1$ and exchange $A[i] \leftrightarrow A[j]$

So, $A[1]$ and $A[2]$ are exchange then $i \leftarrow i + 1$

3	8	4	6	7	2	1	9	5
$A[1]$	$A[2]$	$A[3]$	$A[4]$	$A[5]$	$A[6]$	$A[7]$	$A[8]$	$A[9]$

Check $A[3] < 5$ true $j \leftarrow j + 1$

So, $A[2]$ and $A[3]$ are exchange, $i \leftarrow i + 1$

3	4	8	6	7	2	1	9	5
$A[1]$	$A[2]$	$A[3]$	$A[4]$	$A[5]$	$A[6]$	$A[7]$	$A[8]$	$A[9]$

Check $A[4] < 5$ false, $i \leftarrow i+1$

Check $A[5] < 5$ false, $i \leftarrow i+1$

Check $A[6] < 5$ true

So $j \leftarrow j+1$ and exchange $A[i] \leftrightarrow A[j]$

So, $A[3]$ and $A[6]$ are changed $50i \leftarrow i+1$

3	4	2	6	7	8	1	9	5
$A[1]$	$A[2]$	$A[3]$	$A[4]$	$A[5]$	$A[6]$	$A[7]$	$A[8]$	$A[9]$

Check $A[7] < 5$ true

So $j \leftarrow j+1$ and exchange $A[i] \leftrightarrow A[i]$

So, $A[4]$ and $A[7]$ are exchanged, $i < i$

3	4	2	1	7	8	6	9	5
$A[1]$	$A[2]$	$A[3]$	$A[4]$	$A[5]$	$A[6]$	$A[7]$	$A[8]$	$A[9]$

Check $A[8] < 5$ false

So, $j < j+1$ and exchange $A[j+1]$ with our data (5)

3	4	2	1	5	8	6	9	7
$A[1]$	$A[2]$	$A[3]$	$A[4]$	$A[5]$	$A[6]$	$A[7]$	$A[8]$	$A[9]$

The answer is 3 4 2 1 5 8 6 9 7.

Hence, the correct option is (C).

25. (A)

Bubble sort is the sorting algorithm in which every iteration it eliminates largest element form the given array and reduces the array size for the next iteration.

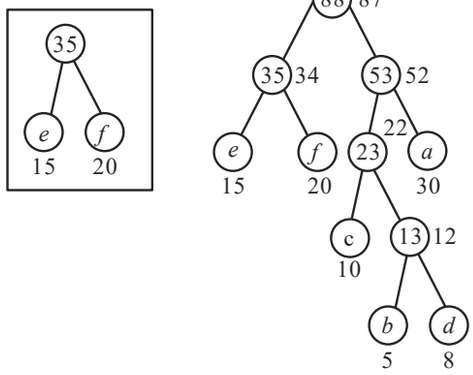
Hence, the correct option is (A).

26. (C)

1. Dijkshtra $\Rightarrow 0(E+V)\log V$ or $E\log V$
2. Floyd warshall $\Rightarrow n^3$ or V^3
3. Bellman $\Rightarrow n^3$ or V^3
4. BFS $\Rightarrow 0(E+V)$

Hence, the correct option is (C).

27. 207



Minimum record movements

$= 12+22+34+52+87 = 207$

Hence, the correct answer is 207.

28. 77

Index position in upper triangular matrix is,

$$= n(i-1) - \frac{(i-1)\times(i-2)}{2} + j - i$$

$$= 15(7-1) - \frac{(7-1)\times(7-2)}{2} + 9 - 7$$

$$= 15\times 6 - \frac{6\times 5}{2} + 2$$

$$= 90 - 15 + 2 = 77$$

Hence, the correct answer is 77.

29. (B)

$A \rightarrow$ Prim's algorithm $\Rightarrow$ Greedy algorithm

$B \rightarrow$ Quick sort $\Rightarrow$ Divide and conquer

$C \rightarrow$ Bellman ford $\Rightarrow$ D.P.

$D \rightarrow$ Subset sum problem $\Rightarrow$ D.P.

Hence, the correct option is (B).

30. 495

Number of vertices $(n) = 50$

Number of edges in minimum spanning tree $= (n-1)$

$= (50-1) = (49)$

Weight of every edge increased by 5 $= 49 * 5$

$= 245$

New weight $= 250 + 245 = 495$

Hence, the correct answer is 495.

31. **9**

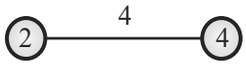
We will use Kruskal's algorithm (For MST)

	1	2	3	4	5
1	0	1	6	1	3
2	1	0	10	4	7
3	6	10	0	5	2
4	1	4	5	0	2
5	4	7	3	2	0

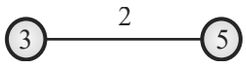
node 1 : Minimum weight edge (1, 2) & (1, 4)

Note : node 1 is a leaf node so out of (1, 2) or (1, 4) only 1 can be considered.

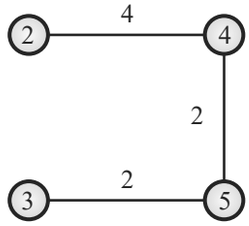
Node 2 :



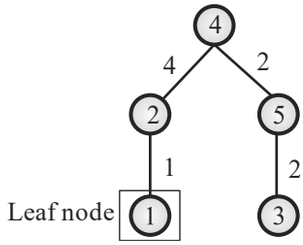
Node 3 : min edge $\Rightarrow$(3, 5)



Node 4 : min edge $\Rightarrow$(4, 5)



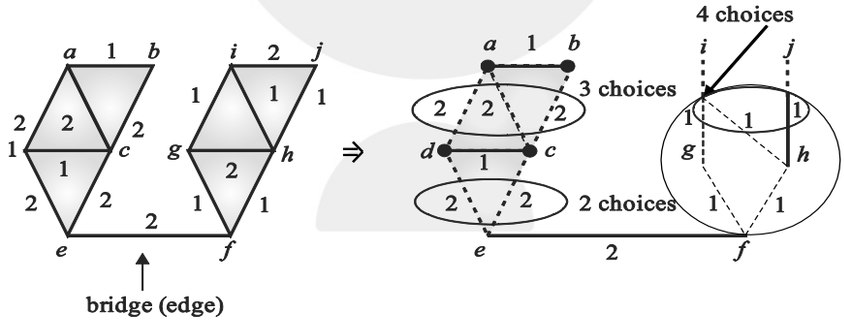
Final tree with node 1 as leaf node



Total weight of MST $= 4+2+1+2 = 9$

Hence, the correct answer is 9.

32. **24**



Total MST possible $= 3 \times 2 \times 4 = 24$

Hence, the correct answer is 24.

33. **(B,C)**

(A) False : Due to distinct weight there will be unique MST.

(B) True : e_{min} will always be part of MST due to distinct weight

(C) True : If e_{max} is a part of MST it means it is bridge whose removal disconnects graph.

(D) False : Option C is the reason

Hence, the correct option are (B,C).

34. **(A,D)**

(A) True :

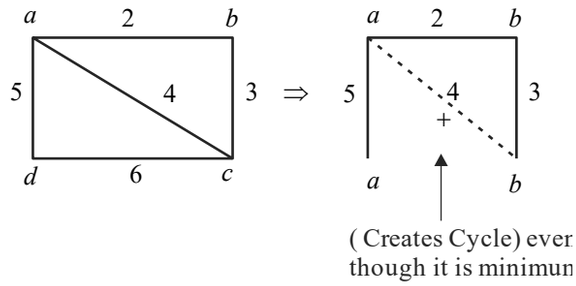
(C) False : Shortest path may differ.

Ex : 5 edges with shortest path 15 and other path with 2 edges with weight 25 but now 10 cost increased then,

$5 * 10 = 50 + 15 = 65$

$2 * 10 = 20 + 25 = 45$ this becomes now shortest path.

(B) False :



(D) True :

Hence, the correct option are (A,D).

35. (C)

Asymptotically better means for sufficiently large inputs, *X* is better than *Y*. i.e., beyond a large input size *N*, time taken by *X* is lower than that taken by *Y*. Only option C is TRUE.

Option D is wrong because "1 million" is not a limit to be "large" - this limit can be any value - 1 million +100,1 billion or even larger value. All we need is to ensure such a limit exists, however large that may be.

Hence, the correct option is (C).

36. (A)

Given that, the values: 13, 107, 49, 50, 64, 98, 16, 33

- 13 mod 10 = 3 – No collision
- 107 mod 10 = 7 – No collision
- 49 mod 10 = 9 – No collision
- 50 mod 10 = 0 – No collision
- 64 mod 10 = 4 – No collision
- 98 mod 10 = 8 – No collision
- 16 mod 10 = 6 – No collision
- 33 mod 10 = 3 – There is collision, so 33 will go to next free slot.

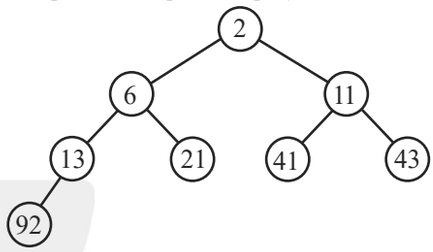
Hash Table

Index	Values
0	50
1	
2	
3	13
4	64
5	33
6	16
7	107
8	98
9	49

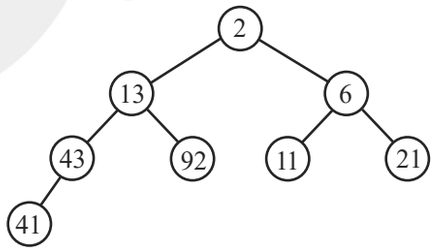
Hence, the correct option is (A).

37. (A,C)

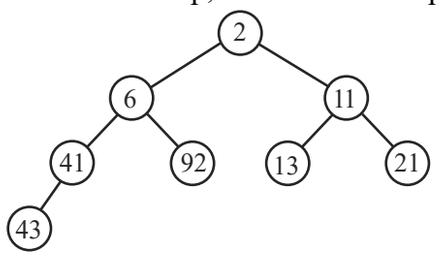
We know, that heap can be either min heap or max heap, but not both at the same time (Similar to EXOR gate in digital logic).



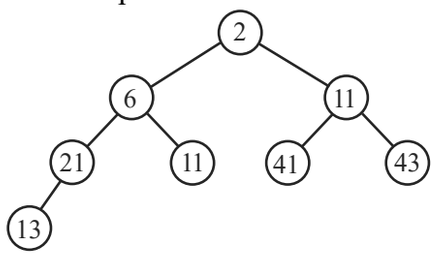
(A) Min Heap



(B) Not a min heap, or not a max heap



(C) Min heap



(D) Not a min heap, or not a max heap

Hence, the correct option are (A,C).

38. **(C,D)**

Huffman coding is a lossless coding and has an exact greedy algorithm. In this coding, the codes are represented by the binary paths from root to leaf and thus no code can be a prefix of another.

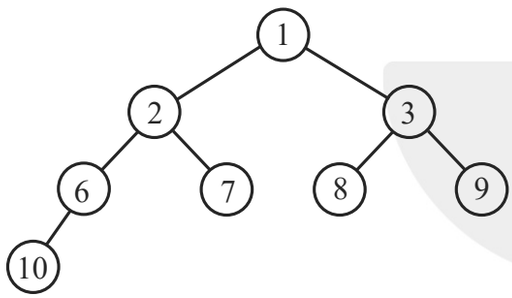
39. **(A,B,C,D)**

Ceil and floor do not affect the asymptotic growth. And the base of logarithm also does not affect the asymptotic growth. So, here,

$$\log_{10} n = \Theta(\log_2 n) = \Theta\left(\lceil \log_2 n \rceil\right) = \Theta\left(\lfloor \log_2 n \rfloor\right)$$

Hence, the correct option are (A,B,C,D).

40. **3**



7 is in level 3.

Hence, the correct answer is 3.

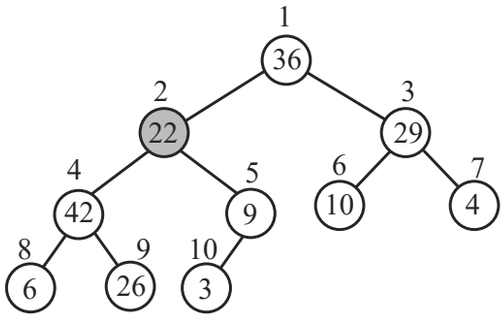
41. **(A)**

Question is implying a stable sort. Among the ones in options, only Merge Sort is stable.

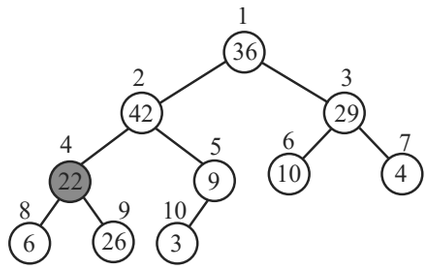
Hence, the correct option is (A).

42. **9**

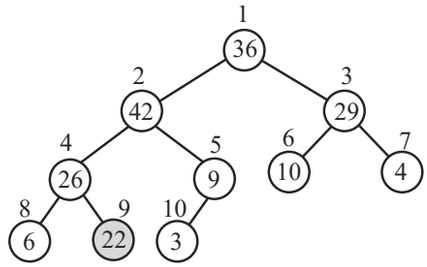
We need to perform swapping, to get max-heap.



Swapped 22 and 42, we get



Swapped 22 and 26, we get max-heap.



Hence, the correct answer is 9.

43. **1.5**

In a hash-table with chaining and uniform hashing, the expected number of comparisons in an unsuccessful search is given by α where $\alpha = \frac{m}{n}$ is the load factor.

Here, $\alpha = \frac{3}{2} = 1.5$. So, expected number of comparisons for an unsuccessful search $= 1.5$

Hence, the correct answer is 1.5.

44. **(A)**

In first pass 34 is the pivot. So, it'll get position as in the final sorted order which is 4th position. This is true only for option A.

Hence, the correct option is (A).

45. **(B)**

The best possible algorithm will find the k^{th} smallest element in $O(n)$ time and then move all elements smaller than this to its left - partition part of quick sort which again takes $O(n)$. Finally, these k elements can be sorted in 0(k log k) time.

Hence, the correct option is (B).

46. (B)

We want all the n keys to go to $m-1$ locations only. Probability for this will be

$$\frac{(m-1)^n}{m^n} \Rightarrow (1-0.125)^6 = 0.875^6$$

Hence, the correct option is (B).

47. (A)

Enqueue node 1 in the queue.

Queue: 1

Mark it as visited. Dequeue 1 and enqueue its non-visited adjacent nodes in ascending order.

Queue: 8 5 4 3 2

Mark 8 as visited. Dequeue 8 and enqueuer its non-visited adjacent nodes in ascending order.

Queue :5 4 3 2 7 6

Mark 5 as visited. Dequeue 5 and enqueue it non-visited adjacent nodes.

Queue :4 3 2 7 6

Mark 4 as visited. Dequeue 4 and enqueue it non-visited adjacent nodes.

Queue :3 2 7 6

Mark 3 as visited. Dequeue 3 and enqueue it non-visited adjacent nodes.

Queue: 2 7 6

Hence, the correct option is (A).

48. 136

Given that,

$arr[0]=1, arr[1]=4, arr[2]=10$

$arr[3]=12,$ and $len=4$

initially, the value of result = 0

- When

  $i=0 \mid \text{result} = \text{result} + arr[0]*$

  $(0+1)*(4-0) = 0+1*1*4 = 4$

- When

  $i=1 \mid \text{result} = \text{result} + arr[1]*(1+1)$

  $*(4-1) = 4+4*2*3 = 28$

- When

  $i=2 \mid \text{result} = \text{result} + arr[2]*(2+1)*$

  $(4-2) = 28+10*3*2 = 88$

- When

  $i=3 \mid \text{result} = \text{result} + arr[3]*(3+1)*$

  $(4-1) = 88+12*4*1 = 136$

Hence, the correct answer is 136.

49. (A,B)

- 32 mod $6=2-$ occupies slot 2
- 7 mod $6=1-$ occupies slot 1
- 14 mod $6=2-$ collide. Occupies next slot which is slot 3
- 22 mod $6=4-$ occupies slot 1
- 29 mod $6=5-$ occupies slot 5
- 3 mod $6=3-$ collide on slot 3. Occupies next slot which is slot 0.

Hence, the correct option are (A,B).

50. 94

Solve in bottom-up fashion.

Find me (0) = 1

- $\text{findme}(1) = \text{findme}(0) + \text{findme}(0) = 2$
- $\text{findme}(2) = \text{findme}(1) + \text{findme}(1) = 4$
- $\text{findme}(3) = \text{findme}(1) + \text{findme}(2) = 6$
- $\text{findme}(4) = \text{findme}(1) + \text{findme}(3) = 10$
- $\text{findme}(5) = \text{findme}(2) + \text{findme}(4) = 14$
- $\text{findme}(6) = \text{findme}(3) + \text{findme}(5) = 20$
- $\text{findme}(7) = \text{findme}(3) + \text{findme}(6) = 26$
- $\text{findme}(8) = \text{findme}(4) + \text{findme}(7) = 36$
- $\text{findme}(9) = \text{findme}(4) + \text{findme}(8) = 46$
- $\text{findme}(10) = \text{findme}(5) + \text{findme}(9) = 60$
- $\text{findme}(11) = \text{findme}(5) + \text{findme}(10) = 74$
- $\text{findme}(12) = \text{findme}(6) + \text{findme}(11) = 94$

Hence, the correct answer is 94.

51. **(C,D)**

17 Worst case complexity of quick sort occurs in 2 cases, when smallest or largest element of array is chosen as pivot element of array. So both the case of worst cases are avoided and hence worst case can't be $O(n\hat{}2)$.

Hence, the correct option are (C,D).

52. **(C)**

The i loop iterates $n/2=\Omega(n)$ times

j loop does call to foo(j). So, enumerating the calls to foo(j) we get

$foo(1)+foo(2)+foo(2^2)+...+foo(2^{\lg n})$

Complexity of $foo(k)=\Theta(\log k)$

So, we get complexity of j loop as

$$\Theta(\lg 1)+\Theta(\lg 2)+\Theta(\lg 2^2)+...+\Theta(\lg 2^{\lg n})$$
$$=\Theta(1+2+3+...+\lg n)$$
$$=\Theta\left((\lg n)^2\right)$$

So, the time complexity of entire code

$$=\Theta\left((\lg n)^2\right).$$

Hence, the correct option is (C).

53. **(B)**

The while loop is iterating $\lg n$ times as in each iteration n is halved. So times complexity will be $\Theta(\lg n)$.

There is only constant amount of space required in the function. So, space complexity is $O(1)$.

α value is incremented as

$$n+n/2+n/4+...n/2^{\lg n}$$
$$=n[1+1/2+1/4+...1/n]$$
$$=n\frac{\left[1-1/2^{\lg n}\right]}{0.5}$$ (Sum to n terms of GP

with $\alpha=1, r=0.5=\frac{\alpha.(1-r^n)}{1-r}$

$$=2n\left[\frac{n-1}{n}\right]=2(n-1)=\Theta(n).$$

Hence, the correct option is (B).

54. **12.5**

$$2\times 2000+2\times 300+1\times 50=4650.$$

So, 5 notes in minimum $\Rightarrow 5\times 2.5=12.5$

Hence, the correct answer is 12.5.

55. **(B)**

Only B option is true here.

The expected number of comparisons in a successful linear search is $\lceil n/2\rceil$ As the successful item is equally likely to be in any of the n location.

In best case both linear search and binary search can work in $\Omega(\log n)$ comparisons as after each search half the elements get eliminated.

Hence, the correct option is (B).

56. **2**

Arranging by the order of probability of occurrences we get

- $a:0.33$
- $d:0.3$
- $c:0.2$
- $b:0.16$

So, first we combine c and b nodes. Sum of their probabilities will be 0.36.

Next, we combine the two smallest probabilities which are for a and d. This will give sum as 0.63.

So, we get complete and full binary tree with 3 levels and so all codes are of length 2. So, expected length of the binary codes will be 2.

Hence, the correct answer is 2.

57. **A,B,C,D**

$h(x,i)=(h_1(x)+i\times h_2(x))\bmod m.$

$13: h_1(x) = 6$.goes to slot 6

$18: h_1(x) = 4$.goes to slot 4

$25: h_1(x) = 4$.goes to slot 4, collision

$h_2(x) = 4, (2\times4) \bmod 7 = 1$ – goes to slot 1

$11: h_1(x) = 4$.goes to slot 4, collision-

$h_2(x) = 2, (4\times2) \bmod 7 = 6$ – collision

$(4+2\times2) \bmod 7 = 1$ collision-

$(4+3\times2) \bmod 7 = 3$ – goes to slot 3.

$20: h_1(x) = 6$ – goes to slot 6, collision-

$h_2(x) = 3, (6+3) \bmod 7 = 2$ – goes to slot 2.

$29: h_1(x) = 1$ – goes to slot 1. Collision.

Thus, 25,11,20,29 all collide.

Hence, the correct option are (A,B,C,D).

58. (A,D)

A is TRUE. Happens for a left-skewed or right-skewed binary tree.

B is FALSE. Minimum number of comparisons to sort 5 elements is 7

C is FALSE. There can be at most $\left\lceil \frac{n}{2^{h-1}} \right\rceil$ nodes of height h in any n element heap when h starts from 1 and this changes to $\left\lceil \frac{n}{2^{h+1}} \right\rceil$ when h starts from 0.

D is TRUE as maximum element in a min-heap will be at the last level and it can be any one of the possible $n/2$ elements in the last level.

Hence, the correct option are (A,D).

59. 32000

By a quick look we can see that 90 is by far the largest dimension. So, we must do $(M_1 \times M_2)$ to get rid of this dimension. This means the only orderings left are $(((M_1 \times M_2) \times M_3) \times M_4)$ and $(M_1 \times M_2) \times (M_3 \times M_4)$.

These two will give the total number of multiplications as

$$[20\times90\times10] + [20\times10\times15] + [20\times15\times40] = 33000$$

And

$$[20\times90\times10] + [10\times15\times40] + [20\times10\times40] = 32000$$

So, minimum number of multiplication required $= 32000$.

Hence, the correct answer is 32000.

60. (A)

Maximum subarray sum can be found in linear time using dynamic programming.

So, option A is TRUE.

Hence, the correct option is (A).

61. (C)

Given : Series

$$T(n) = 1.2^1 + 2.2^2 + 3.2^3 + 4.2^4 + 5.2^5 + 6.2^6 + 7.2^7 + ...n.2^n$$

Above series is bot A.P AND G.P series

Convert it into G.P. series by method given below

$$2.T(n) = 1.2^2 + 2.2^3 + 3.2^4 + 4.2^5 + 5.2^6 + 6.2^7 + 7.2^8 + ...n.2^{n+1}$$

$$T(n) - 2.T(n) = 1.2^1 + (2-1).2^2 + (3-2).2^3 + (4-3).2^4 + ... - n.2^{n+1}$$

$$-T(n) = 2^1 + 2^2 + 2^3 + 2^4 + 2^5 + 2^6 + 2^7 + ... + 2^n - n.2^{n+1}$$

Now we get the G.P series

$$-T(n) = 2.((2^n - 1)/(2-1)) - n.2^{n+1}$$

$$T(n) = 2 + n.2^{n+1} - 2^{n+1}$$

$$T(n) = O(n.2^n)$$

Hence, the correct option is (C).

62. (B)

for ($j = 2$ to array. length)

key = array [j];

$i = j - 1$;

While ($i > 0$ && array$[i] >$ key)

array $[i+1]$ = array[i];

$i = i - 1$;

array $[i+1]$ = key;

above is the standard algorithm of insertion sort, from this we can easily infer that

$(j > 0)$ && $(arr[j-1] > value)$ is the right option.

Hence, the correct option is (B).

63. (A)

Only Option A is correct

Option A: simple calculation or GCD$(9,13) = 1$

Option B: what if I take $m = 2$ the code will run for $n/2 + \text{steps} = \Omega(n)$; So, Option B is wrong.

Option C: Given algorithm is doing GCD not LCM

Option D: space complexity is 0(1) for the given algorithm

Hence, the correct option is (A).

64. (B)

Even to sort 10% of the elements insertion sort in worst case can take $\Theta(n^2)$ comparisons.

Number of comparisons in insertion sort is $O(k)$, where k is the number of inversions in the input array.

For option C, consider the case where the smallest element is at the end of the array for ascending sort.

This element will come to the correct position only after $\Theta(n^2)$ comparisons in bubble sort.

Hence, the correct option is (B).

65. 2

This recurrence is same as LCS problem. In LCS we had "max" but here we have "min".

Time complexity of LCS is $O(mn)$.

Here it will be $O(n^2)$. a = 2, b = 0.

Hence, the correct answer is 2.

66. (A)

(This question aim to make you understand that top down is better if there are only few sub problems to be computed)

Bottom-up approach will fill $m \times n$ matrix, and each sub problem will take $\theta(1)$ so total time in bottom up $= \theta(mn)$

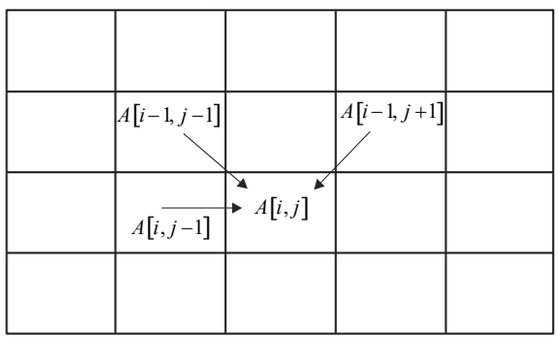
The top-down approach will start with a function call $A(n, n)$ and call sub problems recursively. And will only call required sub problems, not all sub problems.

Top-down method only calculates the needed sub problems, which are of the form $A\left(\left\lfloor \frac{m}{2^6} \right\rfloor, \left\lfloor \frac{m}{2^f} \right\rfloor\right)$. There are only $\Theta(\log m \log n)$ such sub problems, hence its time complexity is only $\Theta(\log m \log n)$.

Buttom-up method will require computing every sub problem, resulting in time complexity $\Theta(mn)$.

Hence, the correct option is (A).

67. (C)



Hence, the correct option is (C).

68. (D)

1. Control enters into the first while $(i < n)$ (condition is true)
2. Control also enters into the inner while $(i < n)$ loop.
3. Control again enter into innermost while $(i < n^3)$ loop and then continues its execution until $i$is equal to n^3. Then the control cannot go inside any of the while loop because all the 3 conditions will result in false.

Hence total iteration is n^3 (inner most while) + 1 (inner while) + 1 (outer most while)

Hence time complexity $= O(n^3)$,

Hence, the correct option is (D).

69. 28

Capacity = 20

Weights are (18,15,10)

Profit values (25, 24, 15)

Find $\frac{\text{Weight}}{\text{value}} \Rightarrow \frac{18}{25}, \frac{15}{24}, \frac{10}{15}$

$\Rightarrow$ 0.72, 0.625, 0.666

Select the item with highest ratio.

After selection of the 1st item, remaining

Capacity = 2 and value = 25

Now select 1/5 part of 3rd item,

Remaining capacity = 0

Total value =25+(15/5)=28 .

Hence, the correct answer is 28.

70. (A,C)

Concept : A minimum spanning tree (MST) or minimum weight spanning tree is a subset of the edges $(V-1)$ of a connected, edge-weighted undirected graph G (V,E) that connects all the vertices, without any cycles and with the minimum possible total edge weight.

Data:

Number of edges in $G = e = 6$

Number of vertices in $G = n$

Formula:

For a complete graph,

Degree of each vertex $= n-1$

From handshaking Lemma

$$2 \times 6 = n \times (n-1)$$

Calculation:

$$2 \times 6 = n^2 - n$$

$\therefore$ $n^2 - n - 12 = 0$

$(n-4) \times (n+3) = 0$

$\therefore$ $n = 4 \text{ or } n = -3$

Since $n \neq -3$

$\therefore$ $n = 4$

For a minimum spanning tree,

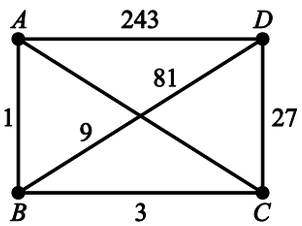
Number of edges needed $= 4 - 1 = 3$

One of the minimum spanning tree will defiantly be

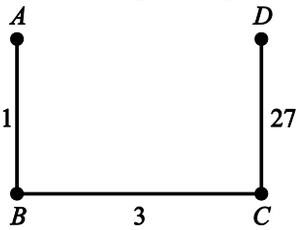
$1 \rightarrow 3 \rightarrow 9(13)$

Other possible

Graph: G



Weight for minimum spanning tree



Possible weight of a minimum spanning tree $= 1 + 3 + 27 = 31$

Only two MST is possible

Therefore option 1 and 3 are not possible

Hence, the correct option are (A,C).

71. (A)

For 0/1 knapsack problem,

1. Each item either can be chosen (or) cannot be chosen
2. Also, sum of the weights of the items in the knapsack should be less than (or) equal to W which is 6

Considering these two. Some of the possible solutions which satisfy the above two constraints.

Set 1: items (l, 2, 3), total value $= 60$

Set 2: items (4,2), total value $= 60$

Set 3: items (4, 3), total value $= 55$

Set 4: items (5,3), total value $= 65$

Set 5: items (l, 2), total value $= 45$

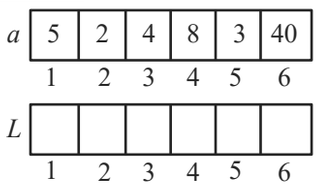
Set 7: items (l, 3), total value $= 40$

Set 8: items (2,3), total value $= 35$

Out of these, clearly optimal solution is 65 and only Set 4 has this max value.

Hence, the correct option is (A).

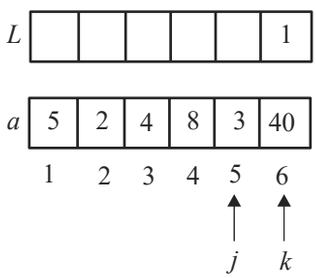
72. (B)



$a[j] \le \min\left(a[j+g]\ a[\mathrm{n}]\right)$

Base Case :

$L(6) = 1$



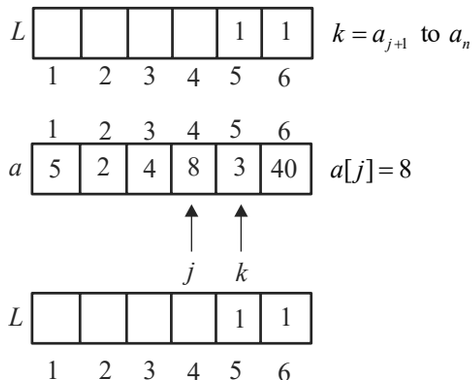
$\min\left(a[6]\right) = 40$

$a[j] = 3$

$a[j] \le \min\left(a[6]\right)$

$\Rightarrow \quad L[s] = 1$

So basically use are Checking that what hen the than minimum element. If so than mark 1 in $L[j]$.



$\min\ (3,4\ 0) = 3$

and $a[j] \ge \min\left(a[j+1],\ a[j+2]..., a[n]\right)$

So apply second case

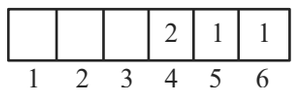
i) $a[4] > \mathrm{a}[5]$

$\max = 1$

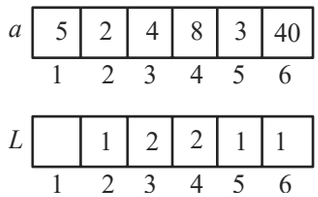
ii) $a[4] > \mathrm{a}[5]$

So condition doesn't work

$1 + \max\left(L[5]\right) = 2$

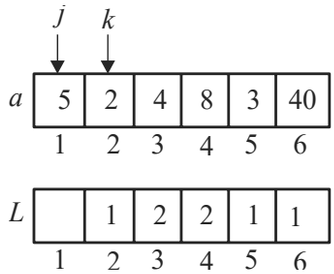


Like this way before last step ;



e) Now analyze for $a[1]$

$k = a_{j+1}$ to a_n



We can see

$a[1] > \min(a[j+1]...a[n])$

$5 > 2$, So apply second condition

So apply second case :

(i) $a[1] > a[2]$

max = 1

(ii) $a[1] > a[3]$

max = 2

(iii) $a[1] < a[4]$

max = 2 [Conditional able so max remains some]

(iv) $a[1] > a[5]$

max = 2

(v) $a[1] < a[6]$

max = 2

So, $L[1] = 1 + \max$

$= 1 + 2 = 3$

L	3	1	2	2	1	1

So length of longest decreasing subsequence is 3

Another example :

a	1	2	3	4

L				1

→ Here use can see everytime condition 1 will apply

So,

L	1	1	1	1

So length of longest decreasing subsequence is 1.

Hence, the correct option is (B).

73. (B)

In the question we miss the point that we have to count the number of paths from vi to vn, not the count of nodes in that path.

Option C will return all nodes count in all the paths starting from i.

But we only want the count of paths which can be possible only when we return 1 from the end of any particular path & just take summation over that 1's which is what Option B is doing.

Hence, the correct option is (B).

74. 1860

The number of scalar multiplications required for multiplying matrices A_{mxn}, B_{nxp} is $m*n*p$.

Assuming we need to get least number of scalar multiplications, we eliminate the larger dimensions first.

Following are the 6 matrices and their dimensions

$A_{5\times10}, B_{10\times3}, C_{3\times12}, D_{12\times5}, E_{5\times50}, F_{50\times6}$

→ $5\times10, 10\times3, 3\times12, 12\times5, 5\times6$

(Multiplying matrices $E_{5\times50}, F_{50\times6}, 50*5*6 = 1500$ multiplications)

→ $5\times10, 10\times3, 3\times5, 5\times6$

(Multiplying matrices $C_{3\times12}, D_{12\times5}, 3*12*5 = 180$ multiplications)

→ $5\times3, 3\times5, 5\times6$

(Multiplying matrices with dimensions $3\times5, 5\times6, 3*5*6 = 90$ multiplications)

→ 5×6

(Multiplying matrices with dimensions $5\times3, 3\times6$ total $= 90$ multiplications)

Total scalar multiplications = 1860

Hence, the correct answer is 1860.

75. (C)

	0	1	2	3	4	5	6	
0	0	0	0	0	0	0	0	
1	0	0	1	1	1	1	1	b
2	0	1	1	1	2	2	2	a
3	0	1	1	2	2	2	3	c
4	0	0	2	2	2	3	3	b
		a	b	c	a	b	c	

There are four longest common subsequences : "*bac*" and "*bab*" and "*bcb*" and "*acb*"
Hence, the correct option is (C).

76. (A)

Given,

$\text{OPT}[1]=1$

For OPT [2] we need to look at OPT [1]
For OPT [3] we need to look at OPT [1] and OPT [2].
For OPT[n] we need to look from OPT [1] to OPT $[n-1]$.

At first, for loop will run a single time, then two times, …… then $(n-1)$ times.

So the time complexity $T(n)$ will be:

$$T(n)=1+2+3+4+.....+(n-1)$$
$$T(n)=O(n^2)$$

Space complexity will be $O(n)$ because we are taking one extra array OPT which is a single-dimensional array.
Hence, the correct option is (A).

77. (A)

Option A– this is correct as this is satisfying the given constraint. For calculating $f(n)$ which is the maximum value with n coins we are either taking $(cn+f(n-2)$ or $f(n-1))$. So we are making sure that we are not taking coins that lie beside each other.

Option B, D – this is not correct as it is not satisfying the given constraint "don't ever pick up two coins that lie beside each other".

Option C – this is not correct as it is not taking the value of the current coin.

Row of coins with values

5	1	2	10	6	2
c_1	c_2	c_3	c_4	c_5	c_6

Given, $f(0)=0,\ f(1)=5$

$f[n]$ be maximum total value with *n* coins:

Index	0	1	2	3	4	5	6
	0	5					

So, $f[1]$ is the maximum value with 1 coin.

$f[2]$ is the maximum value with 2 coins:

→ We have two choices either taking c_1 or c_2. We can't take both coins due to the given constraint. So $\max(f[1], c_2+f[0])=5$. With two coins maximum value is 5.

Index	0	1	2	3	4	5	6
	0	5	5				

$f[3]$ is the maximum value with 3 coins:

→ We have two choices either (taking $f[2]$ which is the maximum value with 2 coins) or ($c_3+f[1]$ which is the maximum value with 1 coin). So $\max(f[2], c_3+f[1])=7$.

Index	0	1	2	3	4	5	6
	0	5	5	7			

$f[4]$ is the maximum value with 4 coins:

→ We have two choices either (taking $f[3]$ which is the maximum value with 3 coins) or ($c_4+f[2]$ which is the maximum value with 2 coin). So, $\max(f[3], c_4+f[2])=15$.

Index	0	1	2	3	4	5	6
	0	5	5	7	15		

$f[5]$ is the maximum value with 5 coins:

→ We have two choices either (taking $f[4]$ which is the maximum value with 4 coins) or ($c_5+f[3]$ which is the maximum value with 3 coin). So $\max(f[4], c_5+f[3])=15$.

Index	0	1	2	3	4	5	6
	0	5	5	7	15	15	

$f[6]$ is the maximum value with 6 coins:

→ We have two choices either (taking $f[5]$ which is the maximum value with 5 coins) or ($c_6 + f[4]$ which is the maximum value with 4 coin).

So, $\max(f[5], c_6 + f[4]) = 17$.

Index	0	1	2	3	4	5	6
	0	5	5	7	15	15	17

So, maximum value with 6 coins is 17.

Hence, the correct option is (A).

78. (B)

Code Explanation:

```
int i = 0, j = 0, val = 1
for (i = 1; i < = n; i++)// n times Time complexity = O(n)
        {
        j = n;
if (i % 2 = =0)// out of n only n/2 times if will run
        {
while (j < 1) {// log n times, since j = n}
val = val * j;
        j = j/2; // j decrease in power of 2 leads to log n
        }
        }
        }
```

Outer for loop $= O(n)$

Inner for loop $= O(\log n)$

Since nested loop

Time complexity

$$= O(n) \times O(\log n) = O(n \log n)$$

Hence, the correct option is (B).

79. (B)

Level - 1 is compared with root – 2 comparisons.

Level – 2 is compared with level – 1 elements – 4 comparisons.

$2 + 4 + 8 + ... + 2^k$ where, $n = 2^k$

$\Rightarrow$ $2(1 + 2 + ... + 2^{k-1})$

$\Rightarrow$ $2(2^k - 1) = 2(n-1) = 2n - 2 = O(n)$

Hence, the correct option is (B).

80. (C)

$$T(n) = 7T\left(\frac{n}{2}\right) + k \cdot n^2$$

Using master theorem $[n^{\log_2 7} > kn^2]$

$$T(n) = O\left(n^{\log_2 7}\right)$$

Hence, the correct option is (C).

81. (A)

Both dynamic and Greedy algorithm find optimal substructure in the problem but only dynamic programming uses the bottom-up approach, whereas greedy algorithm uses top-down approach. So, S_1 is true so,

Hence, the correct option is (A).

82. 8

In the above graph, there are three stages with 2 vertices. Topological sort picks the element with zero in degree at any point of time. At each of two vertices stages, either the top vertex or the bottom vertex can be processed. So at each of these stages there will be two possibilities.

Total number of possibilities $= 2 \times 2 \times 2 = 8$

Hence, the correct answer is 8.

83. (B)

Strassen matrix multiplication → Divide and conquer

Insertion sort → Decrease and Conquer

Gaussian Elimination → Transform and Conquer

Floyd shortest path algorithm → Dynamic programming

Hence, the correct option is (B).

84. (D)

$f(n) = 2^n \le g(n) = n!$ for $n \ge 4$

$f(n) = O(g(n))$

$h(n) = n^{\log n} \le f(n) = 2^n$ for $n \ge 2$

$h(n) = O(f(n))$

Hence, the correct option is (D).

85. (B)

$$S = (a_0, S_1)$$

$$S_1 = (a_1, a_2, a_3, ...a_{n-1})$$

Two possible cases arise :

1. a_0 is included in the max weight subsequence of S :

In this case,

$$\text{X = weight } (a_0, S_1) = a_0 + \frac{Y}{2}$$

2. a_0 is not included in the max weight subsequence of S :

In this case, $X =$ weight $(S_1) = Y$

Since the value of a_0 can be anything (negative or $< \frac{Y}{2}$ in general) $\{\because\ a_i \in \mathbb{R}\}$, it is possible that $Y > a_0 + \frac{Y}{2}$.

The maximum possible weight of a subsequence of S is given by

$$X = \max\left(Y, a_0 + \frac{Y}{2}\right)$$

Hence, the correct option is (B).

86. (B)

$f(x)$ grows exponentially as a function of x

Hence, the correct option is (B).

87. (D)

In a connected graph, *a* vertex *v* is said to be an articulation point if by removing that vertex together with its edges the graph become disconnected. In the given graph there is no articulation point.

Hence, the correct option is (D).

88. (C)

There are $\left\lceil \frac{n}{2} \right\rceil$ number of leaf nodes. It requires $\left\lceil \frac{n}{2} \right\rceil - 1$ number of comparisons to find the maximum elements.

Hence, the correct option is (C).

89. (A)

$$T(n) = T(n-1) + T(n-2) - T(n-3)$$

Better way of solving is substitute

$$T(1) = 1$$

$$T(2) = 2$$

$$T(3) = 3$$

$$T(4) = T(3) + T(2) - T(1) = 4$$

$$T(5) = T(4) + T(3) - T(2) = 5$$

:

:

$$T(n) = T(n-1) + T(n-2) - T(n-3)$$

$$= n - 1 + n - 2 - n + 3 = n$$

So order is O(n)

Hence, the correct option is (A).

90. (A)

Above code segment recurrence relation is

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

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

$$T(0) = 1$$

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

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

$$T(n-2)=T(n-2+1)+1$$
$$T(n)=[(T(n-3)+1)+1]+1$$
$$=T(n-3)+3$$
$$=T(n)=T(n-k)+k$$

Note: let k=n

Then $T(n)=T(0)+n=1+n$

$\therefore$ $O(n)$

Hence, the correct option is (A).

91. (C)

P. $T(n)=3T\left(\frac{n}{4}\right)+O(n^2)$

$a=3, b=4, f(n)=cn^2$

From case 3 of Master Method.

$$T(n)=\Theta(f(n))=\Theta(n^2)$$

Q. $T(n)=T\left(\frac{n}{3}\right)+T\left(\frac{2n}{3}\right)+O(n)$

Use substitution with good guess

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

$$T\left(\frac{n}{3}\right)+T\left(\frac{2n}{3}\right)+\frac{1\text{n}}{3}=\frac{n}{3}\log\left(\frac{n}{3}\right)+$$

$$\frac{2n}{3}\log\left(\frac{2n}{3}\right)+\frac{1n}{3}$$

$$=\frac{n}{3}(\log n-\log 3)+\frac{2n}{3}(\log(2n)-\log 3)$$

$$+\frac{n}{3}$$

$$=\frac{n}{3}\log n-\frac{n}{3}\log 3+\frac{2n}{3}(\log 2n)$$

$$-\frac{2n}{3}\log 3+\frac{n}{3}$$

$$=\frac{n}{3}\log n+\frac{2n}{3}(\log 2+\log n)-\frac{n}{3}\log 3$$

$$-\frac{2n}{3}\log 3+\frac{n}{3}$$

$$=n\log n+\frac{2n}{3}-n\log 3+\frac{n}{3}=n\log n$$

R. $T(n)=\sum_{n=1}^{\log n}\left(\frac{n}{2}\right)$

$$=\frac{n}{2}\times\log_2 n=O(n\log n)$$

Assume $n=2^k$

$\Rightarrow$ $\log n=k$

$$=\sum_{n=1}^{k}\left(\frac{n}{2}\right)=k\frac{n}{2}$$

Hence, the correct option is (C).

92. (A)

$$T(n)=T(n/5)+T(7n/10)+n$$

$$=\sum_{i=0}^{\log\frac{n}{5}}\cdot n=\Theta(n)$$

$$n=\left(\frac{n}{10}\right)$$

Hence, the correct option is (A).

93. (A)

Given : $g_1(n)=\begin{cases}n^3 \text{ for } 0\le \text{n} \le 10{,}000\\ n^2 \text{ for n} \ge 10{,}000\end{cases}$

$$g_2(n)=\begin{cases}n \text{ for } 0\le n\le 100\\ n^3 \text{ for } n>100\end{cases}$$

For n> 10,000,

$$g_1(n)=0(n^2)$$

$$g_2(n)=0(n^3)$$

We can conclude

$$g_1(n)=0(g_2(n))$$

Function $g_1(n)$ is said to be Big-Oh of $g_2(n)$ if

$g_1(n)\le cg_3(n)$, for $c>0$ and

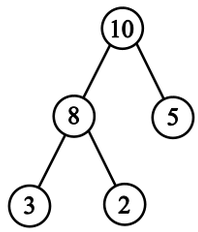
$n\ge n_0$

$n_0>0$

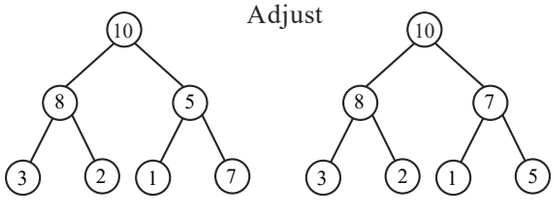
Hence, the correct option is (A).

94. (D)

Max- heap using priority Queue



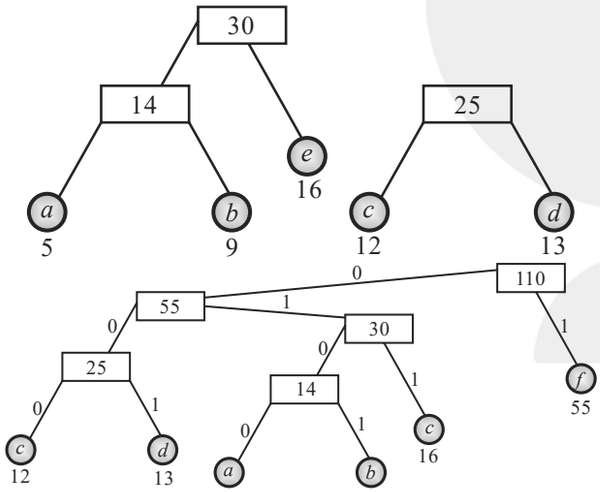
Insert 1 and 7



Hence, the correct option is (D).

95. 2.12

a	*b*	*c*	*d*	*e*	*f*
5	9	12	13	16	55



Huffman Tree.

a	0100	(4 bit)
b	0101	(4 bit)
c	000	(3 bit)
d	001	(3 bit)
e	011	(3 bit)
f	1	(1 bit)

Average length

$$= \frac{5\times4+9\times4+12\times3+13\times3+16\times3+55\times1}{110}$$

$$= 2.12$$

Hence, the correct answer is 2.12.

96. 2.428

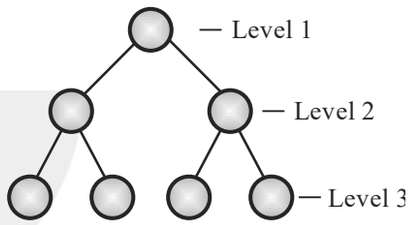
Average number of Comparison in Binary search with n keys in array can be calculated by a simple trick.

Make Almost complete BST, compute level wise comparisons for example, at level 1, one comparison on each element, at level 2, 2 comparisons on each element. At level 3, 3 comparisons on each element and so on.

Then Calculate Average by

$$\frac{\text{Total number of Comparisons}}{\text{Number of Elements}}$$

Example:-



Average number of comparisons

$$= \frac{1\times1+2\times2+3\times4}{7} = \frac{1+4+12}{7} = 2.428$$

Hence, the correct answer is 2.428.

97. 270

First we draw table

Item	W_i	V_i
I_1	5	30
I_2	10	20
I_3	20	100
I_4	30	90
I_5	40	160

Taking value per weight ratio i.e., $P_i = V_i / W_i$

Item	W_i	V_i	$P_i = \frac{V_i}{W_i}$
I_1	5	30	6

I_2	10	20	2
I_3	20	100	5
I_4	30	90	3
I_5	40	160	4

$\rightarrow$Now arrange the value P_i in decreasing order

Item	W_i	V_i	P_i
I_1	5	30	6
I_3	20	100	5
I_5	40	160	4
I_4	30	90	3
I_2	10	20	2

I_1	I_3	$\frac{7}{8}$ I_5	

$W = 60 \quad 55 \quad 35 \quad 0$

We have remaining W is 35 but I_5 required 40

so we get only $\frac{35}{40} \times I_5 = \frac{7}{8} I_5$

So the maximum profit or a value is

$= 30 + 100 + \frac{7}{8} \times 160$

$= 30 + 100 + 140 = 270$

98. (D)

i loops are execute $\frac{n}{2}$ times $\left[1 \text{to} \frac{n}{2} \text{times}\right]$

But j 1oop are executes $\log n$ time

Because $j = 1, 2, 4, 8, ----2^K$

Until $2^K \leq n$

So the maximum value of K is $2^K = n$

Apply $\log_2$ on both side

$\log_2 2^K = \log_2 n$

$K.\log_2{}^2 = \log_2 n$

$K = \log_2 n$

i- is the outer loop & j–is the inner loop so the total time complexity is $= O(n * \log_2 n)$

Hence, the correct option is (D).

❖❖❖❖

6 Theory of Computation

Practice Questions

Q.1 Number of Trivial substring in "GATE 2023" are _____

Q.2 Let the string be defined over symbols a and b then what will be the number of states in minimal *DFA*, if every string starts and ends with different symbols?

Q.3 The total number of substring present in "GATE" is :

Q.4 Let $\sum = \{a, b\}$, what are the number of states in Minimal *DFA*, length of every string congruent to Mod 5.

Q.5 A minimal *DFA* that is equivalent to a *NFA* has :

(A) Always more states

(B) Always less number of states

(C) Exactly 2^n states

(D) Sometimes more states

Q.6 **[MSQ]**

$S \to AB$

$A \to BB \mid a$

$B \to AB \mid b$

Choose correct statement?

(A) *aabbb* can be derived from above Grammar

(B) *aabb* can be derived from above Grammar

(C) *ababab* can be derived from above Grammar

(D) *abbb* can be derived from above Grammar

Q.7 One of the following Regular expressions is not the same as others. Which one?

(A) $(a*+b*a*)*$

(B) $(a*b*+b*a*)*(a*b*)*$

(C) $\left((ab)*+a*\right)*$

(D) $(a+b)*a*b*a*b*$

Q.8 The complement of CFL.

(A) Recursive

(B) Recursive enumerated but not recursive

(C) Not R.E

(D) The empty set

Q.9 What are the number of states needed in minimal *DFA*, that accepts $(1+1111)*$

Q.10 Consider the following languages. **[MSQ]**

$L_1 = \left\{a^n b^n \mid n \geq 0\right\}$

$L_2 =$ Complement (L_1)

Choose appropriate options regarding languages L_1 and L_2

(A) $L_1 + L_2$ are context free

(B) L_1 is CFL but L_2 is *RL*

(C) L_1 is CFL but L_2 is not *CSL*

(D) None

Q.11 The language $L = \left\{ \begin{matrix} a^N b^N \mid 0 < N \\ < 327^{\text{th}} \\ \text{prime number} \end{matrix} \right\}$ is

(A) Regular
(B) Non context sensitive
(C) Not recursive
(D) None

Q.12 Let $\sum = \{0,1\}$
What will be the number of states in minimal *DFA*, if the Binary number string is congruent to (mod 8)

(A) 8 (B) 9
(C) 7 (D) 4

Q.13 What are the number of final states in Minimal *DFA*, where $\sum = \{a,b\}$, if every string starts with 'aa' and length of string is not congruent to 0 (mod 4),

(A) 7 (B) 6
(C) 3 (D) 5

Q.14 How many *DFA* with four states can be constructed over the alphabet $\sum = \{a,b\}$ with designated initial state?

(A) $4^{16} * 2^4$ (B) 2^{20}
(C) 2^{16} (D) 2^{24}

Q.15 Let $\sum = \{a\}$, assume language, $L = \left\{ a^{2023\text{K}} \mid K > 0 \right\}$, what is minimum number of states needed in a *DFA* to recognize L?

(A) $2^{2023} + 1$ (B) 2024
(C) 2^{2023} (D) None

Q.16 What type of grammar is this most accurately described as?

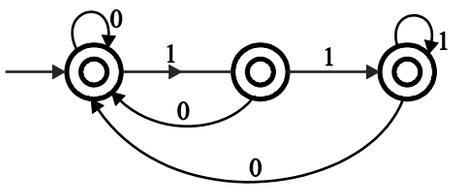
$S \to b \mid aD$
$D \to a \mid aDD$

(A) Regular grammar
(B) CFG
(C) CSG
(D) Type-0

Q.17 Let $M = (Q, \sum, \delta, q_0, F)$ and $M' = (Q, \sum, \delta, q_0, Q - F)$ where M accepts L and M' accepts L' and M is *NFA*, what could be the relation between L and L'?

(A) $L + L'$ are complement to each other
(B) $L + L'$ are similar to each other
(C) $L + L'$ relation cannot be predicted
(D) None of the above

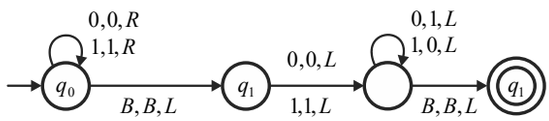
Q.18



The *DFA* above accepts :

(A) The set of all strings containing two consecutive 1's
(B) $(0+1)^*$
(C) Set of all strings not containing two consecutive 1's
(D) Set of all strings containing two consecutive 0's

Q.19



Consider *TM* :
If input strings 1000, what will be the output?

(A) 1100 (B) 1000
(C) 0111 (D) None

Q.20 Give the strongest correct statement about finite language over finite $\sum$?

(A) It could be undecidable
(B) It is Turing-recognizable
(C) It is CSL
(D) It is regular language.

Q.21 Let n_1 be the number of states in Minimal NFA of a partial language and n_2 be the DFA. Relation?

(A) $n_1 \geq n_2$ (B) $n_1 \leq n_2$

(C) $n_1 < n_2$ (D) $n_2 > n_1$

Q.22 S_1 : L is Regular, infinite union of L will also be regular

i.e. $(L^0 \cup L' \cup L^2 \ldots)$

S_2 : L is Regular, It's subset will also be regular.

(A) Both are true

(B) Both are false

(C) $S_1 \rightarrow \mathrm{T}, S_2 \rightarrow \mathrm{F}$

(D) $S_1 \rightarrow \mathrm{F}, S_2 \rightarrow \mathrm{T}$

Q.23 Consider $r = (11+111)^*$ over $\sum = \{0,1\}$. Number of states in Minimal NFA is X and in Minimal DFA is Y then X+Y=?

Q.24 Consider 2 Scenarios :

C_1 : For DFA $(\phi, \sum, \delta, q_0, F)$

if $F = \phi$, then $L = \sum^*$

C_2 : For NFA $(\phi, \sum, \delta, q_0, F)$

if $F = \phi$, then $L = \sum^*$

Where, $F =$ Final states set

$\phi =$ Total states set

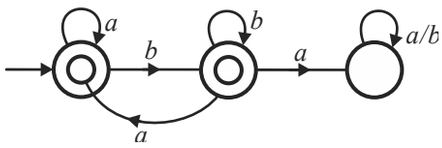
(A) Both are true

(B) Both are False

(C) C_1 is true, C_2 is false

(D) C_1 is false, C_2 is true

Q.25 Consider this FA :



How many strings will be there in the complement of the language accepted by this FA?

(A) Infinite (B) 2

(C) 3 (D) 0

Q.26 In programming language, and identifier has to be a letter followed by any number of letters or digits. If L and D denotes the sets of letter and digits respectively, examine the correct expressions?

(A) $(L \cup D)^*$ (B) $(L \cdot D)^*$

(C) $L \cdot (L \cup D)^*$ (D) $L \cdot (L \cdot D)^*$

Q.27 Total number of DFA possible with 2 states $q_0 \rightarrow$ start and non-final, $q_1 \rightarrow$ final over $\sum = \{a, b\}$ is

(A) 16 (B) 32

(C) 48 (D) 64

Q.28 $\sum = \{0,1\}, L = \sum^*, R = \{0^n 1^n \mid n \geq 1\}$

Language $L \cup R$ and R are respectively.

(A) Regular, Regular

(B) Regular, Not Regular

(C) Not Regular, No Regular

(D) Not Regular, Regular

Q.29 $L_1 = \{a^m \mid m \geq 0\}, L_2 = \{b^m \mid m \geq 0\}$

$L_1 \cdot L_2 = ?$

(A) $\{a^m b^m \mid m \geq 0\}$

(B) $\{a^m b^n \mid m, n \geq 0\}$

(C) $\{a^m b^n \mid m, n \geq 1\}$

(D) None

Q.30 Consider these statements:

S_1 : If a language is finite, it has to be non-Regular

S_2 : Let L be any language.

$(\bar{L})^* \neq (\overline{L^*})$

(A) Both are True

(B) Both are False

(C) $S_1 \rightarrow$ True, $S_2 \rightarrow$ False

(D) $S_1 \rightarrow$ False, $S_2 \rightarrow$ True

Q.31 Which of the following are not equivalent to expression $(a+b+c)^*$?

(A) $(a^* + b^* + c^*)^*$ (B) $\left((ab)^* + c^*\right)^*$

(C) $(a^*b^*c^*)^*$ (D) $(a^*b^* + c^*)^*$

Q.32 $M = (K, \sum, \delta, S, F)$ be a FA.

$K = \{A, B\}$ $F = \{B\}$

$\delta(A, a) = A$ $\delta(B, a) = B$

$\delta(A, b) = B$ $\delta(B, b) = A$

A Grammar $(V, \sum, P, S)$ is used to generate language accepted by M. Which set of rules will make $L(G) = L(H)$?

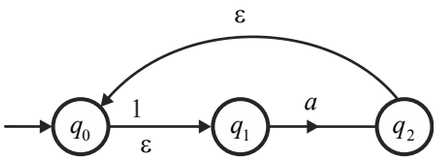
(A) $\left\{\begin{matrix} A \to aB, A \to bA, B \to bA, \\ B \to aA, B \to \varepsilon \end{matrix}\right\}$

(B) $\left\{\begin{matrix} A \to aA, A \to bB, B \to aB, \\ B \to bA, B \to \varepsilon \end{matrix}\right\}$

(C) $\left\{\begin{matrix} A \to bB, A \to aB, B \to aA, \\ B \to bA, B \to \varepsilon \end{matrix}\right\}$

(D) $\left\{\begin{matrix} A \to aA, A \to bA, B \to aB, \\ B \to bA, B \to \varepsilon \end{matrix}\right\}$

Q.33 Consider NFA :



What will be $\delta^*(q_0, a)$?

(A) $\{q_0, q_1, q_2\}$ (B) $\{q_1, q_2\}$

(C) $\{q_0, q_1\}$ (D) None

Q.34 $L_1 = \left\{a^m b^n \mid m+n = \text{Even}\right\}$

$L_2 = \left\{a^m b^n \mid m-n = 4\right\}$

(A) L_1 is Regular, L_2 is Not Regular

(B) Both are Regular

(C) Both are non-Regular

(D) L_2 is Regular, L_1 is Not Regular

Q.35 Let r be any Regular expression :

$S_1 \to r + \phi = r = \phi + r$

$S_2 \to r + \varepsilon = r = \varepsilon + r$

(A) Both are true

(B) Both are false

(C) $S_1 \to \text{T}, S_2 \to \text{F}$

(D) $S_1 \to \text{F}, S_2 \to \text{T}$

Q.36 L_1 = Set of all strings having equal number of 00 and 11.

L_2 = Set of all strings having equal number of 01 and 10.

(A) Both are regular

(B) Both are Context-free

(C) L_1 is regular, L_2 is CFL

(D) L_1 is CFL, L_2 is Regular

Q.37 Suppose a language L is accepted by LBA then,

(A) A always halts on all input's as L is decidable

(B) L may be undecidable as A need not half on all input.

(C) L need not be context-sensitive language

(D) None

Q.38 Suppose there exist a NPDA of language L. Then

(A) There always exist a DPDA for L

(B) There doesn't exist a DPDA for L

(C) There may or may not exist a DPDA for L

(D) None

Q.39 $L \subseteq \sum^*$ is said to be co-finite *iff* their complement is finite. What can you say?

(A) All co-finite language are regular

(B) There exist a co-finite language which is not context free

(C) There exist a co-finite language which is not decidable.

(D) None

Q.40 Suppose L is a CFL, then $\overline{L}$

(A) is necessarily context-free

(B) is necessarily non-context free

(C) is necessarily context-sensitive but nor recursive

(D) is necessarily Recursive.

Q.41 Let G be grammar in CNF. Let $W_1W_2 \in L(G)$ such that $|W_1| < |W_2|$

(A) Any derivation of W_1 has exactly same number of steps as any derivation of W_2

(B) Some derivation of W_2 may be shorter than of steps as any derivation of W_1

(C) All derivation of W_1 will be shorter than any derivation of W_2

(D) None

Q.42 Consider an ambiguous grammar G and its disambiguated version D. Let the language recognized by them are $L(G)$ and $L(D)$ respectively. Which one is true?

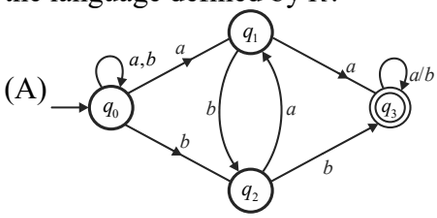
(A) $L(D) < L(G)$ (B) $L(G) < L(D)$

(C) $L(D) = L(G)$ (D) $L(D)$ is empty

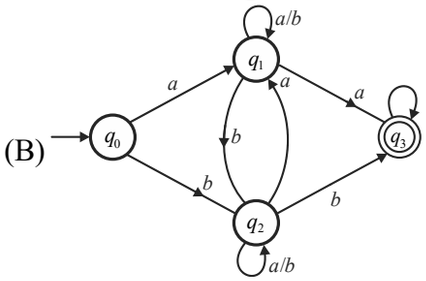
Q.43 Consider $R = (a+b)^*(aa+bb)(a+b)^*$

Which of the following NFA recognizes the language defined by R?

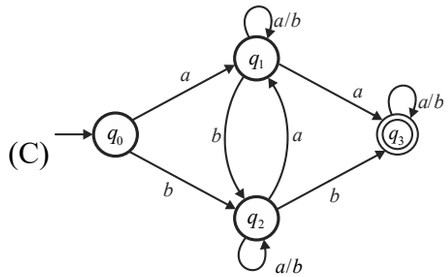
(A)



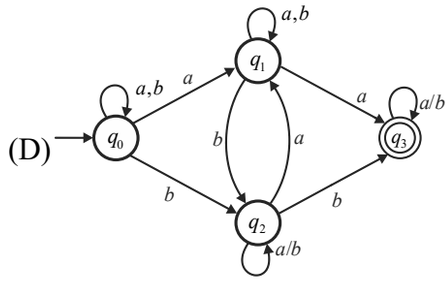
(B)



(C)



(D)



Q.44 For $n \geq 0, L_n = \{a^i b^k \mid i \geq n, 0 < k < i\}$

(A) L_n is regular, independent of value of n

(B) L_n is not regular, independent of value of n

(C) L_n is regular only for small value of n

(D) None of above

Q.45 Let L_1 be an infinite regular language. Let L_2 be an infinite set such that $L_2 \subset L_1$.

(A) L_2 is definitely regular because L_1 is Regular.

(B) L_2 is Never regular because L_2 is infinite.

(C) L_2 may or may not be regular

(D) None of above

Q.46 Consider $L_1 \cdot L_2 \subseteq \Sigma^*$ such that L_1 and $L_1 \cup L_2$ are Regular.

(A) L_2 is definitely Regular

(B) L_2 may not be regular.

(C) L_2 is context free

(D) None of above

Q.47 W^R denotes the Reverse of W. For $L \subseteq \sum^*, L^R = \{W^R \mid W \in L\}$

Suppose L^R is not regular. Then,

(A) L is definitely regular

(B) L may or may not be regular

(C) L is definitely not regular

(D) None of above

Q.48 Consider these 2 statements :

$S_1 : a^* \cdot \phi = a^*$

$S_2 : \phi^k = \phi$

(A) Both are False

(B) Both are True

(C) $S_1 \to \text{T}, S_2 \to \text{F}$

(D) $S_1 \to \text{F}, S_2 \to \text{T}$

Q.49 Statement I : L_i be regular language $i = 1, 2, \ldots \infty$

Language $n_{i=1}^{\infty} L_i$ is regular i.e. infinite intersection

Statement II :

$L = \{WX \mid W \in \sum^*, |W| = |X|\}$ is regular.

(A) Both are True

(B) Both are False

(C) $S_1 \to \text{True}, S_2 \to \text{False}$

(D) $S_1 \to \text{False}, S_2 \to \text{True}$

Q.50 Let the class of languages accepted by finite state machine be L_1 and the class of Languages represented by regular expression be L_2 then.

(A) $L_1 < L_2$ (B) $L_1 \geq L_2$

(C) $L_1 \cup L_2 = \sum^*$ (D) $L_1 = L_2$

Q.51 Regular Grammar is/are : **[MSQ]**

(A) CFL (B) CSG

(C) Type-0 (D) none

Q.52 Which of the following is/are True? **[MSQ]**

(A) $(01)^*0^* = 0(10)^*$

(B) $(01)^*0 = 0(10)^*$

(C) $(0+1)^*(0+1)^* \mid (0+1)^* = (0+1)^*01(0+1)^*$

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

Q.53 FSM with output capability can be used to add two given integer in binary representation. This is

(A) True

(B) False

(C) May be True

(D) None of the above

Q.54 Number of states require to simulate a computer with memory capable of storing '3' words each of length '8'

(A) $3^{(2*8)}$ (B) $3^{(3*8)}$

(C) $3^{(3+8)}$ (D) None

Q.55 How many DFA'S exits with 3 states over input alphabet $\sum = \{0,1\}$?

(A) 16 (B) 26

(C) 32 (D) 5832

Q.56 Regular expression for all strings starts with *ab* and ends with *bba* is

(A) aba^*b^*bba

(B) $ab(ab)^*bba$

(C) $ab(a+b)^*bba$

(D) All of the above

Q.57 String W is accepted by finite automata if (A is the acceptance state)

(A) $\delta^*(Q, W) \in A$

(B) $\delta(Q, W) \in A$

(C) $\delta^*(Q_0, W) \in A$

(D) $\delta(Q_0, W) \in A$

Q.58 $\delta^*(q, Ya)$ is equivalent to

(A) $\delta\big((q, Y), a\big)$

(B) $\delta\big(\delta^*(q, Y), a\big)$

(C) $\delta(q, Ya)$

(D) independent from δ rotation

Q.59 Extended transition function is

(A) $Q \times \Sigma^* \to Q$

(B) $Q \times \Sigma \to Q$

(C) $Q^* \times \Sigma^* \to \Sigma$

(D) $Q \times \Sigma \to \Sigma$

Q.60 Definite $init(L) =$ {Set of all prefixes of L}

Let, $L = \left\{ \begin{matrix} W / W \text{ has equal number} \\ \text{of 0's and 1's} \end{matrix} \right\}$

$init(L)$ is

(A) all binary strings with unequal number of 0's and 1's

(B) all binary strings with ε-string.

(C) all binary strings with exactly one more 0 than the number of 1's or one more 1 than number of 0's

(D) None of above

Q.61 Consider regular grammar :

$S \to bS \mid aA \mid \varepsilon$

$A \to aS \mid bA$

Myhill-Nerode equivalence classes for language generated by grammar are

(A) $\{W \in (a+b)^* \mid \#_a(W) \text{ is even}\}$

(B) $\{W \in (a+b)^* \mid \#_b(W) \text{ is even}\}$ and $\{W \in (a+b)^* \mid \#_b(W) \text{ is odd}\}$

(C) $\{W \in (a+b)^* \mid \#_a(W) = \#_b(W)\}$ and $\{W \in (a+b)^* \mid \#_a(W) \neq \#_b(W)\}$

(D) $\{\varepsilon\}, \left\{ \begin{matrix} Wa \mid W \in (a+b)^* \\ \text{and } W_b \mid W \in (a+b)^* \end{matrix} \right\}$

Q.62 Consider the CFG below :

$S \to aSAb \mid \varepsilon$

$A \to bA \mid \varepsilon$

Grammar Generates

(A) $(a+b)^*b$

(B) $a^m b^n \mid m \leq n$

(C) $a^m b^n \mid m = n$

(D) a^*b^*

Q.63 Which of the following statements about regular language is true? **[MSQ]**

(A) Every language has a regular subset

(B) Every language has a regular superset

(C) Every subset of regular language is regular

(D) Every subset of finite language is regular

Q.64 Which of the following is accepted by NPDA but not by DPDA?

(A) $\{a^n b^n c^n \mid n \geq 0\}$

(B) $\{a^n b^n \mid n \geq 0\}$

(C) $\{a^n b^m \mid m, n \geq 0\}$

(D) $\{a^i b^j c^k \mid i \neq j \text{ or } j \neq k\}$

Q.65 Let L be CFL and M be a Regular language. Language $L \cap M$ is always

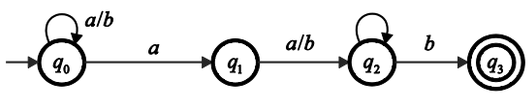
(A) always Regular

(B) never regular

(C) always DCFL

(D) always CFL

Q.66 R.E but describing this below NFA?



(A) $(a+b)^*a(a+b)b$

(B) $(a+b)^*a(a+b)b$

(C) $(a+b)^*a(a+b)b(a+b)^*$

(D) $(a+b)^*$

Q.67 Consider of CFG

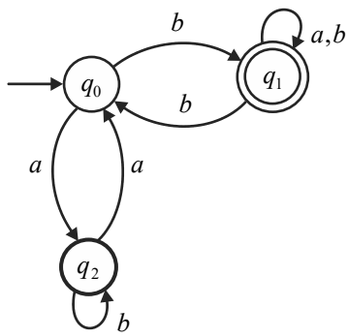
$S \to aSa \mid bSb \mid a \mid b \mid \varepsilon$

Which of the following strings is NOT generated by grammar?

(A) *aaaa* (B) *baba*

(C) *abba* (D) *baba abab*

Q.68



Consider $u = abbaba$

$v = bab$

$w = aabb$

(A) It accepts *u*, *v* but not *w*

(B) It accepts all

(C) It rejects all

(D) It rejects u only

Q.69 If L_1 and L_2 are Turing-Recognizable then $L_1 \cup L_2$ will be

(A) Decidable

(B) Turing recognizable but may not be decidable

(C) May not be Turing recognizable

(D) None of above

Q.70 Which of the following is true for input alphabet $\sum$ and tape alphabet Γ of a standard T_M ?

(A) It is possible for $\sum$ and Γ to be equal.

(B) Γ is always a strict superset of $\sum$

(C) It is possible for $\sum$ and Γ to be disjoint.

(D) None

Q.71 Language

$$L = \left\{ \begin{matrix} a^n b^n W \mid n \geq 0, \\ W \in \{c,d\}^*, |W| = \text{constant} \end{matrix} \right\} \text{ is}$$

(A) Regular

(B) DCFL

(C) CFL

(D) Non Context-free

Q.72 $L = \left\{ \begin{matrix} a^i b^j c^k d^m \mid i+j+ \\ k+m \text{ is multiple of } 13 \end{matrix} \right\}$ L is?

(A) Regular

(B) Context-free

(C) Turing-decidable

(D) Turing Recognizable

Q.73 S_1 : A non-deterministic T_m can decide language that a standard T_m cannot decide.

S_2 : L be a Context free language. $\overline{L}$ is turing-decidable.

(A) Both are True

(B) Both are False

(C) $S_1 \to$ True, $S_2 \to$ False

(D) $S_1 \to$ False, $S_2 \to$ True

Q.74 $\gamma_1 = (01+1)^*(\varepsilon+0)$

$\gamma_2 = (0+\varepsilon)(10+1)^*$

(A) Both represent same language.

(B) r_1 represent strings with no consecutive 00 and

r_2 represent strings with no consecutive 11.

(C) r_1 represents strings with no consecutive 11 and

r_2 represents strings with no consecutive 00

(D) None of above

Q.75 Consider this

$S_1 : r_1 = (\varepsilon + a + b)^{100}$ represents strings of length strictly less than 100.

$S_2 : r_2 = (00+11+01+10)^*(0+1)$ represents all odd length strings.

(A) Both are True

(B) Both are False

(C) $S_1 \rightarrow$ True, $S_2 \rightarrow$ False

(D) $S_1 \rightarrow$ False, $S_2 \rightarrow$ True

Q.76 Consider this R.E $= (0+1)^*(00+11)$

What will be the number of states in minimal DFA and NFA?

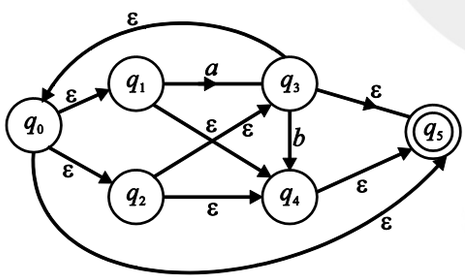
(A) DFA-5, NFA-5

(B) DFA-5, NFA-4

(C) DFA-4, NFA-4

(D) None

Q.77 Consider the following NFA



Find the epsilon closure of state q_2 :

(A) $\{q_4, q_3, q_5\}$ only

(B) $\{q_3, q_4\}$ only

(C) $\{q_0, q_5\}$ only

(D) $\{q_0, q_1, q_2, q_3, q_4, q_5\}$ only

Q.78 Which of the following statements are True?

S_1 : Every Left recursive grammar can be converted to right recursive grammar and vice-versa.

S_2 : All ε-production can be removed from any context free grammar.

S_3 : An Unambiguous Context free grammar always has a unique parse tree for each string of the language generated by it.

(A) Only S_1 and S_2

(B) Only S_1 and S_3

(C) Only S_2 and S_3

(D) S_1, S_2 and S_3

Q.79 If string of length 10 is used to test for membership, then the number of table entries in CYK algorithm is

(A) 50 (B) 55

(C) 45 (D) 99

Q.80 Let $< M >$ be the encoding of Turing machine as a string over $\sum = \{0,1\}$, Let

$$L = \left\{ \begin{matrix} < M > | \, M \text{ is } T_m \\ \text{on input } W \text{ will} \\ \text{visit some state } P \end{matrix} \right\}.$$

The language L is

(A) Decidable

(B) Undecidable and not even partially decidable.

(C) Undecidable and not even partially decidable

(D) Not a decision problem

Q.81 Let $L \leq_m L'$ denote the language L is mapping reducible (Many to one reducible) to language L'. Which one of the following is true?

(A) If $L \leq_p L'$ and L' semi-decidable then L is semi-decidable

(B) If $L \leq_p L'$ and L is RE then L' is RE.

(C) If $L \leq_p L'$ and L is decidable then L' decidable.

(D) If $L \leq_p L'$ and L is recursive.

Q.82 Let L be the language containing only the string S where

$$S = \begin{cases} 0 & \text{if you will never clear the gate} \\ 1 & \text{if you will clear the gate some day} \end{cases}$$

Which of the following is true? (L' is the complement of language L)

(A) L is decidable

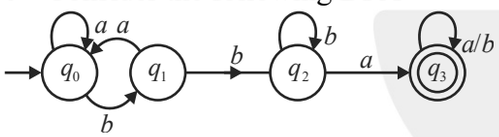
(B) L' is decidable

(C) L and L' both are decidable

(D) L is undecidable

Q.83 If G is a Context free grammar and W is a string of length 10 in $L(G)$. The length of derivation of W in G, if G is in Chomsky normal form is _____.

Q.84 Consider the following DFA



The number of strings upto length 5 where first and last character of string is 'a' are _____.

Q.85 Which of the following is True?

(A) Complement of CSL is CSL

(B) Complement of CFL is CFL

(C) Complement of RE is RE

(D) Complement of non-CFL Can't be CFL

Q.86 Consider the following statements

1. The complement of every Turing recognizable language is Turing recognizable
2. Deciding if a given string is generated by a given Context free grammar is decidable.

Which of the above statements are correct?

(A) Only 1

(B) Both 1 and 2

(C) Only 2

(D) Neither 1 nor 2

Q.87 Consider the following language $L = \{W \in (a+b)^* \mid W$ has atleast as many occurrences of $(bba)'s$ as $(abb)'s\}$. Which of the following is/are true? **[MSQ]**

(A) L is regular

(B) Complement of L is CFL

(C) Complement of L is CSL

(D) Reversal of L is CFL

Q.88 Consider the following Grammar G.

$G: S \to XC \mid AY$

$X \to aXb \mid \in$

$C \to cC \mid c$

$A \to aA \mid a$

$Y \to bYc \mid \in$

Which of the following is correct?

(A) G is ambiguous but $L(G)$ is not inherently ambiguous.

(B) G is ambiguous but $L(G)$ is inherently ambiguous.

(C) G is not ambiguous but $L(G)$ is not inherently ambiguous.

(D) None of the above

Q.89 Consider the language

$L_1 = \{0^n 1^n 2^m \mid n, m \geq 0\}$ and

$L_2 = \{0^n 1^m 2^m \mid n, m \geq 0\}$

Which of the following statements is True? (L^c is the complement of L)

(A) $L_1 \cap L_2$ is CSL

(B) $L_1 \cap L_2$ is CFL

(C) $L_1^c \cdot L_2^c$ is CFL

(D) None of these

Q.90 Consider the following context free grammar G :

$G: R \to XRX \mid S$

$S \to aAb \mid bAa$

$A \to XAX \mid X \mid \varepsilon$

$X \to a \mid b$

Which of the following correctly describes the above grammar G?

(A) $L(G)$ contain all strings over 'a' and 'b' that are palindrome only.

(B) $L(G)$ contain all strings will equal number 'a' and 'b' only.

(C) $L(G)$ contain all strings will equal number of 'a' and but different of 'b' only.

(D) None of the above.

Q.91 Let $L_1 = a*b*$ and $L_2 = \{ab\}$, $L_3 =$ Prefix $(L_1^* \cap L_2)$, where prefix $(L) = \{U \mid uv \in L \text{ for any } V\}$.

The number of strings in L_3 is _____.

Q.92 Which of the following does not perform with the help of Turing machine?

(i) Addition of two Numbers i.e., $f(m,n) = m+n$

(ii) Multiplication of two Numbers i.e., $f(m,n) = m \times n$

(iii) Acceptance of language $L = \{W/W \in (a,b)^*\}$

(iv) Acceptance of language $L = \{a^n b^n c^n d^n e^n \mid n \geq 1\}$

(A) i and ii

(B) iii and iv

(C) iii only

(D) None of these.

Q.93 Which one of the following is a DCFL?

(A) $L = \{a^n b^n c^n \mid n > 1000\}$

(B) $L =$ Set of all balanced parenthesis

(C) $L = \{WW^R \mid W \in (a,b)^*\}$

(D) All of these

Q.94 Let G and G_1 be a CFG with productions

$G: \; S \to S+S \mid S*S \mid (S) \mid a$

$G_1: \; S \to S+\mathrm{T} \mid \mathrm{T}$

$\mathrm{T} \to \mathrm{T}*\mathrm{F} \mid \mathrm{F}$

$\mathrm{F} \to (S) \mid a$

Then which of the following is true?

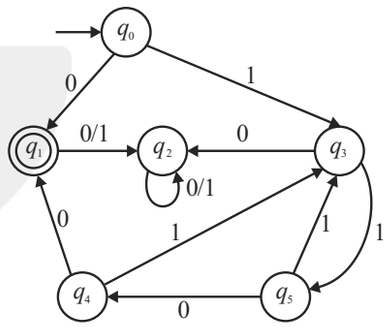
(A) $L(G) \neq L(G_1)$

(B) $L(G_1) \subseteq L(G)$

(C) $L(G) \subset L(G_1)$

(D) $L(G) = L(G_1)$

Q.95 Which of the following language is accepted by the following finite automata?



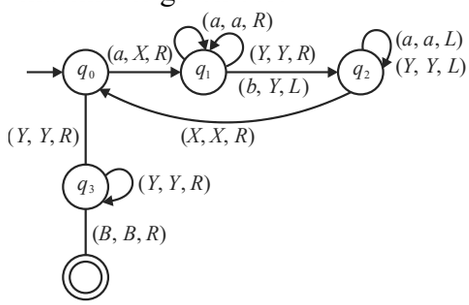
(A) $(110)*01$

(B) $0+(1(11)*10)^+0$

(C) $0+(1(11)*101)^+0$

(D) $(11+10)*01$

Q.96 The transition diagram for Turing machine is given below :



Which of one of the following strings is accepted by the above *TM*?

(A) *aabbb* (B) *aabb*

(C) *abbb* (D) None

Q.97 Which of the following is TRUE?

(A) The equality problem $(L_1 = L_2)$ of CFLs is decidable

(B) The emptiness of CSL'S is decidable

(C) The Finiteness of CFL is decidable

(D) IS $L_1 \cap L_2 = \phi$ is decidable for CSL's.

Q.98 Consider the following languages :

$L_{ne} = \{< M > | L(M) \neq \phi\}$

$L_e = \{< M > | L(M) = \phi\}$

Where $< M >$ denotes encoding of a *TM M*. Then which one of the following is TRUE?

(A) L_{ne} is r.e. but not recursive and L_e is not r.e.

(B) Both are not r.e.

(C) both are recursive

(D) L_e is r.e. but not recursive and L_{ne} is not r.e.

Q.99 Finite automata can be used in

(A) Lexical Analysis

(B) Syntax Analysis

(C) Semantic Analysis

(D) None of these

Q.100 Let $L = \{ab, aa, baa\}$

Which of the following are not in L^*?

(A) *abaa b aaaa*

(B) *aaaa baaaa*

(C) *baaaaabaa*

(D) *baaaabaaababa*

Q.101 The minimum number of states are required for Turing machine as unary to binary conversion is

(A) 7 (B) 5

(C) 3 (D) 9

Q.102 Consider the following languages

(I) $[a^m b^n c^p d^q \mid m + p = n + q$ where $m, n, p, q \geq 0]$

(II) $[a^m b^n c^p d^q \mid m = n$ and $p = q$ where $m, n, p, q \geq 0]$

(III) $[a^m b^n c^p d^q \mid m = n = p$ and $p \neq q$ where $m, n, p, q \geq 0]$

(IV) $[a^m b^n c^p d^q \mid m.n = p + q$ where $m, n, p, q \geq 0]$

Which of the above language are context free?

(A) I & IV only (B) I & II only

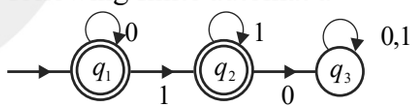
(C) II & III only (D) II & IV only

Q.103 For $\Sigma = [a, b]$, find the minimum number of states are is DFA for all strings in which 3rd symbol from right hand side is

(A) 6 (B) 7

(C) 9 (D) 8

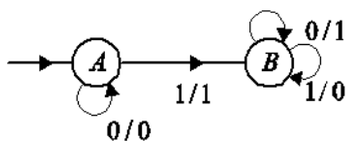
Q.104 Find the regular expression for the following finite automat a



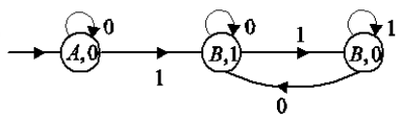
(A) 0^+1^* (B) 0^*

(C) 1^* (D) 0^*1^*

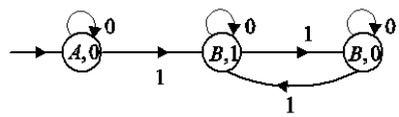
Q.105 Mealy to Moore equivalent circuit



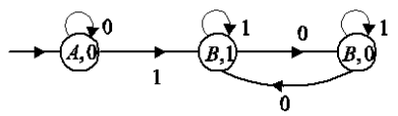
(A)



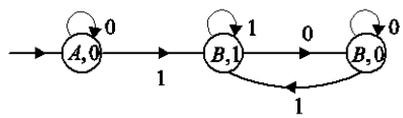
(B)



(C)



(D)



Answers Theory of Computation

1.	2	2.	5	3.	1	4.	5	5.	D
6.	A,C,D	7.	C	8.	A	9.	1	10.	A,C
11.	A	12.	A	13.	C	14.	B	15.	B
16.	B	17.	C	18.	B	19.	B	20.	D
21.	B	22.	B	23.	7	24.	C	25.	D
26.	C	27.	A	28.	B	29.	B	30	D
31.	B	32.	B	33.	A	34.	A	35.	C
36.	B	37.	A	38.	C	39.	A	40	D
41.	C	42.	C	43.	A	44.	B	45.	C
46.	B	47.	C	48.	A	49.	D	50.	D
51.	A,B,C	52.	B,D	53.	A	54.	B	55.	D
56.	C	57.	C	58.	B	59.	A	60.	B
61.	A	62.	B	63.	A,B,D	64.	D	65.	D
66.	A	67.	B	68.	B	69.	B	70.	B
71.	B	72.	C	73.	D	74.	A	75.	F
76.	B	77.	D	78.	B	79.	B	80.	B
81.	A	82.	C	83.	19	84.	6	85.	A
86.	C	87.	A,B,C,D	88.	B	89.	A	90.	D
91.	3	92.	C	93.	B	94.	D	95.	B
96.	B	97.	C	98.	A	99.	A	100.	D
101.	C	102.	A	103.	D	104.	D	105.	A

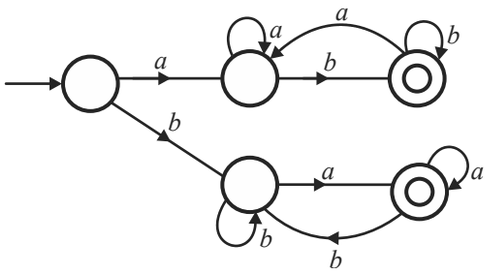
1. **2**

Trivial substring of any string always 2, ε and string itself.

Hence, the correct answer is 2.

2. **5**

$L = \{ab, ba, \ldots\}$



Hence, the correct answer is 5.

3. **11**

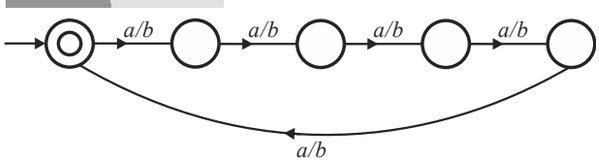
Number of substrings $= \frac{n(n+1)}{2} + 1$

[Where n is the length of substring]

$= \frac{4 \times 5}{2} + 1 = 11$

Hence, the correct answer is 11.

4. **5**



Hence, the correct answer is 5.

5. **(D)**

When we convert *NFA* with N states into *DFA* then *DFA* have maximum 2^N states.

Hence, the correct option is (D).

6. **(A,C,D)**

A. $S \to AB$
$\to BBB$
$\to ABBB$
$\to aBBB$
$\to aABBB$
$\to aabbb$

B. $S \to AB$
$\to aB$
$\to aAB$
$\to aBBB$
$\to abBB$
$\to abABB$
$\to abaBB$
$\to ababAB$
$\to ababab$

C. $S \to AB$
BBB
$ABBB$
$abbb$

Hence, the correct option are (A,C,D).

7. **(C)**

A, B and D Generate the same language.

Hence, the correct option is (C).

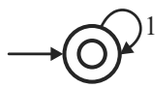
8. **(A)**

The complementation of CFL is not always CFL, but it must be recursive language

Hence, the correct option is (A).

9. **1**

$L = \{\varepsilon, 1, 11, 111, 1111, \ldots\}$



Hence, the correct answer is 1.

10. **(A,C)**

$L_1 = \{a^n b^n \mid n \geq 0\}$ this is *DCFL* we can construct *DPDA* for this.

$L_2 = \underbrace{\{a^m b^m \mid m \neq n\}}_{DCFL} \cup \underbrace{(a+b)^* ba(a+b)^*}_{RL}$

$= DCFL$

Hence, the correct option are (A,C).

11. **(A)**

Given language is finite and every finite language is regular.

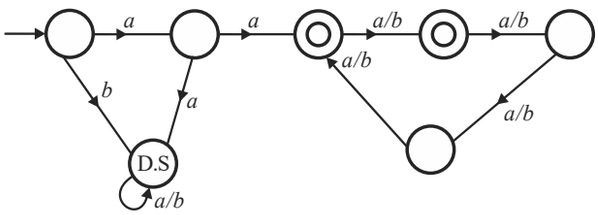
Hence, the correct option is (A).

12. (A)

$x \bmod n$, if $n =$ even and $n = 2^m$ then number of states in $NDFA = m+1$

Hence, the correct option is (C).

13. (C)



Hence, the correct option is (B).

14. (B)

$2^n \times 2^{n \times m}$ number of *DFA* possible with *n* states and *m* input alphabet

$= 2^4 * 4^{4\times 2} = 2^4 \times 2^{16} = 2^{20}$

Hence, the correct option is (B).

15. (B)

Hence, the correct option is (B).

16. (B)

Type-3

$A \to aB \mid a$ where $a \in T*$

or

$A \to Ba \mid a$ $\quad A, B \in V$

Type-2

$A \to \alpha,$ where $\alpha \in (V+T)*$

$A \in V$

Type-1

$\alpha \to \beta \quad \alpha \in (V+T)* \forall (V+T)*$

and

$|\alpha| \le |\beta| \quad \beta \in (V+T)*$

Type-0

$\alpha \to \beta$

$\alpha \in (V+T)* \forall (V+T)*$

$\beta \in (V+T)*$

Hence, the correct option is (B).

17. (C)

Complement of *NFA* does not exist.

Hence, the correct option is (C).

18. (B)

A. False it accepts ε.

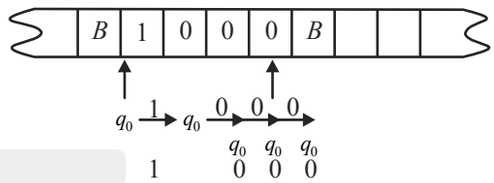
B. True

C. False it accepts $\varepsilon, 0, 1$

D. False it accepts $\varepsilon, 0, 1$

Hence, the correct option is (B).

19. (B)



Hence, the correct option is (B).

20. (D)

Finite language always regular.

Hence, the correct option is (D).

21. (B)

When we create NFA with N state into DFA then DFA have $\le 2^N$ states.

Hence, the correct option is (B).

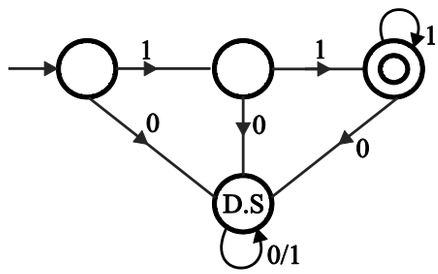
22. (B)

Regular languages are not closed under infinite union and subset operations.

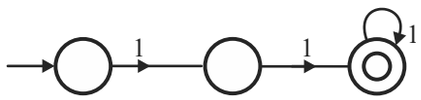
Hence, the correct option is (B).

23. 7

DFA

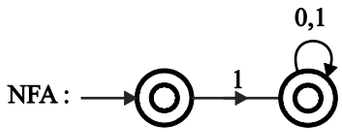


NFA



Hence, the correct answer is 7.

24. (C)



$L(NFA) \neq \sum^*$

Hence, the correct option is (C).

25. (D)

$L(FA) = (a+b)^*$

$\bar{L} = *\{\}$

Hence, the correct option is (D).

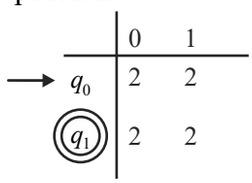
26. (C)

R.E $= L \cdot (L+D)^*$

Hence, the correct option is (A).

27. (A)

16 DFA'S are possible



Total $= 2 \times 2 \times 2 \times 2 = 16$

Hence, the correct option is (A).

28. (B)

$L \cup R \rightarrow$ Regular

$L \rightarrow$ CFL

Hence, the correct option is (B).

29. (B)

$L_1 = \{a^m \mid m > 0\}$

$L_2 = \{b^m \mid m > 0\}$

In individually they both have power terms is m, but if we concatenate it. i.e.,

$L_1.L_2 = \{a^m b^n \mid m,n \geq 0\}$

Because they both languages have not any type of relation is given so in this case, they both power terms must be different

Hence, the correct option is (B).

30. (D)

Infinite can also be regular $\rightarrow a^*$

$(\bar{L})^*$ will surely contain ε

but $(\overline{L^*})$ will not contain ε

So, they are not equal.

Hence, the correct option is (D).

31. (B)

Option (A): $(a^* + b^* + c^*)^*$

According to regular expression closure identities.

It can also generates all possible combination of a, b & c including ε

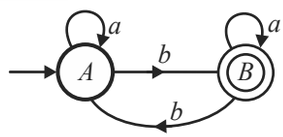
Option (B): $((ab)^* + c^*)^*$

It cannot generate only a's combination b's combination

Option C & D, can also generate all possible combination of a, b & c including ε .

Hence, the correct option is (B).

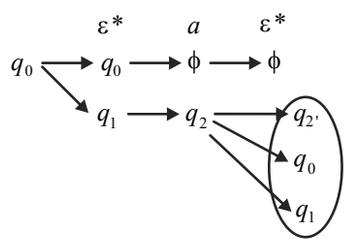
32. (B)



Hence, the correct option is (B).

33. (A)

$\delta^*(q_0, a) =$



Hence, the correct option is (A).

34. **(A)**

$$R=(aa)^*(bb)^*+a(aa)^*b(bb)^*=L_1$$

L_2 involves infinite counting so not regular

Hence, the correct option is (A).

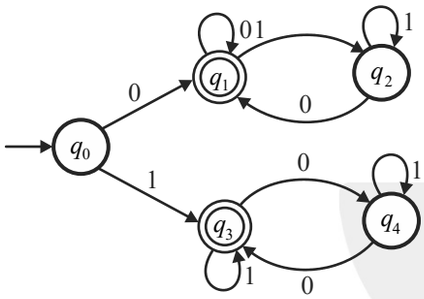
35. **(C)**

r may not contain ε, So $r+\varepsilon \neq r$

Hence, the correct option is (C).

36. **(B)**

L_2 is important and specific case.



Hence, the correct option is (B).

37. **(A)**

All CSL'S are decidable.

Hence, the correct option is (A).

38. **(C)**

If DPDA is possible for L, surely NPDA can also be made.

Hence, the correct option is (C).

39. **(A)**

If complement is finite $\rightarrow L^c$ is Regular So, L has to be Regular.

Hence, the correct option is (A).

40. **(D)**

Using closure properties.

Hence, the correct option is (D).

41. **(C)**

Derivation always required $2n-1$ steps in CNF.

$n=$ Length of string.

Hence, the correct option is (C).

42. **(C)**

Both grammar Generate same language

Hence, the correct option is (C).

43. **(A)**

44. **(B)**

b is depending on a and number of $a's$ are unbounded.

Hence, the correct option is (B).

45. **(C)**

Take $L_1=(a+b)^*$

L_2 can be 0^n1^n

Hence, the correct option is (C).

46. **(B)**

Take $L_1=(a+b)^*, L_2$ could be either regular or non-regular.

Hence, the correct option is (B).

47. **(C)**

If L^R is Regular, L has to be regular.

Hence, the correct option is (C).

48. **(A)**

$$\phi^k=\varepsilon$$

$$a^k\cdot\phi=\phi$$

Hence, the correct option is (A).

49. **(D)**

For S_1, take

All non-primer I am taking

After taking their intersection, U will get like this.

$$L=\{a^p \mid p \text{ is prime}\}$$ i.e. not regular.

For S_2 : L is nothing but language of even length strings.

$$\text{R.E}=(00+01+10+11)^*$$

So, L is regular.

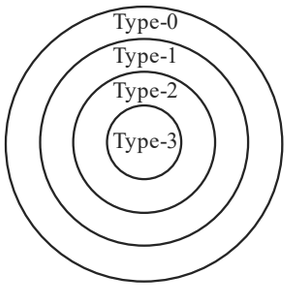
Hence, the correct option is (D).

50. (D)

Finite state machine and Regular expression have same power to express a language.

Hence, the correct option is (D).

51. (A,B,C)



Hence, the correct option are (A,B,C).

52. (B,D)

53. (A)

Use them as a flip flop output.

Hence, the correct option is (A).

54. (B)

Here each state in a FSM can store one bit. So we need to find the number of bits required in this case. Consider the M words as segments of memory and each word is divided into n bits. So, the total number of bits are $m*n$. and each bit can be in two states. Hence the answer is 2^{m*n}.

Hence, the correct option is (B).

55. (D)

Number of DFA'S $= 2^3 * 3^{3\times 2} = 5832$

Hence, the correct option is (D).

56. (C)

Starts with ab then any number of a or b and ends with bba.

Hence, the correct option is (C).

57. (C)

If automata starts with starting state and after finite moves if reaches to final step then it called accepted.

Hence, the correct option is (C).

58. (B)

First it parse Y string after that it parse a.

Hence, the correct option is (B).

59. (A)

This takes single state and string of input to produce a state.

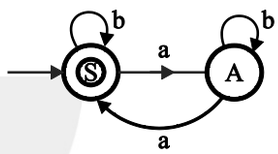
Hence, the correct option is (A).

60. (B)

$$init(L) = (a+b)*$$

Hence, the correct option is (B).

61. (A)



Myhill-Nerode equivalence classes are actually the number of states in FA

Hence, the correct option is (A).

62. (B)

Verify using aab. It is getting rejected.

Hence, the correct option is (B).

63. (A,B,D)

A. True if $L = (a+b)*$

$L_1 = \phi$

$L_1 \subset (a+b)*$

B. True if $L =$ any language over $\sum = \{a,b\}$

$L_1 = (a+b)* -$ Regular

$L_1 \supset L$

C. False if $L = (a+b)*$

$L_1 = a^n b^n \mid_{n\geq 0}$ not regular & $L_1 \subset L$

D. True every finite language is regular.

Hence, the correct option are (A,B,D).

64. (D)

(*a*) is CSL

b and *c* are accepted by DPDA.

Hence, the correct option is (D).

65. (D)

According to closure property.

Hence, the correct option is (D).

66. (A)

(*b*) is not because *aab* is rejected.

Hence, the correct option is (A).

67. (B)

Language of palindromes it is.

Hence, the correct option is (B).

68. (B)

69. (B)

We can build a T_m for union but decidability may not always be guaranted.

Hence, the correct option is (B).

70. (B)

Γ always contains members of $\sum$ and special Block

Symbol also, which is not in $\sum$.

Hence, the correct option is (B).

71. (B)

Not possible to check for *W* as stack will be empty after checking for *a* and *b*.

Hence, the correct option is (B).

72. (C)

We just had 13 states to remainders $(0,1,\ldots 12)$.

We start by state with 0 remainder and as we visit new character, we change state to next remainder.

Hence, the correct option is (C).

73. (D)

S_1 : NTM $\cong$ DTM

$S_2 : \bar{L}$ is Recursive.

Hence, the correct option is (D).

74. (A)

Both are regular expression represents strings with no consecutive zeroes.

Hence, the correct option is (A).

75. (D)

$S_1 \rightarrow$ F

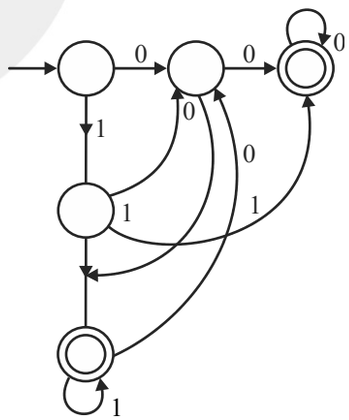
$S_2 \rightarrow$ T

r_1 represents strings of length at most 100.

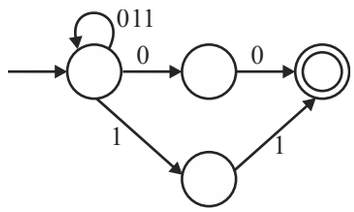
Hence, the correct option is (D).

76. (B)

DFA



NFA



Hence, the correct option is (B).

77. (D)

Null closure of any state are those state which are reachable only by ε-transition, i.e, here q_2 to q_3 and q_4 by ε-transition. From q_3 we can

reach q_0 and q_5 and from q_0 to q_1 by using ε-transition.

So ε-closure of q_2 is $\{q_0, q_1, q_2, q_3, q_4, q_5\}$

Hence, the correct option is (D).

78. (B)

Explanation : Statement S_1 and S_3 are True.

S_2 is false because all ε-production can be removed from grammar only when the language do not contain ε-string but if language contain ε-string then removal of the Null production is not possible.

Hence, the correct option is (B).

79. (B)

By theorem if n is the length of string to test for membership, then the number of table entries in CYK algorithm is $\frac{n(n+1)}{2}$

So, $\frac{10\times 11}{2} = 55$

Hence, the correct option is (B).

80. (B)

Language L is state entry problem, halting problem of Turing machine can be reduced to state entry problem.

Hence, the correct option is (B).

81. (A)

$L \leq_p L'$. Since L' is semi-decidable then L is semi-decidable is one way theorem.

Hence, the correct option is (A).

82. (C)

The language L is one of the two languages $\{0\}$, $\{1\}$.

In either case the language is finite only. Hence L is decidable. Since complement of decidable is decidable only.

So L and L' both are decidable.

Hence, the correct option is (C).

83. 19

$|W| = n$ then number of length of derivation of W in $G = 2n-1 = 2\times 10 - 1 = 19$

Hence, the correct answer is 6.

84. 6

String of one length $= 0 \rightarrow$ Not possible

String of two length $= 0 \rightarrow$ Not possible

String of three length $= bba$ — (1 string)

String of four length $= abba$ — (1 string)

String of five length $= abbba,\ abbaa,$

$abbab, aabba$ (4 strings)

Total 6 strings possible.

Hence, the correct answer is 6.

85. (A)

CSL closed under complement so complement of CSL is CSL RE and CFL are not closed under complement.

Complement of non-CFL can be CFL i.e.

$\{WW = \text{CSL}\}$, Complemen $=$ CFL

Hence, the correct option is (A).

86. (C)

1. Turing recognizable language are RE language which are not closed under complementation. So statement is false.

2. Second statement is True.

Hence, the correct option is (C).

87. (A,B,C,D)

There is no need to keep the number of $bba's$ in the memory because whenever two $abb's$ comes together (adjacent), then one $bba's$ always come between them, so language L is regular. Since Regular language is closed under complement reversal and regular language are subset of CSL and CFL.

Hence, the correct option are (A,B,C,D).

88. (B)

The grammar generates the following language.

$L(G) = \{a^n b^n c^m \mid n, m \geq 0\} \cup \{a^n b^m c^m \mid n, m \geq 0\}$

Hence, the correct option is (B).

89. (A)

The intersection of L_1 and L_2 is given by $L_1 \cap L_2 = \{0^n 1^n 2^n \mid n \geq 0\}$ which is well known CSL.

Hence, the correct option is (A).

90. (D)

Sometimes it generates equal number of a & b, but that is not true for all cases, sometimes number of a's and b's are not equal and also it cannot generate palindrome.

So, the correct option is D.

Hence, the correct option is (D).

91. 3

$$L_1 = a^*b^* \Rightarrow L_1^* = (a^*b^*)^* = (a+b)^*$$

$$L_2 = \{ab\}$$

$$L_1^* \cap L_2 = (a+b)^* \cap \{ab\} = \{ab\}$$

$$L_3 = \text{Prefix}(L_1^* \cap L_2) = \{\varepsilon, a, ab\}$$

Hence, the correct answer is 3.

92. (C)

$$L = \{W / W / (a,b)^*\}$$

We can't identify the boundary of language so cannot be accepted by T.M.

93. (B)

Option (A) is not CFL

Option (C) is NCFL

Option (B) is DCFL

Hence, the correct option is (B).

94. (D)

G_1 is the unambiguous expression of G.

Hence, the correct option is (D).

95. (B)

In the given DFA, state q_2 is the dead state. We obtain the following Regular Expression $0 + (1(11)^*10)^+ 0$ after removing the dead state.

Hence, the correct option is (B).

96. (B)

According to the given Turing machine diagram, we can clearly say that machine only accepts the language those number of a's are followed by same number of b's

So, **option (A)** - False because number of a's are not followed by same number of b's

Option (B) -Ture because number of a's are followed by same number of b's

Option (C)- False because number of a's are not followed by same number of b's

Option (D)- False because option B is correct

Hence, the correct option is (B).

97. (C)

According to Decidability Table.

Hence, the correct option is (C).

98. (A)

L_{ne} is r.e., since we can accept M, if M accepts a string.

Hence, the correct option is (A).

99. (A)

Finite automata is used during Lexical Analysis to recognize tokens.

Hence, the correct option is (A).

100. (D)

Option A (True)

{ab} {aa} {baa} {aa}

these all are L so it is generated

Option B (True)

{aa} {aa} {baa} {aa}

these all are L so it is also generated

Option C (True)

{baa} {aa} {ab} {aa}

these all are L so it is also generated

Option D (False)

{baa} {aa} {baa} {ab} {ab} a

but last term a is not in L so it cannot generated

Hence, the correct option is (D).

101. C

In unary

1–1

2–11

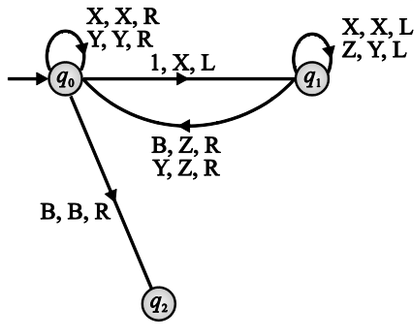
3–111

4–1111

5–11111

But in binary $0-Y, 1-Z$ according to the weight $[2^0, 2^1 --\text{etc}]$

So the turing machine for unary to binary is



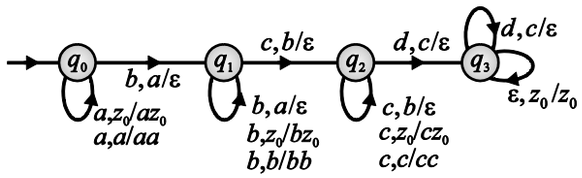
Here no final state so here minimum 3 states are required

102. A

If language is context free then we can construct a PDA pushdown automata

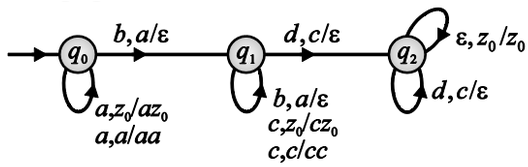
Option I: PUSH all a If b comes then pop all a and if a is finished and top symbol of stack is Z_0 then we push b

If c comes and top of the symbol is b then pop all b and is b is finished and top symbol of stack is Z_0 then we push C if d comes then pop all the c and if input symbol is ε and top symbol of the stack is Z_0 then it reaches to the final state



Option II :

Push all a, If b comes pop all a, push all c If d comes pop all c



Option II is the correct option.

Option III is similar like $a^n b^n c^n$ we have only one memory clement so it is not a context free language so option III is incorrect option

Option IV $a^m b^n c^p d^q \mid m.n = p+q$

So we have only a memory (stack) so it is impossible to multiply two variable power & store it, so it is not a context free language so option IV is incorrect option. So option I and II are correct options.

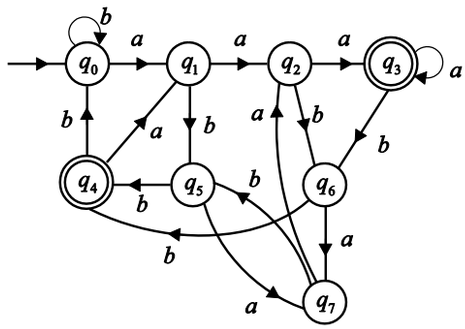
Hence, the correct option is (A).

103. D

According to question 3rd last symbol must be a.

So, its equivalent regular expression are

$$=(a+b)^*a(a+b)(a+b)$$



So the minimum number of states are 8 so the correct answer is D.

104. D

Equation according to the diagram

$$q_1 = \varepsilon + q_1.0 \quad \ldots(i)$$

$$q_2 = q_1.1 + q_2.1 \quad \ldots(ii)$$

$$q_3 = q_2.0 + q_3.0 + q_3.1 \quad \ldots(iii)$$

When we have more than one final state than we add both final state Regular expression, first we find these two are separately

For equation (i)

$$q_1 = \varepsilon + q_1.0$$

Using Arden's theorem if $R = Q + RP$ where P does not contain ε and only one input state than it has a unique solution i.e.,

$$R = QP^*$$

So, $q_1 = \varepsilon.0^*$

$$\Sigma.R^* = R^*$$

[Regular expression identities]

$$q_1 = 0^* \quad \ldots(iv)$$

Now we find q_2

$$q_2 = q_1.1 + q_2.1$$

Using equation 4 $[q_1 = 0^*]$

So $q_2 = 0^*.1 + q_2.1$

Using Arden's method

q_2=0*.1.1* …(v)

Union of both final state

$$R.E. = 0^* + 0^*.1.1^*$$

$$R.E. = 0^*[\varepsilon + 1.1^*]$$

$$\varepsilon + R.R^* = R^*$$

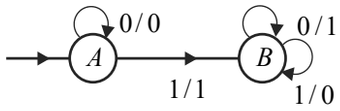
[using regular expression (RE) Identities]

$$R.E. = 0^*.1^*$$

Hence, the correct option is (D).

105. A

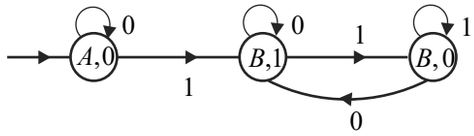
Mealy circuit is



Make state transition table

State	Inputs 0	1
A	(A, 0)	(B,1)
B	(B, 1)	(B,0)

Draw its equivalent more machine



So the option A is the correct option.

7 Compiler Design

Practice Questions

Q.1 Which of the following statements is false?

(A) Unambiguous grammar has different derivation tree

(B) An LL(1) parser is a top-down parser

(C) LALR is more powerful than SLR

(D) Ambiguous grammar can't be LR(k)

Q.2 Assume that the CLR parser for a grammar G has n_1 states and the LALR parser for G has n_2 states. The relationship between n_1 and n_2 is

(A) n_1 is necessarily less than n_2

(B) n_1 is necessarily equal to n_2

(C) n_1 is necessarily greater than n_2

(D) n_1 is necessarily greater than or equal to n_2

Q.3 Consider the following grammar G = {bexpr, {bexpr, bterm, bfactor}, {not, or, and, ( ), true, false}, P} with P given below

bexpr → bexpr or bterm | bterm
bterm → bterm and bfactor | bfactor
bfactor → not bfactor | (bexpr) | true | false

The equivalent non-left recursive grammar for the given grammar is

(A) bexpr → bterm E'
E' → or bterm E' | ε
bterm → bfactor F'
F' → and bfactor F'
bfactor → not bfactor | (bexpr) | true | false

(B) bexpr → bterm E'
E' → or bterm E' | ε
bterm → bfactor and F'
F' → bfactor F' | ε
bfactor → not bfactor | (bexpr) | true | false

(C) bexpr → bterm E'
E' → or bterm E' | ε
bterm → bfactor F'
F' → and bfactor F' | ε
bfactor → not bfactor | (bexpr) | true | false

(D) bexpr → bterm E'
E' → or bterm E'
bterm → bfactor F'
F' → and bfactor F' | ε
bfactor → not bfactor | (bexpr) | true | false

Q.4 Consider the following Code fragment

```
int main ()
{
   int x, y, total;
   x = 10, y = 20;
```

total $= x + y;$

printf ("Total = %d \n", total);

}

Number of tokens in the given code fragment is _____.

Q.5 Match the description of several parts of a classic optimizing compiler in **List-I,** with the names of those parts in **List-II:**

	List-I		**List-II**
(a)	A part of a compiler that is responsible for recognizing syntax.	(i)	Optimizer
(b)	A part of a compiler that takes as input a stream of characters and produces as output a stream of words along with their associated syntactic categories.	(ii)	Semantic Analysis
(c)	A part of a compiler that understand the meanings of variable names and other symbols and checks that they are used in ways consistent with their definitions.	(iii)	Parser
(d)	An IR-to-IR transformer that tries to improve the IR program in some way (Intermediate Representation).	(iv)	Scanner

Code :

	(a)	**(b)**	**(c)**	**(d)**
(1)	(iii)	(iv)	(ii)	(i)
(2)	(iv)	(iii)	(ii)	(i)
(3)	(ii)	(iv)	(i)	(iii)
(4)	(ii)	(iv)	(iii)	(i)

(A) 1 (B) 2

(C) 3 (D) 4

Q.6 Consider the following code segment.

$x = u - t;$

$y = x \times V;$

$z = y + w;$

$w = t - z;$

$u = x \times y;$

The minimum number of total variables required to convert the above code segment to static singe assignment form is _____

Q.7 The left factored and non-left recursive grammar for the given grammar is

Numeral : :-

Digits | Digits . Digits

| Digits e Sign Digits

| Digits . Digits e Sign Digits

Digits : :- Digit | Digits Digit

Digit : :- 0 | 1 | 2 | 3

(A) Numeral : := Digits N1 N2

N1 : := θ Sign Digits | ε

N2 : := Digits | ε

Digits : := Digit Digits | Digit

Digit : := 0 | 1 | 2 | 3

(B) Numeral : := Digits N1 N2

N1 : := θ Sign Digits | ε

N2 : := Digits | ε

Digits : := Digit Digits | Digit

Digit : := 0 | 1 | 2 | 3

(C) Numeral : := Digits N
N : := θ Sign Digits | . Digits | ε
Digits : := Digit Digits | Digit
Digit : := 0 | 1 | 2 | 3

(D) Numeral : := Digits N1
N1 : := *e* Sign Digits | ε | .Digits N2
N2 : := θ Sign Digits | ε
Digits : := Digit D
D : := Digits | ε
Digit : := 0 | 1 | 2 | 3

Q.8 Consider the following grammar
SL → SL. S
SL → ε
S → stmt
The given grammar is
(A) LR(0) and SLR(1)
(B) Not LR(0) but SLR(1)
(C) Neither LR(0) nor SLR(1)
(D) LL(1) but not LR(0)

Q.9 The non-left recursive grammar from the given grammar is

$A \to B \mid a \mid CBD$
$B \to C \mid b$
$C \to A \mid c$
$D \to d$

(A) $A \to B \mid a \mid CBD$
$B \to C \mid b$
$C \to A \mid c$
$D \to d$

(B) $A \to aA' \mid bA' \mid cA' \mid cBDA'$
$A' \to \varepsilon \mid BDA'$
$B \to C \mid b$
$C \to A \mid c$
$D \to d$

(C) $A \to aA' \mid bA' \mid cA'$
$A' \to \varepsilon \mid BDA'$
$B \to C \mid b$
$C \to A \mid c$
$D \to d$

(D) $A \to aA' \mid bA' \mid cBDA'$
$A' \to \varepsilon \mid BDA'$
$B \to C \mid b$
$C \to A \mid c$
$D \to d$

Q.10 Consider the following grammar:

$R \to R \mid R$
$R \to RR$
$R \to R*$
$R \to (R)$
$R \to a$
$R \to b$

where the terminals are $\{|, *, (,), a, b\}$
Follow(R) is _____
(A) {$}
(B) {|, *,)}
(C) {|, *,), $}
(D) {(, a, b, |, *,), $}

Q.11 Consider the following grammar

$S \to CC$
$C \to cC$
$C \to d$

The number of canonical collections of CLR(1) items which are having the same reductions with different lookaheads is
(A) 0 (B) 1
(C) 2 (D) 3

Q.12 Consider the following context-free grammar, the symbols (, *a* ,) and , are terminals and *S* is the initial symbol.

$S \to (L)$
$S \to a$
$L \to L, S$
$L \to S$

The closure of the LR(1) item $[S \to (\cdot L)[\$]$ is

(A) $S \to (.L)|\$$
$L \to .L, S|)$
$L \to .S,|)$

(B) $S \to (.L)|\$$
$L \to .L, S|)$
$L \to .S,|)$
$S \to .(L)\,|\,)$
$S \to .a\,|\,)$

(C) $S \to (.L),\$$
$L \to .L, S,)$
$L \to .S,)$
$S \to .(L),)$
$S \to .a,)$

(D) $S \to (.L)|\$$
$L \to .L, S|\,)$
$L \to .S,|\,)$
$L \to .L, S\,|,$
$L \to .S\,|,$
$S \to .(L)\,|\,)$
$S \to .a\,|\,)$
$S \to .(L)\,|\,,$
$S \to .a\,|\,,$

Q.13 Consider the following grammar with the semantic rules

Grammar	Semantic Rules
$E_1 \to E_2 + T$	$E_1.\text{string} = E_1.\text{string} \,\|\|\, T.\text{string} \,\|\|\, '*'$
$E_1 \to T$	$E_1.\text{string} = T.\text{string}$
$T_1 \to T_2 * F$	$T_1.\text{string} = T_2.\text{string} \,\|\|\, F.\text{string} \,\|\|\, '+'$
$T \to F$	$T.\text{string} \to F.\text{string}$
$F \to (E)$	$F.\text{string} \to E.\text{string}$
$F \to \underline{\text{num}}$	$F.\text{string} \to \text{num.string}$

The output produced by the SDT for the input string "3*4+5*2" is _____

(A) 34*+52+ (B) 34*52*+

(C) 34+52+* (D) 34+*52+

Q.14 Consider the following grammar **[MSQ]**

$S \to A$
$A \to BC \,|\, DBC$
$B \to Bb \,|\, \varepsilon$
$C \to c \,|\, \varepsilon$
$D \to a \,|\, d$

Which of the following is part of the FIRST(A) is

(A) $\{a, b\}$ (B) $\{c, d\}$

(C) $\{a, b, c, d, \varepsilon\}$ (D) $\{a, d\}$

Q.15 Compiler can check _____ error **[MSQ]**

(A) Logical (B) Syntax

(C) Semantic (D) All of them

Q.16 Consider the following SDT

$A \to b$ {print("a")}A
$A \to a$ {print("b")}A
$A \to c$ {print("d")}

The output produced by the SDT for the input string *bbac*

(A) *aabd* (B) *abda*

(C) *dbaa* (D) None of these

Q.17 Consider the following context free grammar

$S \to ABBA$
$A \to a \,|\, \varepsilon$
$B \to b \,|\, \varepsilon$

The entries in the following LL(1) parse table M is

	a	b	$\$$
S	$S \to ABBA$	$S \to ABBA$	$S \to ABBA$
A			
B		$B \to b$	

The entries for the $M[A,a], M[A,b], M[A,\$]$ is

(A) $M[A,a] = A \to a$,
$M[A,b] = A \to \varepsilon$,
$M[A,\$] = A \to \varepsilon$

(B) $M[A,a] = \{A \to a, A \to \varepsilon\}$
$M[A,b] = A \to \varepsilon$,
$M[A,\$] = A \to \varepsilon$

(C) $M[A,a] = A \to a$,
$M[A,b] = A \to \varepsilon$,
$M[A,\$] =$ Nil

(D) $M[A,a] = \{A \to a, A \to \varepsilon\}$
$M[A,b] = A \to \varepsilon$,
$M[A,\$] =$ Nil

Q.18 Given the following expression grammar:

$E \to E * F \mid F + E \mid F$

$F \to F - F \mid id$

The output produced by the expression grammar after evaluating the expression $5+3*4-2$

(A) 16 (B) 10

(C) 4 (D) None of these

Q.19 In a bottom-up evaluation of a syntax direction definition, inherited attributes can

(A) Always be evaluated

(B) Be evaluated only if the definition is L-attributed

(C) Evaluation only done if the definition has synthesized attributes

(D) None of these

Q.20 Consider the following statements related to compiler construction:

I. Lexical Analysis is specified by context-free grammar and implemented by pushdown automata.

II. Syntax Analysis is specified by regular expressions and implemented by finite-state machine.

Which of the above statement(s) is/are incorrect?

(A) Only I (B) Only II

(C) Both I and II (D) Neither I nor II

Q.21 Consider the following Grammar

$S \to X$

$X \to Yb \mid aa$

$Y \to a \mid bYa$

The given grammar is

(A) LR(0) and SLR(1)

(B) Not LR(0) but SLR(1)

(C) LR(0) but not SLR(1)

(D) Neither LR(0) nor SLR(1)

Q.22 Consider the following syntax directed translation scheme.

$E \to E_1 * T \{E.val = E_1.val * T.val\}$

$E \to T \{E.val = T.val\}$

$T \to F - T_1 \{T.val = F.val - T_1.val\}$

$T \to F \{T.val = F.val\}$

$F \to 3 \{F.val = 2\}$

$F \to 5 \{F.val = 4\}$

The output produced by the SDTS after evaluating the given expression is $5-3*5*3$.

Assume attribute evaluation with bottom-up parsing, i.e., attributes are evaluated immediately after a reduction.

(A) 15 (B) – 42

(C) 30 (D) None of these

Q.23 Consider the following context free grammar

$S \to P$

$P \to (P)P$

$P \to \varepsilon$

In the LL(1) parse table M, the entries for $M[S,\$]M[P,)]$ are

(A) $S \to P, P \to \varepsilon$

(B) $S \to \varepsilon, P \to \varepsilon$

(C) $P \to \varepsilon, P \to (P)P$

(D) None of these

Q.24 Given the CFG

$G = \{S, \{S,U,V,W\}, \{a,b,c,d), P\}$ with

P given as shown below:

$S \to UVW$

$U \to (S) \mid aSb \mid d$

$V \to aV \mid \varepsilon$

$W \to cW \mid \varepsilon$

Then Follow $(U) =$

(A) $\{a,c\}$ (B) $\{a,c,b,)\}$

(C) $\{a,c,\$,b\}$ (D) $\{a,c,\$,b,)\}$

Q.25 Consider the following context free grammar

$S \to bAB \mid bb \mid C$

$A \to BC \mid aCB \mid \varepsilon \mid a$

$B \to bB \mid C \mid \varepsilon$

$C \to aaC \mid bbC \mid D$

$C \to a \mid b$

The Equivalent simplified (After Elimination of Unit, Null, Useless Symbols) from the grammar is

(A) $S \to bAB \mid bb \mid aaC \mid bbC \mid a \mid b$

$A \to BC \mid aCB \mid a$

$B \to bB \mid aaC \mid bbC \mid a \mid b$

$C \to aaC \mid bbC \mid a \mid b$

$D \to a \mid b$

(B) $S \to bAB \mid bb \mid aaC \mid bbC \mid a \mid b$

$A \to BC \mid aCB \mid a$

$B \to bB \mid aaC \mid bbC \mid a \mid b$

$C \to aaC \mid bbC \mid a \mid b$

(C) $S \to bAB \mid bb \mid aaC \mid bbC$

$A \to BC \mid aCB \mid a$

$B \to bB \mid aaC \mid bbC \mid a \mid b$

$C \to aaC \mid bbC \mid a \mid b$

$D \to a \mid b$

(D) None of these

Q.26 Which one of the following statements is FALSE?

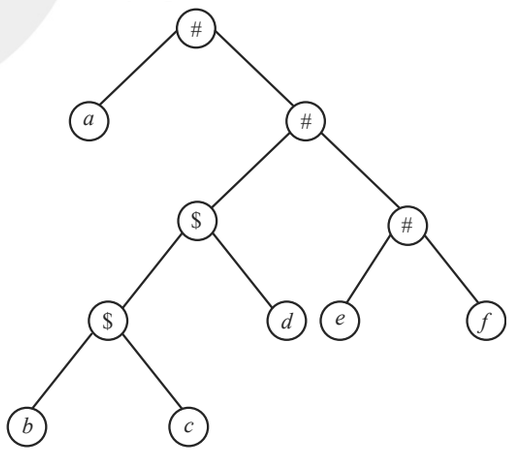
(A) Context-free grammar can be used to specify both lexical and syntax rules.

(B) Type checking is done before parsing.

(C) High-level language programs can be translated to different Intermediate Representations.

(D) Arguments to a function can be passed using the program stack.

Q.27 Consider the following parse tree for the expression $a\#b\$c\$d\#e\#f$, involving two binary operators \$ and #.



Which one of the following is correct for the given parse tree?

(A) \$ has higher precedence and is left associative; # is right associative

(B) # has higher precedence and is left associative; \$ is right associative

(C) \$ has higher precedence and is left associative; # is left associative

(D) # has higher precedence and is right associative; \$ is left associative

Q.28 The attributes of three arithmetic operators in some programming languages are given below:

Operator	Precedence	Associativity	Arity
+	High	Left	Binary
–	Medium	Right	Binary
*	Low	Left	Binary

The value of the expression $2-5+1-7*3$ in this language is

(A) 9 (B) 10

(C) 11 (D) 12

Q.29 Which of the following statements are CORRECT?

1. Static allocation of all data areas by a compiler makes it impossible to implement recursion.
2. Automatic garbage collection is essential to implement recursion.
3. Dynamic allocation of activation records is essential to implement recursion.
4. Both heap and stack are essential to implement recursion.

(A) 1 and 2 only (B) 2 and 3 only

(C) 3 and 4 only (D) 1 and 3 only

Q.30 For the grammar below, a partial LL(1) parsing table is also presented along with the grammar. Entries that need to be filled are indicated as E_1, E_2 and E_3. ε is the empty string, $ indicates end of input, and 1 separate alternate right hand sides of productions.

$S \to aAbB \mid bAaB \mid \varepsilon$

$A \to S$

$B \to S$

	A	b	$
S	E_1	E_2	$S \to \varepsilon$
A	$A \to S$	$A \to S$	error
B	$B \to S$	$B \to S$	E_3

The FIRST and FOLLOW sets for the non-terminals A and B are

(A) $\text{FIRST}(A) = \{a, b, \varepsilon\} = \text{FIRST}(B)$
$\text{FOLLOW}(A) = \{a, b\}$
$\text{FOLLOW}(B) = \{a, b, \$\}$

(B) $\text{FIRST}(A) = \{a, b, \$\}$
$\text{FIRST}(B) = \{a, b, \varepsilon\}$
$\text{FOLLOW}(A) = \{a, b\}$
$\text{FOLLOW}(B) = \{\$\}$

(C) $\text{FIRST}(A) = \{a, b, \varepsilon\} = \text{FIRST}(B)$
$\text{FOLLOW}(A) = \{a, b\}$
$\text{FOLLOW}(B) = \phi$

(D) $\text{FIRST}(A) = \{a, b\} = \text{FIRST}(B)$
$\text{FOLLOW}(A) = \{a, b\}$
$\text{FOLLOW}(B) = \{a, b\}$

Q.31 The appropriate entries for E_1, E_2 and E_3 are

(A) $E_1 : S \to aAbB, A \to S$
$E_2 : S \to bAaB, B \to S$
$E_3 : B \to S$

(B) $E_1 : S \to aAbB, S \to \varepsilon$
$E_2 : S \to bAaB, S \to \varepsilon$
$E_3 : S \to \varepsilon$

(C) $E_1 : S \to aAbB, S \to \varepsilon$
$E_2 : S \to bAaB, S \to \varepsilon$
$E_3 : B \to S$

(D) $E_1 : A \to S, S \to \varepsilon$
$E_2 : B \to S, S \to \varepsilon$
$E_3 : B \to S$

Q.32 The program below uses six temporary variables a, b, c, d, e, f.

a = 1
b = 10
c = 28
d = a + t

e = c + d
f = c + e
b = c + e
e = b + f
d = 5 + e
return d + f

Assuming that all operations like their operands from registers, what is the minimum number of registers needed to execute this program without spilling?

(A) 2 (B) 3
(C) 4 (D) 6

Q.33 Which of the following statements are TRUE?

I. There exist parsing algorithms for some programming languages whose complexities are less than $\theta(n^3)$.

II. A programming language which allows recursion can be implemented with static storage.

III. No L-attributed definition can be evaluated in the framework of bottom-up parsing.

IV. Code improving transformations can be performed at both source language and intermediate code level.

(A) I and II (B) I and IV
(C) III and IV (D) I, III and IV

Q.34 FOLLOW (S) set for the postfix grammar after removing left recursion $S \to SS+ \mid SS* \mid a$.

(A) $\{a, \in\}$
(B) $\{+, *\}$
(C) $\{a, \$\}$
(D) None of the above

Q.35 Consider the following statement:

S_1: Three address code is linear representation of syntax tree

S_2: With triples representation optimization can change the execution order.

Which of the above is correct?

(A) Only S_1
(B) Only S_2
(C) Both S_1 and S_2
(D) None of these

Q.36 Consider the following grammar.

$X \to YZ \{Z.x = X.x$
$X.y = Y.y\}$
$Z \to PZ' \{Z'.x = P.x$
$Z.y = P.x + Z', y\}$

Which of the following is true?

(A) Both x and y are inherited attributes
(B) Both x and y are synthesized attributes
(C) x is inherited and y is synthesized
(D) x is synthesized and y is inherited

Q.37 Choose the correct sequence of occurrence during compilation process

(A) Parse tree → Token stream → intermediate code
(B) Parse tree → 3 address code → character stream
(C) Character stream → Parse tree → SDT tree
(D) Token stream → SDT tree → Parse tree

Q.38 Consider the following code.

```
main ()
{
    int temp = 200, 10;
    int l1, l2;
    temp = ++temp;
    l1+ = l2
    printf("%d", temp + l1);
}
```

The number of tokens in the above code is_____.

Q.39 Consider the regular expression with the respective token number in the table.

REX	Token No.
$(a+b)*c$	1
$ca*b$	2
$c*$	3

Choose the correct output when lexical analyzer scans the following input: "cabacccab" Note: The analyzer tries to output the token that matches the longest possible prefix.

(A) 3122

(B) 2132

(C) 1132

(D) Generates lexical error

Q.40 Consider the following translation scheme:

$S \to XY$

$X \to X*Y[\text{Print}[('*')]$

$X \to \text{id}[\text{Print}(\text{id})]$

$X \to \text{id}\ [\text{Print}\ (-)]$

$Y \to +Y[\text{Print}(-)]$

$Y \to \text{id}\{\text{Print}\ (\text{id})\}$

Here id is a token which represent on integer id represent the value of that integer. For an input $6*4*5+7$, this translation scheme prints.

(A) $64*5*7+$ (B) $6*4*5-7$

(C) $64*5*7-$ (D) $64*5-*7-$

Q.41 Consider the following statements:

S_1: While program in execution, access to heap memory is slower as compared to accessing variables allocate on stack.

S_2: While program in execution, in a multithread situation, each threads has its own stack and share a common heap memory.

S_3: During a program execution, heap is stored in main memory and stack is present in secondary memory.

Which of the above is incorrect?

(A) Only S_1 and S_2

(B) Only S_2 and S_3

(C) All of these

(D) Only S_3

Q.42 Consider the basic block given below:

$X \to X*Y$

$Z \to X+Z$

$P \to Z / P$

$X \to Z+P$

Minimum number of edges present in the DAG representation of the above block is_____.

Q.43 Consider the following statement:

I. Three address code is a linearized representation of syntax tree.

II. Type checking is done during all the phases especially in syntax analysis phase.

III. Target code generation phase is machine independent code generation

IV. Symbol table is accessed during lexical, syntax and semantic analysis phase.

The number of the correct statement is/are_____.

Q.44 In SLR parsing for the grammar.

$E \to E$

$E \to aEbE \setminus bEaE \setminus \in$

In state 0, for input 'a' and 'b'

(A) Both will have shift reduce conflict

(B) Only 'a' will have shift reduce conflict

(C) Only 'b' will have shift reduce conflict

(D) Neither of the other options

Q.45 Which of the following statements is true?

(A) $S \rightarrow$ *aabc/ab,* this grammar is not LL(1) but it is LL(2).

(B) Every regular language is LL (1)

(C) Every regular grammar is LL (1)

(D) Both (a) and (b)

Q.46 Consider the following grammar G1 and G2 with S, A, B, C as non-terminals and a, b, c $\in$ as terminals.

$G_1 : S \rightarrow A+B \mid A \mid B \mid AB$

$A \rightarrow A*C \mid a$

$B \rightarrow B+C \mid b$

$C \rightarrow c$

$G_2 : S \rightarrow A*B \mid \in$

$S \rightarrow B-C$

$A \rightarrow a$

$B \rightarrow b$

$C \rightarrow c$

Which of the above grammar is operator grammar?

(A) Only G_1

(B) Only G_2

(C) Both G_1 and G_2

(D) None of these

Q.47 If we merge states in LR(1) parser to form a LALR(1) parser, we may introduce

(A) shift-reduce conflict

(B) reduce-reduce conflict

(C) no extra conflict

(D) both shift-reduce as well as reduce-reduce

Q.48 Suppose we have a rightmost derivation which proceeds as follows:

$S \rightarrow Aabw$

$\rightarrow ABw$

Which of the following is a possible handle for it?

(A) $A \rightarrow ab$ (B) $A \rightarrow a$

(C) $S \rightarrow A$ (D) $B \rightarrow ab$

Q.49 Which of the following statements is FALSE?

(A) In a SLR(1) parser, it is allowable for both shift and reduce items to be in the same state

(B) In a SLR(1) parser, it is allowable for multiple reduce items to be in the same state

(C) All SLR(1) grammars are LR(0)

(D) All LR(0) grammars are SLR(1)

Q.50 Which of the followign statements regarding LR(0) parser is FALSE?

(A) A LR(0) configurating set cannot have multiple reduce items

(B) A LR(0) configurating set cannot have both shift as well as reduce items

(C) If a reduce item is present in a LR(0) configurating set it cannot have any other item

(D) A LR(0) parser can parse any regular grammar

Q.51 Which of the following sentences is CORRECT?

(A) A top-down parse produces a leftmost derivation of a sentence

(B) A bottom-up parse produces a rightmost derivation of a sentence

(C) A top-down parse produces a rightmost derivation of a sentence

(D) A bottom-up parse produces a leftmost derivation of a sentence

Q.52 Which of the following is TRUE regarding (LL0) grammar?

(A) We can have a LL(0) grammar for any regular language

(B) We can have a LL(0) grammar for a regular language only if it does not contain empty string

(C) We can have a LL(0) grammar for any regular language if and only if it has prefix property

(D) We can have a LL(0) grammar for only single string languages

Q.53 Match the following :

(i) LL(1)	(a) bottom-up
(ii) Recursive Descent	(b) Predictive
(iii) Recursive Ascent	(c) Top-down
(iv) LR(1)	(d) Deterministic CFL

(A) i-b; ii-c; iii-a; iv-d

(B) i-d; ii-a; iii-c; iv-d

(C) i-c; ii-b; iii-d; iv-a

(D) i-a; ii-c; iii-b; iv-d

Q.54 Which of the below relations does hold TRUE regarding GRAMMARS?

(A) $LL(1) \subset SLR(1) \subset LR(1)$

(B) $SLR(1) \subset \in -$free $LL(1) \subset LR(1)$

(C) $\in -$free $LL(1) \subset SLR(1) \subset LR(1)$

(D) $LL(1) \subset SLR(1) = LR(1)$

Q.55 The worst case space complexity of operator function table and operator relation table is?

(A) $O(n) \& O(n)$

(B) $O(n^2) \& O(n^2)$

(C) $O(n) \& O(n^2)$

(D) $O(n^2) \& O(n)$

Q.56 Consider the grammar shown below

$E \to E + T / T$

$T \to TF / F$

$F \to F * |a| b$

The minimum number of states are required in SLR (1) parsing table is____.

Q.57 Find the number of SR and RR conflicts in DFA with LR (0) items $S \to SS \mid a \mid \in$

(A) 2, 2 (B) 2, 1

(C) 3, 1 (D) 3, 2

Q.58 Consider the syntax direction definition shown below

$N \to L$ {N. val = L. val;}

$L \to LB$ {L.val = 2 * L.val + B. val;}

|B {L. val = B. val;}

$B \to 0$ {B.val = 0;}

| 1 {B.val= 1; }

If the input is 1010101 then its output are:-

Answers Compiler Design

1.	A	2.	D	3.	C	4.	34	5.	A
6.	7	7.	D	8.	A	9.	B	10.	D
11.	C	12.	C	13.	A	14.	A, B, C, D	15.	B, C
16.	A	17.	B	18.	A	19.	B	20.	C
21.	D	22.	D	23.	A	24.	D	25.	D
26.	B	27.	A	28.	A	29.	D	30	A
31.	C	32.	B	33.	B	34.	B	35.	A
36.	C	37.	C	38.	34	39.	D	40	C
41.	D	42.	8	43.	2	44.	A	45.	D
46.	D	47.	B	48.	D	49.	C	50.	D
51.	A	52.	D	53.	A	54.	C	55.	C
56.	10	57.	B	58.	85				

Explanations Compiler Design

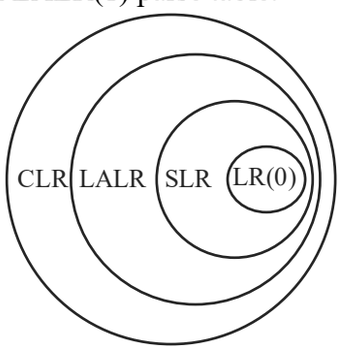
1. (A)

Unambiguous grammar has both kinds of derivation : False

In Unambiguous grammar both LMD and RMD generates the unique parse tree for the given input string

2. (D)

Number of states in a CLR parser table greater than equal LALR(1) parse table.



3. (C)

Non-left recursive grammar for the given grammar is

bexpr → bterm E'

E' → or bterm E' | ε

bterm → bfactor F'

F' → and bactor F' | ε

bfactor → not bfactor | (bexpr) | true | false

4. 34

```
int main() –4
{          –1
 int x, y, total; –7
 x = 10, y = 20; –8
 total = x + y; –6
 printf ("Total = %d\n", total);
     –7
}          –1
```

Total number of tokens are

$4+1+7+8+6+7+1=34$

5. (A)

Parser is a part of compiler and responsible for syntax recognition. Scanner (or tokenization) used by the lexical analyser. In Semantic

analysis consistency and definition of syntax is checked. An optimizer is used improve the IR program.

Hence, the correct option is (A).

6. 7

Static Single Assignment is used for intermediate code in compiler design, In static single Assignment form (SSA) each assignment to a variable should be specified with distinct names. We use subscripts to distinguish each definition of variables.

In the given code segment each definition is distinct.

So, the total number of variable is

(x, u, t, y, v, z, w).

7. (D)

The given grammar is

Numeral : := Digits / Digits. Digits / Digits *e* Sign Digits / Digits. Digits *e* Sign Digits

Digits : := Digit Digits | Digit

Digit : := 0 | 1 | 2 | 3

Apply Left Factoring

Numeral : := Digits N1 N2

N1 : := *e* Sign Digits | ε

N2 : := Digits | ε

Digits : := Digit D

D : := Digits | ε

Digit : := 0 | 1 | 2 | 3

8. (A)

LR(0) Items : No conflicts in LR(0), SLR(1)

s0 :

[S' −> .SL]

[SL−> .SL; S]

[SL−> .] goto [s0, SL] = s1;

s1 :

[S' −> SL.]

[SL−> SL. ; S] goto (s1, ;) = s2;

s2 :

[SL −> SL;.S]

[S −> .stmt] goto (s2, S) = s3;

s3 :

[SL −> SL; S.] goto (s2, stmt) = s3;

s4 :

[S −> stmt .] goto (s2, stmt) = s4;

The given grammar is LR(0) and SLR(1)

SLR(1) parse table is

		stmt	S	SL	S
s0	r2		r2		
s1	s2		Accept		
s2		s4			3
s3	r1		r1		
s4	r3		r3		

9. (B)

Given grammar is

$A \to B \mid a \mid CBD$

$B \to C \mid b$

$C \to A \mid c$

$D \to d$

It is having the indirect recursion.

$A \to C \mid b \mid a \mid CBD$

$B \to C \mid b$

$C \to A \mid c$

$D \to d$

$\to$ $A \to A \mid c \mid b \mid a \mid cBD \mid ABD$

$B \to C \mid b$

$C \to A \mid c$

$D \to d$

$\Rightarrow$ $A \to A \mid ABD \mid a \mid b \mid c \mid cBD$

$B \to C \mid b$

$C \to A \mid c$

$D \to d$

$\to$ $A \to aA' \mid bA' \mid cA' \mid cBDA'$

$A' \to \varepsilon \mid BDA'$

$B \to C \mid b$

$C \to A \mid c$

$D \to d$

10. (D)

As R is the start symbol of the grammar, add $\{\$\}$ to the following set.

Follow(R) = $\{\$\} u \{|, *,)\}$

$R \to RR$

Follow(R) = First(R)

First(R) = $\{(, a, b\}$

$\Rightarrow$ Follow(R) = $\{(, a, b, |, *,), \$\}$

11. (C)

Augmented grammar for the given grammar is

Let, $r_1 = S \to CC, r_2 = C \to cC$ and

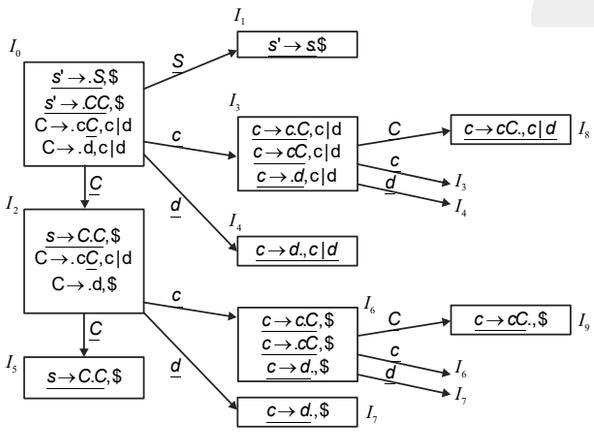
$r_3 = C \to d$

$S' \to S$

$S \to CC$

$C \to cC$

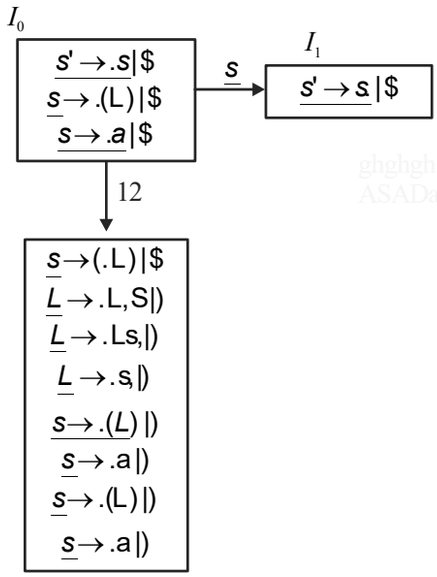
$C \to d$



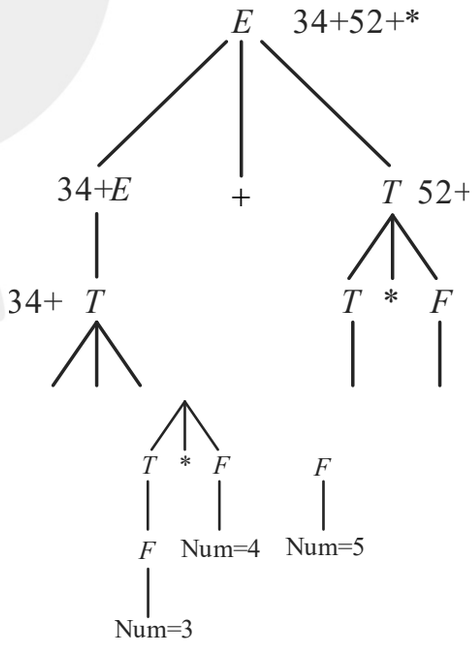
14 and 17 contain the same reductions (r_3) with different lookaheads.

18 and 19 contain the same reductions (r_2) with different lookaheads.

12. (C)



13. (C)



14. A,B,C,D

First(A) = First(B) u First(D)

First(D) = $\{a, d\}$

First(B) = $\{\varepsilon\}$

Substitute ε in place of B

First(B) = $\{b\}$

$\Rightarrow \text{First}(A) = \text{First}(C) = \{c, \varepsilon\}$

Substitute ε in place of C

$\Rightarrow \text{First}(A) = \{\varepsilon\}$

$\Rightarrow \text{First}(A) = \{a, b, c, d, \varepsilon\}$

First(A) contains all the symbols $\{a, b, c, d, \varepsilon\}$

All the options are correct.

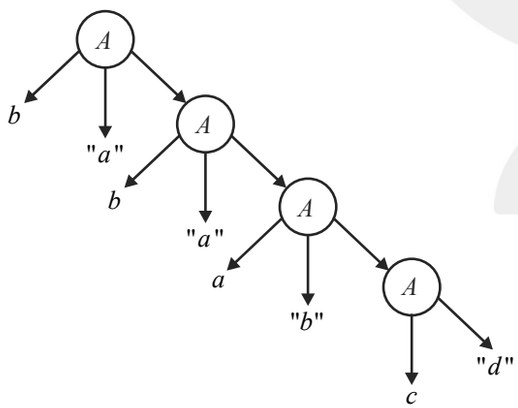
15. B,C

(B) Compiler will recognize all the syntax and semantic errors in the code, May not detect the logical errors.

(C) Compiler will recognize all the syntax and semantic errors in the code, May not detect the logical errors.

16. (A)

Given input string is *bbac* and the output produced by the SDT is *aabd*



17. (B)

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

$\text{First}(A) = \{a, \varepsilon\}$

$\text{First}(B) = \{b, \varepsilon\}$

$\text{Follow}(S) = \{\$\}$

$= \text{First}(B) = \{b\} \cup \text{First}(B)$

$\text{Follow}(A) = \{b\} \cup \text{First}(A)$

$= \{b, a\} \cup \text{follow}(S) = (a, b, \$\}$

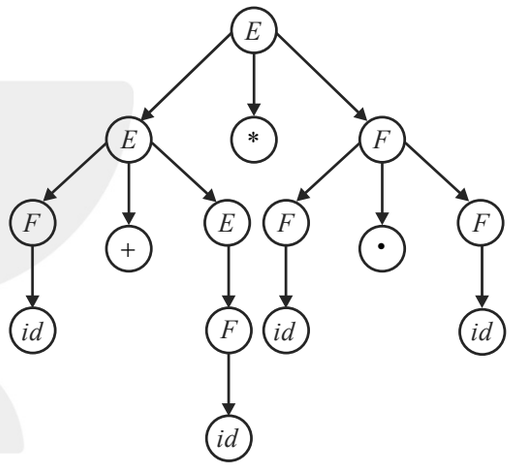
$\text{Follow}(B) = \text{First}(B) = \{b, a, \$\}$

LL(1) parse table is

	a	b	\$
S	$S \to ABBA$	$S \to ABBA$	$S \to ABBA$
A	$A \to a, A \to \varepsilon$	$A \to \varepsilon$	$A \to \varepsilon$
B	$B \to \varepsilon$	$B \to b, B \to \varepsilon$	$B \to \varepsilon$

18. (A)

The parse tree for the given string is $5+3*4-2$



The output is $(5+3)*(4-2) = 8*2 = 16$

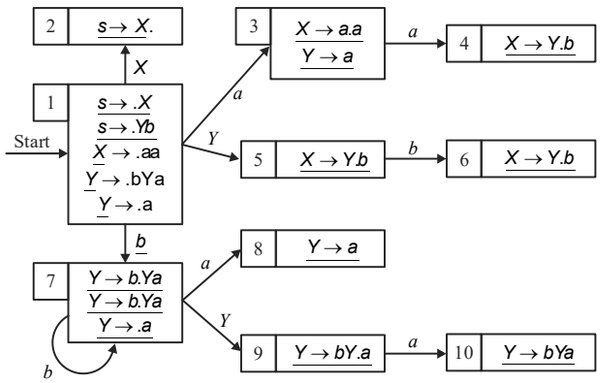
19. (B)

A Syntax Directed Definition (SDD) is called S Attributed if it has only synthesized attributes L. Attributed Definitions contain both synthesized and inherited attributes but do not need to build a dependency graph to evaluate them.

20. (C)

Both the statements are Incorrect. Lexical Analysis is specified by the Regular Expression and implemented by the finite state-machine and Syntax Analysis is specified by the CFG and implemented by the PDA.

21. (D)



State 13 contains *S*/*R* conflict in LR(0). Apply reduction operation on state 13 and shift operation for the input symbol 'a'.

Need to check for the *S*/*R* conflict in SLR(1)

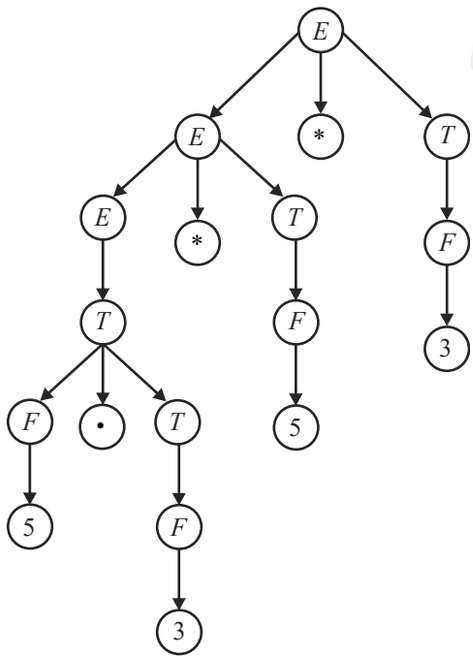
First(a) intersection Follow(Y) $=\{a\}$ intersection $\{a,b\}=\{a\}\neq\Phi$

S/*R* connect in SLR(1).

The given grammar is neither LR(0) nor SLR(1).

22. (D)

Given string is $5-3*5*3$



$(((5-3)*5)*3)$

$\Rightarrow$ $F\to 3\{F.val=2\}$

$F\to 5\{F.val=4\}$

$(((4-2)*4)*2)\Rightarrow 16$

23. (A)

First(S) $=\{(, \varepsilon\}$

First(P) $=\{(, \varepsilon\}$

Follow(S) $=\{\$\}$

Follow(P) $=\{), \$\}$

	(	)	$
S	$S\to P$		$S\to P$
P	$P\to(P)P$	$P\to\varepsilon$	$P\to\varepsilon$

24. (D)

Follow(U) $=$ First(V) $=\{a,\varepsilon\}$

$\Rightarrow$ $\{a\}\cup$ First(W) $=\{a\}\cup\{c,\varepsilon\}$

Substitute $\{\varepsilon\}$ in place of W

$\Rightarrow$ $\{a\}\cup\{c\}$ Follow(S)

$\Rightarrow$ $\{a,c,\$,b,)\}$

25. (D)

$S\to bAB\,|\,bb\,|\,C$

$A\to BC\,|\,aCB\,|\,\varepsilon\,|\,a$

$B\to bB\,|\,C\,|\,\varepsilon$

$C\to aaC\,|\,bbC\,|\,D$

$D\to a\,|\,b$

Eliminate Null productions

$S\to bAB\,|\,bb\,|\,C\,|\,bB\,|\,bA\,|\,b$

$A\to BC\,|\,aCB\,|\,a\,|\,C\,|\,aC$

$B\to bB\,|\,C\,|\,b$

$C\to aaC\,|\,bbC\,|\,D$

$D\to a\,|\,b$

Eliminate the Unit productions

$S\to bAB\,|\,bb\,|\,aaC\,|\,bbC\,|\,a\,|\,b\,|\,bB\,|\,bA\,|\,b$

$A\to BC\,|\,aCB\,|\,a\,|\,aaC\,|\,bbC\,|\,a\,|\,b\,|\,aC$

$B\to bB\,|\,aaC\,|\,bbC\,|\,a\,|\,b\,|\,b$

$C\to aaC\,|\,bbC\,|\,a\,|\,b$

$D\to a\,|\,b$

Eliminate Useless Symbols

$S\to bAB\,|\,bb\,|\,aaC\,|\,bbC\,|\,a\,|\,b\,|\,bB\,|\,bA\,|\,b$

$A \rightarrow BC \mid aCB \mid a \mid aaC \mid bbC \mid a \mid b \mid aC$

$B \rightarrow bB \mid aaC \mid bbC \mid a \mid b \mid b$

$C \rightarrow aaC \mid bbC \mid a \mid b$

26. (B)

Type checking is done in semantic analysis phase after syntax analysis phase (i.e., after parsing).

27. (A)

Since \$ will be evaluated before # so \$ has higher precedence and the left \$ i.e., in $b\$c\$d$ the left "\$" (i.e., $b\$c$) will be evaluated first so it is left associative, whereas # is right associative (as in $d\#e\#f$), the right one (i.e., $e\#f$) will be evaluated first.

28. (A)

+ has highest precedence, so it will be evaluated first.

$$2-5+1-7*3 = 2-(5+1)-7*3$$
$$= 2-6-7*3$$

Now, - has more precedence than *, so sub will be evaluated before * and – has right associative so (6-7) will be evaluated first.

$$2-6-7*3 = (2-(6-7))*3$$
$$= (2-(-1))*3$$
$$= 3*3 = 9$$

29. (D)

The statement, static allocation of all data areas by a compiler makes it impossible to implement recursion is true, as recursion requires memory allocation at run time, so it requires dynamic allocation of memory.

Hence, Dynamic allocation of activation records is essential to implement recursion is also a true statement.

30. (A)

FIRST(P): is the set of terminals that begin the strings derivable from non-terminal P. If P derives epsilon, then we include epsilon in FIRST(P).

FOLLOW(P): is the set of terminals that can appear immediately to the right of P in some sentential form.

FIRST(A) =FIRST(S)

FIRST(S) =FIRST($aAbB$) and FIRST($bAaB$) and FIRST ($\in$)

FIRST(S) $= \{a, b, \in\}$

FIRST(B) = FIRST(S) $= \{a, b, \in\} =$ FIRST(A)

FOLLOW(A) $= \{b\}$ // because of production $S \rightarrow a\,A\,b\,B$

FOLLOW(A) $= \{a\}$ // because of production $S \rightarrow b\,A\,a\,B$

So, FOLLOW(A) $= \{a, b\}$

FOLLOW(B) = FOLLOW(S) // because of production $S \rightarrow a\,A\,b\,B$

FOLLOW(S) = FOLLOW(A) // because of production $S \rightarrow A$

So, FOLLOW(S) $= \{\$, a, b\}$ = FOLLOW(B)

31. (C)

The entries in E_1, E_2 and E_3 is related to S and B, so we have to take only those production which have S and B in LHS.

$$S \rightarrow aAbB \mid bAaB \mid \varepsilon$$

The production $S \rightarrow aAbB$ will go under column

FIRST($aAbB$) $= a$, so $S \rightarrow aAbB$ will be in E_1.

$S \rightarrow bAaB$ will go under column

FIRST($bAaB$) $= b$, so $S \rightarrow bAaB$ will be in E_2.

$S \rightarrow \varepsilon$ will go under

$\text{FOLLOW}(S) = \text{FOLLOW}(B) = \{a, b, \$\}$, So

$S \to \varepsilon$ will go in E_1, E_2 and under column of \$.

So E_1 will have: $S \to aAbB$ and $S \to \varepsilon$.

E_2 will have $S \to bAaB$ and $S \to \varepsilon$.

Now, $B \to S$ will go under
$\text{FIRST}(S) = \{a, b, \varepsilon\}$

Since $\text{FIRST}(S) = \varepsilon$ So $B \to S$ will go under $\text{FOLLOW}(B) = \{a, b, \$\}$

So E_3 will contain $B \to S$.

32. (B)

Here a, b, and c all have 3 different values so we need at least 3 registers r1, r2 and r3.
Assume 'a' is mapped to r1, 'b' to r2 and 'c' to 13.
d = a – b, after this line if u notice 'a' is never present on right hand side, so we can map 'd' to r1.
e = c + d, after this line 'd' is never present on rhs, so we can map 'e' to r1.
at this time mapping is

r1_____e
r2_____b
r3_____c

We have 3 registers for a, b and c.

f = c - e
b = c + e

These two are essentially doing same thing, after these two line 'b' and T are same so we can skip computing 'f' or need not give any new register for 'i'. And wherever 'f' is present we can replace it with 'b', because neither of 'f' and 'b' are changing after these two lines, so value of these will be "c + e' till the end of the program.
At second last line "d = 5 - e"
Here 'd' is introduced, we can map it to any of the register r1 or r3, because after this line neither of 'e' or ' c' is required. Value of 'b' is required because we need to return 'd + f', and 'f' is essentially equal to 'b'
finally, code becomes

r1 = 1
r2 = 10
r3 = 20
r1 = r1 + r2
r1 = r3 + r1
r2 = r3 + r1
r2 = r3 + r1
r1 = r2 + r2
r3 = 5 + r1
return r3 + r2

Therefore minimum 3 registers needed.

33. (B)

Statement II is false, as a programming language which allows recursion requires dynamic storage allocation. Statement III is false, as L-attributed definition (assume for instance the L-attributed definition has synthesized attribute only) can be evaluated in bottom-up framework.
Statement I is true, as the bottom-up and top-down parser take O (n) time to parse the string, i.e. only one scan of input is required.
Statement IV is true, Code improving transformations can be performed at both source language and intermediate code level. For example implicit type casting is also a kind of code improvement: which is done during semantic analysis phase and intermediate code optimization is a topic itself which uses various techniques to improve the code such as loop unrolling, loop invariant.

34. (B)

(after removing left recursion)

$S \to S'$

$S' \rightarrow S + S' / S * S' / a / \in$

$FIRST(S) = \{a, \in\}$

$FIRST(S') = \{a, \in\}$

$FOLLOW(S) = \{+, *\}$

$FOLLOW(S') = \{+, *\}$

35. (A)

S_1 is correct

With triple optimization we cannot change the execution order but with indirect triple we can.

36. (C)

x is inherited

y is synthesized.

37. (C)

Lexical analyzer → Syntax analyzer → Semantic analyzer → intermediate code → Code optimizer.

38. 34

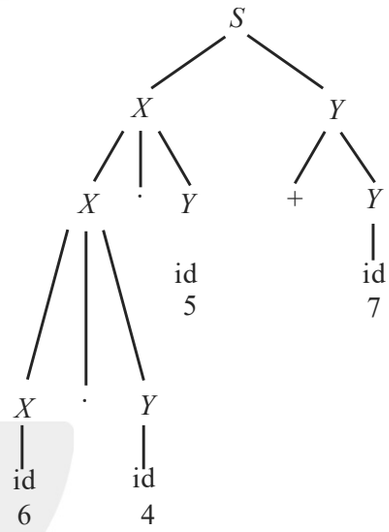
```
main ( )
  1   2  3
{
4
     int temp = 200, 10  ;
      5     6    7  8  9 10 11
      int  l1 ,  l2  ;
     12  13 14 15 16
      temp = ++ temp  ;
       17  18 19 20 21
      l1  +  = l2
      22 23  24
      printf("%d", temp + l1) ;
        25 26 27  28  29 30 31 32 33
}
34
```

39. (D)

$\underbrace{cab}_{2}\underbrace{ac}_{1}\underbrace{cc}_{3}\ \underbrace{ab}_{\text{not generated}}$

Hence, lexical error will generate.

40. (C)



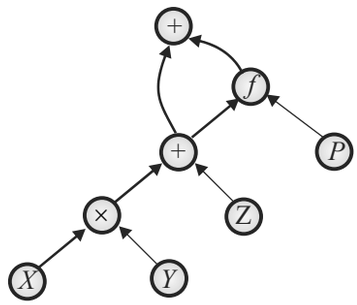
Output: $64*5*7-$

41. (D)

Statement S_1 and S_2 are correct

Statement S_3 in incorrect. Heap and stack both are present in main memory

42. 8



Total 8 edges

43. 2

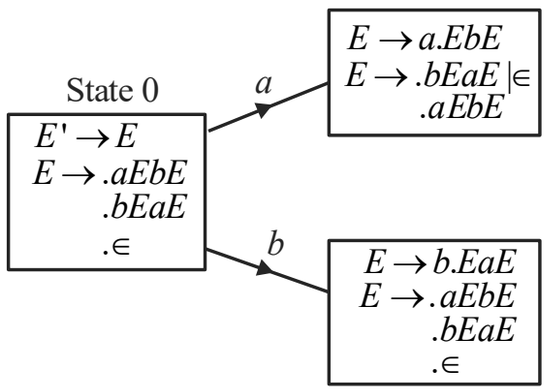
Statement I and IV is correct

Type checking is done at semantic analysis phase

Target code generation is dependent based on the machine

Symbol table is accessed during lexical, syntax and semantic analysis phase.

44. (A)



In state 0, there is reduce $E \rightarrow \in$ which will go under of 'E' which $\{a, b\}$ and also at state 0,

There is shift at 'a' and 'b'. Hence, there is shift reduce conflict.

45. (D)

$S \rightarrow aabc \mid ab$

There is left factoring in LL (1). Hence, not LL (1) but it is LL (2).

Every regular language is LL (1) is true. There exist a regular grammar which is LL (1).

Every regular grammar is LL (1) is false, because regular grammar may contain left recursion, left factoring ambiguity.

46. (D)

A grammar G is said to be operator grammar if

(a) it does not contain null production

(b) it does not contain 2 adjacent variables on right hand side

So, both G_1 and G_2 are not operator grammar.

47. (B)

To go from CLR(1) parsing table to LALR(1) parsing table, we merge the states that have the same final items but different lookaheads.

In doing so, we can only introduce RR conflicts.

48. (D)

Handle is part of the string in sentential form that will be reduced to non-terminal i.e left hand side of a production

In the above derivation, sentential form $Aabw$ is reduced to ABw so has to be a production with $B \rightarrow ab$ and that is the handle at this point of derivation.

49. (C)

1. In a SLR(1) parser, it is allowable for both shift and reduce items to be in the same state even though it leads to sr conflict but it is allow

2. In a SLR(1) parser, it is allowable for multiple reduce items to be in the same state even though it leads to sr conflict but it is allow

3. All SLR(1) grammars are LR(0) this statement is wrong Reason is

LR(0) < SLR(1) < LALR(1) < CLR(1)

→ If a grammar is LR(0) then it is also SLR(1), LALR(1), CLR(1).

→ If a grammar is SLR(1) then it is also LALR(1), CLR(1).

→ If a grammar is LALR(1) then it is also CLR(1).

4. All LR(0) grammars are SLR(1)

Therefore C is incorrect.

50. (D)

Since LR(0) parser places reduce-moves in the entire row of "Action", having anything more than just the reduce-move in the state having final-item would lead to SR or RR conflict.

So, Options A, B, and C are true.

51. (A)

A top-down parse produce a leftmost derivation of a sentence.

A bottom-up parse produces a rightmost derivation of a sentence but in reverse.

52. (D)

LL(0) grammars have no lookhead. And since they follow Leftmost derivation, at each step the parser has to derive the string by seeing 0 symbols $\Rightarrow$ Parser sees nothing.

So whenever we have multiple choices for any Variable in the grammar, LL(0) fails.

Hence, LL(0) parser can only parse grammars that strictly generate one single string.

53. (A)

LL(1) is a top-down or predictive parser

REC Decent is predictive

REC Ascent is a technique for implementing an LALR parser so Bottom up

LR(1) is bottom-up or DCFL, since LR(K) accepts DCFL

54. (C)

$$\in -\text{free LL(1)} \subset \text{SLR(1)} \subset \text{LR(1)}$$

Because every $\in -\text{free LL(1)}$ are SLR(1) and every SLR(1) are LR(1)

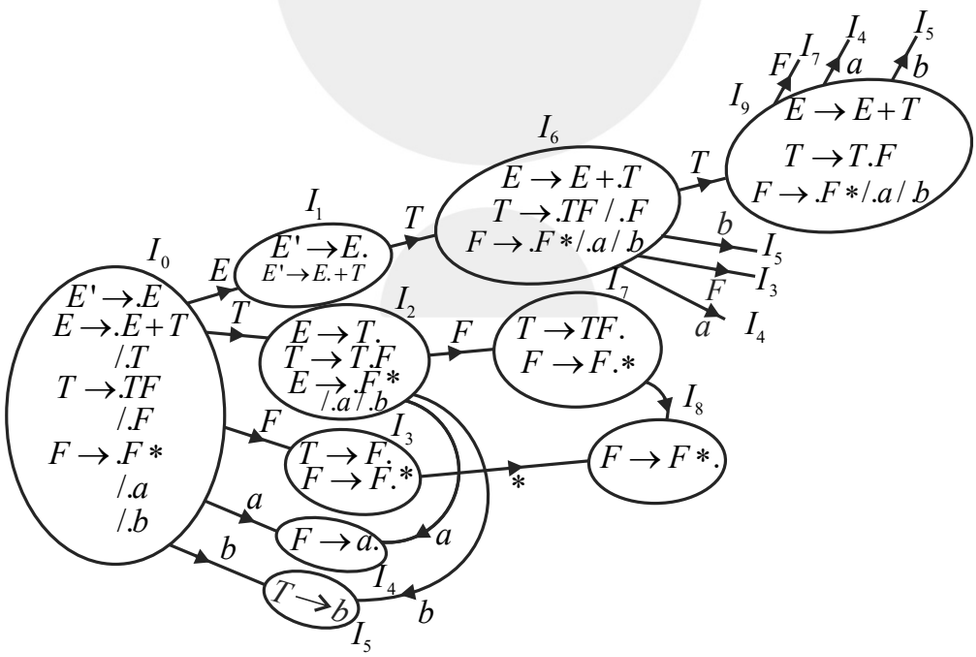
55. (C)

In operator relation table if we have 4 operator then we got is 16 cells so if we have n operator then n^2 is table size.

But in operator function table if we have 4 operators then we got 8 cells so if we have n operator then we got $2n$ table size.

So the option C is the correct option

56. 10



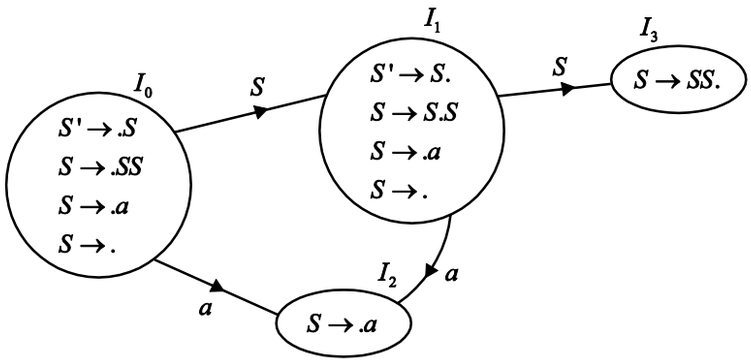
So total 10 states are required

57. (B)

RR conflict:- Means reduce reduce conflict, that means a single state have more than one final production.

SR conflict means in a state there is a final production and here shift more are also occurred. So we find RR & SR conflict in our LR (0) item

$S \rightarrow SS \mid a \mid \in$



In the above LR (0) item I_0 has a final item and it shift to I_2 So I_0 have one SR conflict

in the state I_1 has two Final item so here RR conflict occurred and in I_1 have shift move also, it moves to I_2 So it's have one SR conflict state

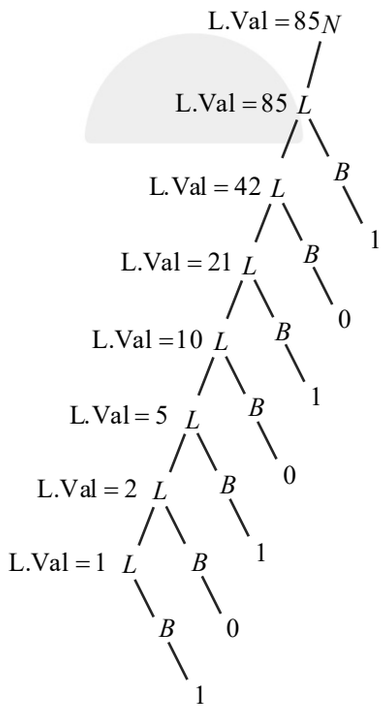
$I_2 \& I_3$ have no conflict so total SR conflicts are 2 (1 in $I_0 \& 1 \text{in} I_1$)

And RR conflicts are only 1 (in I_1)

So the option B is correct option.

58. 85

So it is a logic of binary to decimal conversion



Finally N.val is 85 so the answer is 85

8 Operating System

Practice Questions

Q.1 A circular queue is the most appropriate data structure for
(A) FCFS scheduling
(B) Round Robin scheduling
(C) SJF scheduling
(D) None of these.

Q.2 Which of the following is not possible?
(A) Run→Ready
(B) Blocked→Run
(C) New→Ready
(D) Run→Terminated

Q.3 Which of the following does not interrupt a running process?
(A) A device
(B) Timer
(C) Scheduler process
(D) Power failure

Q.4 Consider the given statements
S1 : If a user-level thread is blocked for I/O operation, then other thread of same process can be scheduled by operating system.
S2 : Multiprogramming is used to improve CPU utilization.
S3 : Multitasking is implemented to improve CPU responsiveness.
Which of the given is/are true?
(A) S1 and S2
(B) S2 and S3
(C) S1 and S3
(D) S1, S2 and S3

Q.5 Which of the following will not be included in the Process Control Block of a Process ?
(A) Process State
(B) Program Counter
(C) Priority
(D) None of these

Q.6 Which one of the following is NOT shared by the threads of the same process?
(A) Stack
(B) Address Space
(C) File Descriptor Table
(D) Message Queue

Q.7 How many process will be created when we run this program

```
main( )
{
    printf("Hello")
    fork ( );
    fork ( );
    fork ( );
}
```

(A) 2 (B) 8
(C) 4 (D) 7

Q.8 On receiving an interrupt from an I/O device, the CPU

(A) Halts for a predetermined time

(B) Hands over control of address bus and data bus to the interrupting device

(C) Branches of the interrupt service routine immediately

(D) Branches off the interrupt service routine after completion of the current instruction.

Q.9 Concurrent processes are

(A) Do not overlap in time

(B) Overlap in time

(C) Are executed by a processor at the same time

(D) None of the above

Q.10 Consider the following set of process with their arrival time and burst times

[MSQ]

Process	(msec) Arrival time	(msec) Burst time
P1	0	7
P2	2	4
P3	3	5
P4	1	2

The average turnaround time and average waiting time are, if you are using shortest remaining time first (SRTF).

(A) Average TAT = 8.5 msec

(B) Average WT = 4 msec

(C) Average TAT = 8.25 msec

(D) Average WT = 4.25 msec

Q.11 Consider the following set of processes in process information table.

Process Id	Arrival Time (msec)	Burst time (msec)
P1	0	4
P2	3	2
P3	5	1
P4	1	3
P5	7	5

The absolute difference in average TAT of FCFS and SJF is _____ msec (upto 2 decimal places).

Q.12 In a lottery scheduler with 40 tickets, distributed among 4 processes as 10%, 5%, 60%, and 25% tickets respectively. Executing each ticket code it needs 1 msec. Processes P_0, P_1, P_2, P_3 having Input output operation of 5 msec, 8 msec, 3 msec and 2 msec respectively. After executing code, the operating system uses a shortest remaining compute time first scheduling algorithm and schedules a new process either when the running process gets blocked on Input output or when running process finishes its compute burst. Assume that all Input output operations can be overlapped as much as possible for what percentage of time does the CPU remains idle?

[All process arrives at 0 msec, context switch time = 1 msec]

(upto two decimal places]

Q.13 Consider 800 Kbytes memory is managed using variable partitions, there is no compaction used. If current two process of size 210 Kbytes and 140 Kbytes are allocated into memory. The smallest size of allocation request in Kbytes that can be denied is equal to

(A) 450 (B) 151

(C) 400 (D) 451

Q.14 Consider a system with specifications :

Virtual address space $= 4$ GB

Physical address space $= 4$ GB

Page size $= 1$ kB

The TLB (Translation Look aside Buffer) used in the system which has 128 entries. The number of virtual addresses translated by the TLB is _____.

Q.15 Consider three CPU-intensive processes, which require 10, 20 and 30 time units and arrive at times 0, 2 and 6 respectively. How many context switches are needed if the operating system implements a shortest remaining time first scheduling algorithm?

(Do not count the context switches at time zero and at the end)

(A) 1 (B) 2

(C) 3 (D) 4

Q.16 Let S be the binary semaphore variable S=1 initially. Assume that no blocked processes exit in the system. If the following operations performed how many blocked processes are present in the system at the end?

5 P, 7 V, 10 P, 12 V, 18 P, 24 V

(A) 0 (B) 13

(C) 14 (D) 11

Q.17 Consider the page references 1, 3, 5, 6, 3, 1, 3, 5

Assume that main memory can accommodate 3 pages and the main memory already has the page 1 and 3 with page. 1 having been brought earlier than page 3. If LRU algorithm is used, then number of page faults that occur would be _____.

Q.18 Consider the following process table:

	Arrival time	**Burst time**
P_1	1	4
P_2	2	8
P_3	3	5
P_4	4	6

If found robin scheduling (with time slice = 2 units) is used to schedule above processes, then the number of context switches (don't consider start and end context switches) is_____

Q.19 Consider a system with five processes and a single resource of multiple instances.

	Allocation	Maximum needed
P_1	2	4
P_2	2	3
P_3	4	10
P_4	3	8
P_5	1	6

Then minimum number of resources need to be available, for the system to be in safe state is _____.

Q.20 Consider a counting semaphore value as 25, if 33 down operations are performed followed by 50 up operations, then resultant value of semaphore is _____.

Q.21 What could be a possible output of following program:

```
main ( )
    {
fork ( );
printf ("X");
fork ( );
printf("Y");
fork( );
printf("Z");
```

}

(A) XYYZZZ

(B) XXYYYZZZZZ

(C) XXYYYYZZZZ

(D) XXYYYYZZZZZZZZ

Q.22 Consider the following program segment, we want to synchronize process P and Q using semaphore X = 1, Y = 0

void Process P_1	void process P_2
{	{
while (1)	while (1)
{	{
P(X);	P(X);
printf ("1")	printf("0")
P(Y);	V(X)
}	V(Y)
}	}
	}

(While P and V are the usual semaphore operation) what will be the output of the following program segment?

(A) It will print 010101

(B) It will print 001001

(C) It will print 101010

(D) None of the above

Q.23 Which of the following system call is generally paired with fork ( ) in the implementation of UNIX shell

[MSQ]

(A) exec() (B) pipe( )

(C) ioctl() (D) wait()

Q.24 Consider the following two arguments:

S1: FIFO scheduling results in the shortest possible average response time if the jobs happen to arrive in the ready queue with the shortest completion times first (or as a special case, if all jobs have the same completion time).

S2: Round robin scheduling behaves identically to FIFO if all the job lengths are longer than the length of the time slice.

Which of the above arguments is correct?

(A) Only S1

(B) Only S2

(C) Both (A) and (B)

(D) None of these

Q.25 Consider a paged virtual memory system with 32-bit virtual addresses and 1 KB page

size. Each page table entry requires 32 bits. It is desired to limit the page table size to one page. Assume multi-level paging is used to implement the above requirement then how many level are required?

(A) 5 (B) 2

(C) 4 (D) 3

Q.26 Consider the following set of processes with their Arrival Times and Burst Times

Process	Arrival Time	Burst Time
P1	0	10
P2	1	7
P3	2	6
P4	3	5

The average Turnaround time and average waiting times are, if we are using the Highest Response Ratio Next Scheduling algorithm is used. (Assume there is no pre-emption)

(A) 11.18 (B) 18.11

(C) 10.17 (D) 17.10

Q.27 Consider an operating system that uses 48-bit virtual addresses and 16KB pages. The system uses a hierarchical page table design to store all the page table entries of a process, and each page table entry is 4 bytes in size. What is the total number of pages that are required to store the page table entries of a process, across all levels of the hierarchical page table?

(A) $2^{22}+1$ (B) $2^{10}+1$

(C) $2^{22}+2^{10}+1$ (D) 2^{22}

Q.28

P1: repeat Obtain an empty buffer Fill it Return a full buffer forever	P2: repeat Obtain a full buffer empty it Return an empty buffer forever

style = “font-weight : 400;”> increasing the number of buffers is likely to do which of the following?

I. Increase the rate at which requests are satisfied (throughput)

II. Decrease the likelihood of deadlock

III. Increase the ease of achieving a correct implementation

(A) III only

(B) II only

(C) I only

(D) II and III only

Q.29 Consider a job scheduling problem with 4 jobs J_1, J_2, J_3, J_4 and with corresponding deadlines: $(d_1, d_2, d_3, d_4) = (4, 2, 4, 2)$. Which of the following is not a feasible schedule without violating any job schedule?

(A) J_2, J_4, J_1, J_3 (B) J_4, J_1, J_2, J_3

(C) J_4, J_2, J_1, J_3 (D) J_4, J_2, J_3, J_1

Q.30 Virtual memory is

(A) Part of Main memory only used for swapping

(B) A technique to allow a program, of size more than the size of main memory, to run

(C) Part of secondary storage used in program execution

(D) None of these

Q.31 The number of page frames that must be allocated to a running process in a virtual memory environment is determined by

(A) The instruction set architecture

(B) Page size

(C) Number of processes in memory

(D) Physical memory size

Q.32 A particular parallel program computation requires 100 sec when executed on a single processor. If 40 % of this computation is inherently sequential (i.e. will not benefit from additional processors), then theoretically best possible elapsed times of this program running with 2 and 4 processors, respectively, are

(A) 20 sec and 10 sec

(B) 30 sec and 15 sec

(C) 50 sec and 25 sec

(D) 70 sec and 55 sec

Q.33 The Operating System of a computer may periodically collect all the free memory space to form contiguous block of free space. This is called:

(A) Concatenation

(B) Garbage collection

(C) Collision

(D) Dynamic Memory Allocation

Q.34 Disk requests come to a disk driver for cylinders in the order 10, 22, 20, 2, 40, 6 and 38 at a time when the disk drive is reading from cylinder 20. The seek time is 6 ms/cylinder. The total seek time if the disk arm scheduling algorithms is first-come-first-served is 360 ms

(A) 360 ms

(B) 850 ms

(C) 900 ms

(D) None of the above

Q.35 Four jobs to be executed on a single processor system arrive at time 0 in the order A, B, C, D. Their burst CPU time requirements are 4,1,8,1 time units respectively. The completion time of A under round robin scheduling with time slice of one time unit is

(A) 10 (B) 4

(C) 8 (D) 9

Q.36 What is the output of the following program?

```
main ( )
{
    int a = 10:
    if ((fork ( ) =  = 0))
    a++;
    printf("%d\n",a);
}
```

(A) 10 and 11 (B) 10

(C) 11 (D) 11 and 11

Q.37 At a particular time, the value of a counting semaphore is 10, it will become 7 after:

(A) 3 V operations

(B) 3 P operations

(C) 5 V operations and 2 P operations

(D) 2 V operations and 5 P operations

Which of the following option is correct?

(A) Only (b) (B) Only (d)

(C) Both (b) and (d) (D) None of these

Q.38 Consider a set of 5 processes whose arrival time, CPU time needed and the priority are given below:

Process	Arrival Time (in ms)	CPU Time Needed	Priority
P1	0	10	5
P2	0	5	2
P3	2	3	1
P4	5	20	4
P5	10	2	3

(smaller the number, higher the priority) If the CPU scheduling policy is priority scheduling without preemption, the average waiting time will be

(A) 12.8 ms (B) 11.8 ms

(C) 10.8 ms (D) 9.8 ms

Q.39 At a particular time of computation the value of a counting semaphore is 7. Then 20 P operations and *x*V operations were completed on this semaphore. If the new value of semaphore is 5, x will be

(A) 18 (B) 22

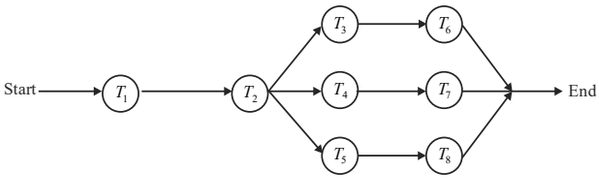
(C) 15 (D) 13

Q.40 Consider three CPU-intensive processes, which require 10, 20 and 30 time units and arrive at times 0, 2 and 6, respectively. How many context switches are needed if the operating system implements a shortest remaining time first scheduling algorithm? Do not count the context switches at time zero and at the end.

(A) 1 (B) 2

(C) 3 (D) 4

Q.41 Below is the precedence graph for a set of tasks to be executed on a parallel processing system S.



What is the efficiency of this precedence graph on S if each of the tasks T1, T2, T3… T8 takes the same time and the system S has five processors?

(A) 25 % (B) 40 %

(C) 50 % (D) 90 %

Q.42 Consider a set of 5 processes whose arrival time, CPU time needed and the priority are given below:

Process Priority	Arrival Time (in ms)	CPU Time Needed (in ms)	Priority
P_1	0	10	5
P_2	0	5	2
P_3	2	3	1
P_4	5	20	4
P_5	10	2	3

Note: Smaller the number higher the priority

If the CPU scheduling Policy is SJF, the average waiting time (without pre-emption) will be

(A) 12.8 ms

(B) 6.8 ms

(C) 17 ms

(D) None of the above

Q.43 Suppose a system contains n processes and system uses the round robin algorithm for CPU scheduling then which data structure is best suited ready queue of the processes.

(A) Stack

(B) Queue

(C) Circular queue

(D) Tree

Q.44 Semaphores are used to solve the problem of

1. Race condition
2. Process synchronization
3. Mutual exclusion

(A) 1 and 2

(B) 2 and 3

(C) All of the above

(D) None of the above

Q.45 An operating system implements a policy that requires a process to release all resources before making a request for another resource.

(A) Both starvation and deadlock can occur

(B) Starvation can occur but deadlock cannot occur

(C) Starvation cannot occur but deadlock can occur

(D) Neither starvation nor deadlock can occur

Q.46 Suppose that a certain computer will paged virtual memory has 4 KB pages, a 32 bit byte addressable virtual address space and, 30 bit byte-addressable physical address space. The system manages an inverted page table. Where each entry includes the page number plus 12 overhead bits. How big is the basic inverted page table including page number and overhead bits?

(A) 2^{10} B (B) 2^{20} B

(C) 2^{30} B (D) 2^{32} B

Common Data for Questions 47 & 48

Consider a paging system with 16 MB of physical memory, 256 pages of logical address space and page size of 1 KB.

Q.47 How many bits are in logical address space

(A) 8 bits (B) 12 bits
(C) 18 bits (D) 16 bits

Q.48 Suppose that the head of a moving head disk with 192 tracks, numbered 0 to 191, is currently serving a request at track 80 and has just finished at track 62. The queue of the request is kept in the FIFO order: 119, 58, 114, 28, 111, 55, 103, 30, 75. What is the total number of tracks traversed by head movements needed to satisfy these request for the Elevator disk-scheduling algorithms?

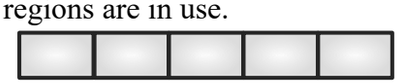
(A) 143 (B) 130
(C) 177 (D) 547

Q.49 The correct matching for the following pairs is

A	Disk scheduling	1	Round robin
B	Batch processing	2	SCAN
C	Time sharing	3	LIFO
D	Interrupt processing	4	FIFO

(A) a-3, b-4, c-2, d-1
(B) a-4, b-3, c-2, d-1
(C) a-2, b-4, c-1, d-3
(D) a-3, b-4, c-3, d-2

Q.50 Consider the following heap in which blank regions are not in use and hatched regions are in use.



The sequence of requests for blocks of size, 150, 12.5, 62.5, 25 can be satisfied if we use,

(A) First fit but not best fit policy
(B) Best fit but not first fit policy
(C) Either first fit or best fit policy
(D) None of the above

Q.51 Consider system with specifications

TLB hit rate = 85%

TLB access time = 5 msec

Memory access time = 150 msec

_____ percentage memory access is slow down due to two level paging? (rounded upto two decimal places).

Q.52 Consider a single level paging scheme. The logical address space is 8 MB and page size is 4 kB. The maximum page table entry size possible such that the entire page table fits well in one page is _____ bytes

Q.53 Consider a single level paging scheme. The virtual address space is 8 GB and page table entry size is 4 bytes. The minimum page size possible such that entire page table fits well into single page is _____ kB. (integer value only)

Q.54 Consider a system using multilevel paging scheme. The page size is 1 MB. The memory is byte addressable and virtual address is 64 bits long. The page table entry size is 4 bytes, The number of bits required to search an entry in outer page table is _____

Q.55 Consider a system with Logical address space = physical address space = 2^{16} Bytes. System uses segmented paging, pager apply on segment pages are power of 2 in size and page table entry size is 4 B. The page size of

segment is _____, so that page table of segment exactly fit into one page. Let consider LAS is divided into 8 equal size segment. (integer value only)

Q.56 A CPU has two modes - privileged and non-privileged. In order to change the mode from privileged to non-privileged

(A) A hardware interrupt is needed.

(B) A software interrupt is needed.

(C) A privileged instruction (which does not generate an interrupt) is needed.

(D) A non- privileged instruction (which does not generate an interrupt) is needed.

Q.57 Consider the following statements about user level threads and kernel level threads.

Which one of the following statements is FALSE?

(A) Context switch time is longer for kernel level threads than for user level threads.

(B) User level threads do not need any hardware support.

(C) Related kernel level threads can be scheduled on different processors in a multi- processor system.

(D) Blocking one kernel level thread blocks all related threads.

Q.58 An operating system uses Shortest Remaining Time First (SRT) process scheduling algorithm. Consider the arrival times and execution times for the following processes:

Process	Execution time	Arrival Time
P1	20	0
P2	25	15
P3	10	30
P4	15	45

What is the total waiting time for process P2?

(A) 5 (B) 15

(C) 40 (D) 55

Q.59 For the processes listed in the following table, which of the following scheduling schemes will give the lowest turnaround time?

Process	Arrival time	Processing time
A	0	3
B	1	7
C	4	4
D	6	2

(A) First Come First Serve

(B) Non- preemptive Shortest Job First

(C) Shortest Remaining Time

(D) Round Robin with Quantum value two

Q.60 Consider three concurrent processes P1, P2 and P3 as shown below, which access a shared variable D that has been initialized to 100

P1	P2	P3
:	:	:
:	:	:
D = D + 20	D = D – 50	D = D + 10
:	:	:
:	:	:

The processes are executed on a uniprocessor system running a time – shared operating system .If the minimum and maximum possible values of D after the three process have completed are X of Y respectively, then the value of Y-X is _____.

Q.61 Which of the following is **NOT** true of deadlock prevention and deadlock avoidance schemes?

(A) In deadlock prevention, the request for resources is always granted if the resulting state is safe

(B) In deadlock avoidance, the request for resources is always granted if the resulting state is safe

(C) Deadlock avoidance is less restrictive than deadlock prevention.

(D) Deadlock avoidance requires knowledge of resource requirements apriori.

Q.62 A system has 6 identical resources and N processes competing for them. Each process can request at most 2 resources. Which one of the following values of N could lead to a deadlock?

(A) 1 (B) 2

(C) 3 (D) 6

Q.63 A system shares 9 tape drives. The current allocation and maximum requirement of tape drives for that processes are shown below:

Process	Current Allocation	Maximum Requirement
P1	3	7
P2	1	6
P3	3	5

Which of the following best describes current state of the system?

(A) Safe, Deadlocked

(B) Safe, Not Deadlocked

(C) Not Safe, Deadlocked

(D) Not Safe, Not Deadlocked

Q.64 Indicate all the false statements from the statements given below: **[MSQ]**

(A) The amount of virtual memory available is limited by the availability of secondary storage.

(B) Any implementation of a critical section requires the use of an indivisible machine – instruction such as test-and-set.

(C) The use of monitors ensures that no deadlocks will be caused.

(D) The LRU Page- replacement policy may cause thrashing for some type of programs.

Q.65 The capacity of memory units is defined by the number of words multiplied by the number of bits/work. How many separate address and data lines are needed for a memory of 4K × 16?

(A) 10 address, 16 data lines

(B) 11 address, 8 data lines

(C) 12 address, 16 data lines

(D) 13 address, 12 data lines

Q.66 Consider a machine with 64 MB physical memory and a 32- bit virtual address space. If the page size is 4KB, what is the approximate size of the page table?

(A) 16 M (B) 8MB

(C) 2MB (D) 24MB

Q.67 Consider a virtual memory system with FIFO page replacement policy. For an arbitrary page access pattern, increasing the number of page frames in main memory will

(A) Always decrease the number of page faults

(B) Always increase the number of page faults

(C) Sometimes increase the number of page faults

(D) Never affect the number of page faults.

Q.68 Assume that there are 3 page frames which are initially empty. If the page reference string is 1, 2, 3, 4, 2, 1, 5, 3, 2, 4, 6, the number of page faults using the optimal replacement policy is ____.

Q.69 Consider a computer system with 40-bit virtual addressing and page size of sixteen kilobytes. If the computer system has a one- level page table per process and each page table entry requires 48 bits, then the size of the per-process page table is_____ megabytes.

Q.70 Recall that Belady's anomaly is that the page-fault rate may increase as the number of allocated frames increases. Now, consider the following statements:

S1 : Random page replacement algorithm (where a page chosen at random is replaced)

Suffers from Belady's anomaly

S2 : LRU page replacement algorithm suffers from Belady's anomaly

Which of the following is CORRECT?

(A) S1 is true, S2 is true

(B) S1 is true, S2 is false

(C) S1 is false, S2 is true

(D) S1 is false, S2 is false

Q.71 Disk requests come to disk driver for cylinders 10, 22, 20, 2, 40, 55 and 36, in that order at a time when the disk drive is reading from cylinder 20. The seek time is 6 msec per cylinder. Compute the total seek time if the disk arm scheduling algorithm is

(A) First come first served

(B) Closest cylinder next

Q.72 Which of the following is true?

(A) When interrupt is enabled, a CPU will be able to process the interrupt.

(B) Loop instructions cannot be interrupted till they complete.

(C) A processor checks for interrupts before executing a new instruction.

(D) Only level triggered interrupts are possible on microprocessors.

Q.73 Consider a disk system with 100 cylinders. The requests to access the cylinders occur in following sequence:

4, 35, 10, 7, 19, 73, 2, 15, 6, 20

Assuming that the head is currently at cylinder 50, what is the time taken to satisfy all requests if it takes 1 ms to move from one cylinder to adjacent one and shortest seek time first policy is used?

(A) 95 ms (B) 119 ms

(C) 233 ms (D) 276 ms

Q.74 An application loads 100 libraries at startup. Loading each library requires exactly one disk access. The seek time of the disk to a random location is given as 10 ms. Rotational speed of disk is 5000 rpm. If all 100 libraries are loaded from random locations on the disk, how long does it take to load all libraries? (The time to transfer data from the disk block once the head has been positioned at the start of the block may be neglected.)

(A) 0.50 s (B) 1.00 s

(C) 1.6 s (D) 1.50 s

Q.75 A FAT (File allocation table) based file system is being used and the total overhead of each entry in the FAT is 4 bytes in size. Given a 100×10^6 bytes disk on which the file system is stored and data block size is 10^3 bytes, the maximum size of a file that can be stored on this disk in units of 10^6 bytes is___.

Answers Operating System

1.	B	2.	B	3.	C	4.	B	5.	D
6.	A	7.	B	8.	D	9.	B	10.	A,D
11.	0.6	12.	14.89	13.	B	14.	131072	15.	B
16.	D	17.	3	18.	11	19.	1	20.	42
21.	D	22.	D	23.	A,D	24.	A	25.	D
26.	D	27.	D	28.	C	29.	B	30	B
31.	A	32.	D	33.	B	34.	D	35.	D
36.	A	37.	C	38.	C	39.	A	40	B
41.	B	42.	B	43.	C	44.	B	45.	D
46.	B	47.	C	48.	D	49.	C	50.	A
51.	33.33	52.	2	53.	181	54.	8	55.	181
56.	D	57.	D	58.	B	59.	C	60.	80
61.	A	62.	D	63.	B	64.	B,D	65.	C
66.	C	67.	C	68.	7	69.	384	70.	B
71.	*	72.	C	73.	B	74.	C	75.	99.6

Explanations Operating System

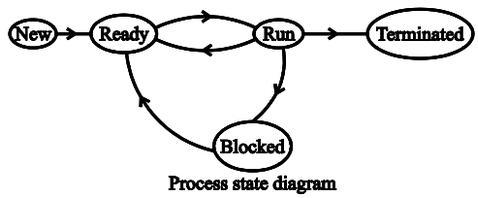
1. (B)

Round Robin scheduling uses circular queue for its implementation.

Hence, the correct option is (B).

2. (B)

Blocked to ready then to run is possible sequence.



Process state diagram

Hence, the correct option is (B).

3. (C)

Scheduler cannot interrupt a running process, but Device, timer and power failure can interrupt a running process

Hence, the correct option is (C).

4. (B)

Operating system does not have information about user level threads, it consider all threads of a process as a single process itself.

If one thread of user level is doing I/O it block entire user level process.

When many processes are present in main memory, if one process is busy on input/output

then other process can be scheduled on CPU from main memory. Hence, multiprogramming improve CPU utilization.

When CPU is time shared among multiple task is known as multitasking. It is done to increase responsiveness.

Hence, the correct option is (B).

5. (D)

Process Control Block (PCB) holds the information about a process.

Process ID
State
Pointer
Priority
Program counter
CPU registers
I/O information
Accounting information
Etc.

PCB diagram

Hence, the correct option is (D).

6. (A)

Stack and register are not shared by the threads of the same process while address space, message queue etc. are shared.

Hence, the correct option is (A).

7. (B)

The number of processes created =

$$2^{\text{number of times the fork called}}$$

$$2^3 = 8$$

But the number of child processes $= 2^3 - 1 = 7$

8. (D)

Branches off the interrupt service routine after finishing current execution.

9. (B)

Concurrent processes overlap in time.

10. A,D

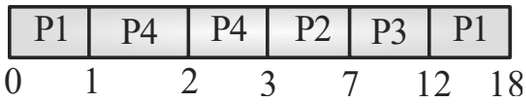
CT $\rightarrow$ Completion time

TAT $\rightarrow$ Turn Around time

WT $\rightarrow$ Waiting Time

PID	AT	BT	CT	TAT	WT
P1	0	6	18	18	12
P2	2	4	7	5	1
P3	3	5	12	9	4
P4	1	2	3	2	0

GANTT Chart



TAT = CT – AT

WT = TAT – BT

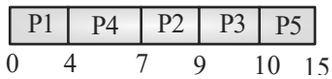
$$\text{Avg. TAT} = \frac{18+5+9+2}{4} = 8.5$$

$$\text{Avg. WT} = \frac{12+1+4+0}{4} = 4.25$$

Hence, the correct options are (A, D).

11. 0.6

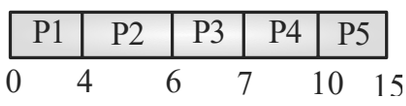
In FCFS



AT	CT	TAT
0	4	4
3	9	6
5	10	5
1	7	6
7	15	8

$$\text{Average TAT} = \frac{4+6+5+6+8}{5} = 5.8$$

In SJF



AT	CT	TAT
0	4	4
3	6	3
5	7	2
1	10	9
7	15	8

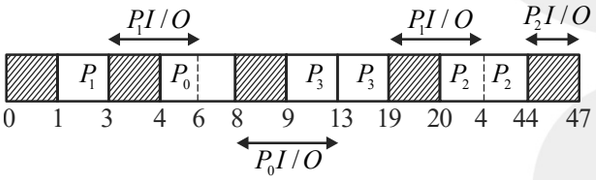
$$\text{Average TAT} = \frac{4+3+2+9+8}{5} = \frac{26}{5} = 5.2$$

Hence, absolute difference $= |5.8 - 5.2| = 0.6$

12. 14.89

Process	CPU Tine (msec)	Input/Output time (msec)
P_0	4	5
P_1	2	8
P_2	24	3
P_3	10	2

Gantt Chart

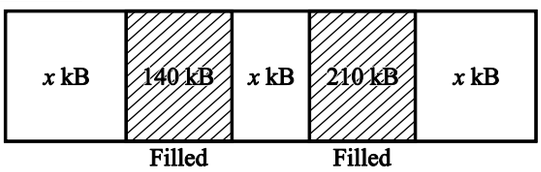


$$\text{CPU remains idle} = \frac{07}{47} \times 100$$

$$= 14.89\%$$

Hence, the correct answer is 14.89

13. (B)



Consider memory is allocated in above manner.

$$x + 140 + x + 210 + x = 800$$

$$3x + 350 = 800$$

$$3x = 450$$

$$x = \frac{450}{3}$$

$$x = 150 \text{ kB}$$

Hence, smallest memory request that cannot be fulfilled = 151 kB.

14. 131072

Logical address space $= 2^{32}$ B

LA = 32 bit

Page size $= 2^{10}$ B

Each byte is an address and each page consist of 1024 addresses

Total addresses mapped by TLB = number of TLB entries × number of address per page

$= 128 \times 1024$

$= 131072$

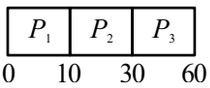
15. (B)

Given :

Let three processes are P_1, P_2 and P_3

Process	Arrival time	Burst time
P_1	0	10
P_2	2	20
P_3	6	30

The Gantt chart for SRTF scheduling algorithm is



So, there is only two context switches at time unit 10 context switches P_1 and P_2 and at time unit 30 context switch from P_2 to P_3.

Hence, the correct option is (B).

16. (D)

Initially $S = 1$

$P =$ Down operation $(-)$

$V =$ Up operation $(+)$

So,

$$1 - 5P = -4$$

Now $-4 + 7V = 3$

$3-10=-7$

$-7+12=5$

$5-18=-13$

$-13+24=11$

Hence, the correct option is (D).

17. 3

1, 3, 5, 6, 3, 1, 3, 5

1 6 5
3
5 1

= 3 page faults

Hence, the correct answer is 3.

18. 11

P_1	P_2	P_3	P_1	P_4	P_2	P_3	P_4	P_2	P_3	P_4	P_2

Ready Queue:

$P_1, P_2, P_3, P_1, P_4, P_2, P_3, P_4, P_2, P_3, P_4, P_2$

Hence, the correct answer is 11.

19. 1

Need matrix:

Process	Need
P_1	2
P_2	1
P_3	6
P_4	5
P_5	5

Resources required to be available is 1.

20. 42

Given:

Counting semaphore value = 25

33 down operations results semaphore value to be $25-33=-8$ and 50 UP operations result semaphore value to be $-8+50=42$

21. (D)

The order of execution of processes are not unique, that is they can execute in any manner. But, there should be 2-X's and 4-Y's and 8-Z's in the result.

22. (D)

Value of the semaphore X = 1 and Y = 0

If Process P_1 execute first then after executing the P(X), X value become 0 and it will print 1. P(Y) is executed, value of semaphore Y is 0 so Process P_1 is blocked and if Process P_2, started executing, after executing P(X). X value is 0 so Process P_2, is also block this is a deadlock condition.

P_2 can run forever and in that case output will be 00000….

So option (D) is correct.

23. A,D

exec () will execute the given command and wait () will allow the parent to wait till child completes.

So, exec () and wait ( ) system call is generally paired with fork ( ) in the implementation of UNIX shell

24. (A)

FIFO scheduling results in the shortest possible average response time if the jobs happen to arrive in the ready queue with the shortest completion times first (or. as a special case, if all jobs have the same completion time).

Round robin scheduling behaves identically to FIFO if the job lengths are No longer than the length of the time slice. So. SI is true. S2 is false.

25. (D)

Page table size of 1^{st} level $= \frac{2^{32}B}{2^{10}B} \times 4B$

$= 2^{24}B > 1\text{KB}$

Page table size of 2^{nd} level $= \frac{2^{24}B}{2^{10}B} \times 4\text{B}$

$= 2^{16}B > 1\text{KB}$

Page table size of 3^{rd} level $= \frac{2^{16}B}{2^{10}B} \times 4B$

$= 2^{8}B < 1\text{ KB}$

So 3 level of page table required.

26. (D)

Gantt Chart

Processes	P1	P4	P3	P2
CT	10	15	21	28

Ready Queue

AT	0	1	2	3
Processes	P1	P2	P3	P4

Response ratio of

$P2 = (\text{WT} + \text{BT}) / \text{BT} = (9+7)/7 = 2.285$

Response ratio of

$P3 = (\text{WT} + \text{BT}) / \text{BT} = (8+6)/6 = 2.333$

Response ratio of

$P4 = (\text{WT} + \text{BT}) / \text{BT} = (7+5)/5 = 2.4$

Turnaround time of $P1 = 10$

Turnaround time of $P2 = 28 - 1 = 27$

Turnaround time of $P3 = 21 - 2 = 19$

Turnaround time of $P4 = 15 - 3 = 12$

Average Turnaround Time

$= (10 + 27 + 19 + 12)/4 = 17$

Waiting time of P1 = 0

Waiting time of P2 = 21-1 = 20

Waiting time of P3 = 15 – 2 = 13

Waiting time of P4 = 10 – 3 = 7

Average Waiting Time

= (0 + 20 + 13 + 7)/4 = 10

27. (D)

Page size $= 2^{14}$ bytes.

So, the number of page table entries $= \frac{2^{48}}{2^{14}} = 2^{34}$

Each page can store $= \frac{16\,KB}{4} = 2^{12}$ page table entries.

So, the number of innermost pages $= \frac{2^{34}}{2^{12}} = 2^{22}$

Now, pointers to all these innermost pages must be stored in the next level of the page table,

So, the next level of the page table has $\frac{2^{22}}{2^{12}} = 2^{10}$ pages

Finally, a single page can store all the 2^{10} page, table entries, so the outermost level has one page. So, the total number of pages that store page table entries are $2^{22} + 2^{10} + 1$.

28. (C)

It only satisfied statement I, because increasing the memory size increases the rate at which requests are satisfied but can not alter the possibility of deadlock and neither does it play any role in implementation.

Hence, the correct option is (C).

29. (B)

Feasible schedule is completing all the jobs within deadline.

From the dead line, we can deduce that Job J_2 & J_4 will complete by time "2" whereas remaining two requires time "4".

So the order of completion of Jobs are Either J_2 or J_4 and followed by either J_1 or J_3.

From the given option, option A, C & D gives the solution because after completion of jobs J_2 & J_4 then only jobs J_1 & J_3 is going to complete.

But in option B, order of completing jobs is J_4, J_1, J_2, J_3 which is not possible and it is not feasible schedule

Hence, the correct option is (B).

30. (B)

A computer can address more memory than the amount physically installed on the system. This extra memory is actually called virtual memory and it is a section of a hard disk that's set up to emulate the computer's RAM. The main visible advantage of this scheme is that programs can be larger than physical memory. Virtual memory serves two purposes. First, it allows us to extend the use of physical memory by using disk. Second, it allows us to have memory protection, because each virtual address is translated to a physical address.

Hence, the correct option is (B).

31. (A)

There are two important tasks in virtual memory management: a page-replacement strategy and a frame allocation strategy. Frame allocation strategy says gives the idea of minimum number of frames which should be allocated. The absolute minimum number of frames that a process must be allocated is dependent on system architecture, and corresponds to the number of pages that could be touched by a single (machine) instruction. So, it is instruction set architecture.

Hence, the correct option is (A).

32. (D)

The computation requires 100 seconds on a single processor implies that 40% of the computation takes 40 seconds on any number of processors and the remaining 60 % takes 60 seconds on parallel computation which becomes 30 seconds on two processors and 15 seconds on four.

Hence, in total, the computation takes 40+30=70 seconds on two processors and 40+15=55 seconds on four processors.

Hence, the correct option is (D).

33. (B)

The Operating System of a computer may periodically collect all the free memory space to form a contiguous block of free space. This is called garbage collection.

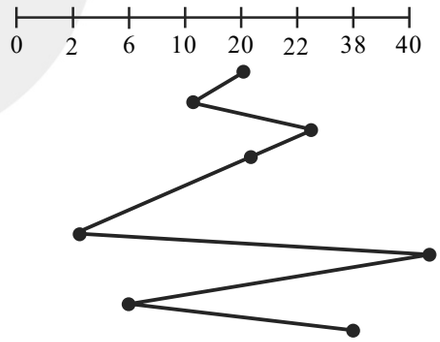
We can also use compaction to minimize the probability of external fragmentation.

In compaction, all the free partitions are made contiguous and all the loaded partitions are brought together.

Hence, the correct option is (B).

34. (D)

FCFS Total seek time in FCFS Scheduling when the disk drive is reading from cylinder 20 for cylinders in the order 10, 22, 20, 2, 40, 6 and 38.



$= (146) \times 6 = 876$ ms

Hence, the correct option is (D).

35. (D)

1. All processes are arrived at time 0.
2. Algorithm used for scheduling is round robin with time quantum of one unit time.
3. The order of execution of the processes A, B, C, D, A, C, A, C, A, C, C, C, C, C
4. After 8 context switches, process A completes it execution so the completion time is 9.

Hence, the correct option is (D).

36. (A)

The purpose of the fork system call is to create a child process.

The parent process fork call will return process ID which will make if condition false then parent process will print 10

The child process will execute the next instruction is a++ because in the child process if the condition is not tested. Execution starts from next instruction and it will print 11

Hence, the correct option is (D).

37. (C)

P: Wait operation decrements the value of the counting semaphore by 1.

V: Signal operation increments the value of counting semaphore by 1.

Current value of the counting semaphore = 10

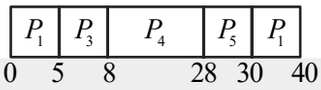
(b) after 3 P operations, value of semaphore = 10–3 = 7

(d) after 2 V operations, and 5 P operations value of semaphore = 10+ 2 – 5 = 7

Hence, the correct option is (C).

38. (C)

Following is the Gantt diagram :



Process	Arrival Time (in ms)	CPU Time Needed	Priority	Waiting Time
P1	0	10	5	30–0=30
P2	0	5	2	0
P3	2	3	1	5–2=3
P4	5	20	4	8–5=3
P5	10	2	3	28–10=18

Average Waiting Time $= \frac{(30+3+3+18)}{5} = 10.8$

Hence, the correct option is (C).

39. (A)

Here, 20 P operations means 20 wait operations. It decrement value by 1 every time. xV operations means x increments operations. It increment value by 1 every time. - New value of semaphore is 5 after performing xV operations

$= -13 + xV$

$= 5$

$xV = 5 + 13 = 18$

After applying 20 P operations in semaphore value is = 7–20 = –13

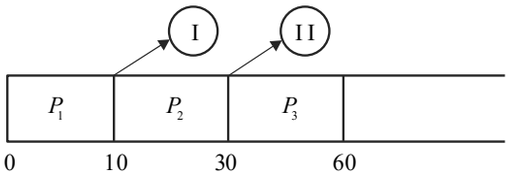
Hence, the correct option is (A).

40. (B)

Shortest Remaining Time. SRT is a preemptive scheduling. In SRT. The process with smallest runtime to complete (i.e remaining time) is scheduled to run next, including new arrivals

In SRT, a running process may be preempted by new process with shorter estimated run time.

Process	AT	BT
P_1	0	10
P_2	2	20
P_3	6	30



Total no. of context switches is 2.

Hence, the correct option is (B).

41. (B)

From the precedence graph, we say that the following tasks executed sequentially

I. Tl, T2

II. T3 and T6

III. T4 and T7

IV. T5 and T8

(T3, T6), (T4, T7) and (T5, T8) will execute parallely. So total number of processes that can be executed in 4 units time using 5 available processors = $5 \times 4 = 20$

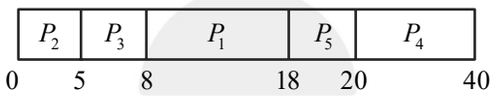
Maximum number of tasks are 8

Efficiency = $\frac{8}{20 \times 100} = 40\%$

Hence, the correct option (B).

42. (B)

Process ID	Priority	Arrival Time	CPU Time	Completion time	T.A.T. (C.T. – A.T.)
P_1	5	0	10	18	18
P_2	2	0	5	5	5
P_3	1	2	3	8	6
P_4	4	5	20	40	35
P_5	3	10	2	20	10



Average waiting time

$$= \frac{(18-10)+(5-5)+(6-3)+(35-20)+(10-2)}{5} = \frac{8+10+3+15+8}{5} = \frac{34}{5} = 6.8 \text{ m.s}$$

43. (C)

In round robin policy each process has allotted fix time quantum, after its time quantum is over it goes to tail of the ready queue if not completed. Hence it act as a circular queue implementation.

44. (B)

Semaphores are used in deadlock avoidance by using them during interprocess communication. It is used to solve the problem of synchronization among processes.

45. (D)

The given operating system follows DEAD LOCK prevention policy which also ensures neither starvation nor deadlock can occur.

46. (B)

Vitual address space $= 2^{32}$ Bytes

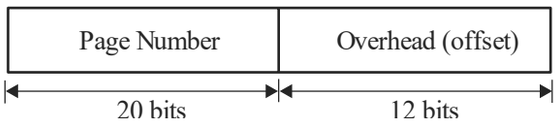
Physical address spaces $= 2^{30}$ Bytes

Page size = 4 KB $= 2^{12}$ Bytes

Number of frames in physical memory

$$= \frac{2^{30}}{2^{12}} = 2^{18}$$

Number of Bits in each page table entry



Page table size = No. of frames $\times(20+12)$ bits

$$= 2^{18} \times 32 \text{ bits}$$

$$= 2^{18} \times \frac{32}{8} \text{ bytes}$$

$$= 2^{18} \times 2^{2} \text{ bytes} = 2^{20} \text{Bytes}$$

47. (C)

Physical memory size = $16\,\text{MB} = 2^{24}\text{Bytes}$

Page size $= 1\text{KB} = 2^{10}\text{Bytes}$

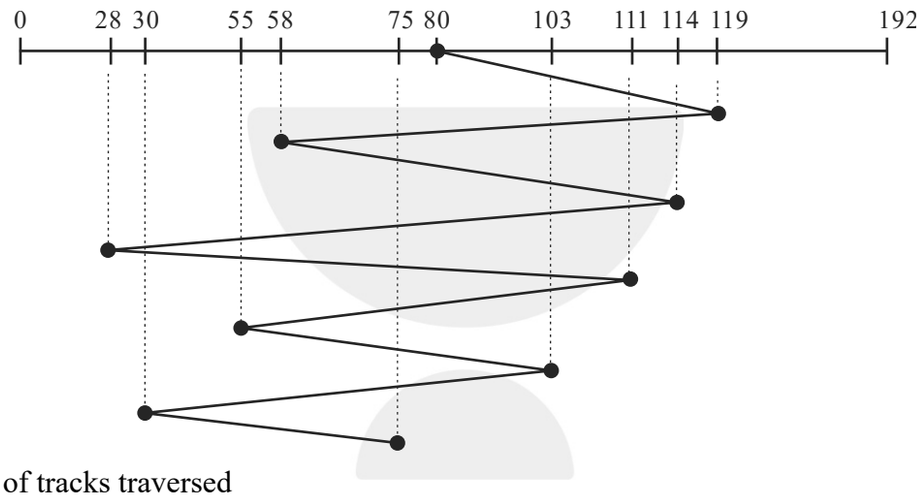
Virtual address space = 256 Pages

$$= 256 \times 1\text{KB}$$

$$= 2^{18}\text{Bytes}$$

Number of bits to identify each address in logical address space of 2^{18} Bytes = 18 bits.

48. (D)



Total number of tracks traversed

$\Rightarrow$ (119 – 80) + (119 – 58) + (114 – 58) + (114 – 28) + (111 – 28) + (111 – 55) + (103 – 55) + (103 – 30) + (75 – 30)

$\Rightarrow$ 39 + 61 + 56 + 86 + 83 + 56 + 48 + 73 + 45

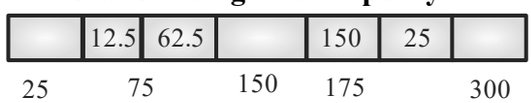
$\Rightarrow$ 547 tracks

49. (C)

1. Scan method is used in Disk scheduling
2. FIFO method is used in Batch processing
3. Round Robin method is used in Time sharing operations
4. LIFO method is used in Interrupt processing.

50. (A)

I. Allocation using First fit policy :



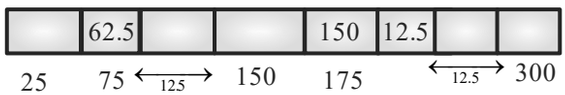
$P_1 = 150$

$P_2 = 12.5$

$P_3 = 62.5$

$P_4 = 25$

II. Allocation using Best fit policy :



$P_1 = 150$

$P_2 = 12.5$

$P_3 = 62.5$

As it gives non contiguous blocks, this policy is not possible

51. 33.33

TLB hit rate $(T_h) = 0.85$

TLB miss rate $(1 - T_h) = 0.15$

Average memory access time

$= 0.85(5 + 150) + 0.15(5 + 3 \times 150)$

$= 131.75 + 68.25$

$= 200$ msec

% slow down

$= \left(\frac{200 - 150}{150}\right) \times 100$

$= \frac{50}{150} \times 100 = 33.33\%$

52. 2

Given:

Logical Address space $= 8$ MB $= 2^{23}$ B

Page size $= 4$ kB $= 2^{12}$ B

Number of pages $= \frac{\text{LAS}}{\text{PS}} = \frac{2^{23}\text{ B}}{2^{12}\text{ B}} = 2^{23-12} = 2^{11}$

Page Table size = 1 Page size $= 4$ kB

Page Table size = entry size × number of pages

Entry size $= \frac{\text{Page Table size}}{\text{number of pages}}$

$e = \frac{2^{12}\text{ B}}{2^{11}} = 2^{12-11}\text{ B} = 2^1$ Byte

53. 181

Given:

Logical address space $= 8$ GB $= 2^{33}$ B

$e = 4$ B $= 2^2$ B

Page Table size = Page size

Let page size $= 2^k$ Bytes

Number of pages $= \frac{\text{LAS}}{\text{PS}} = \frac{2^{33}\text{ B}}{2^k\text{ B}} = 2^{33-k}$

Page Table size = entry size × number of pages

Page size = e × number of pages

$2^k = 2^2\text{ B} \times 2^{33-k}$

$2^k = 2^{35-k}\text{ B}$

$\log_2(2^k) = \log_2(2^{35-k})\text{B}$

$k = 35 - k$. B

$2k = 35$. B

$k = 17.5$ B

Page size $= 2^{17.5}\text{ B} = 2^{10} \cdot 2^{7.5}\text{ B} = 2^{7.5}$ kB

$= 181.019$ kB

54. 8

Given:

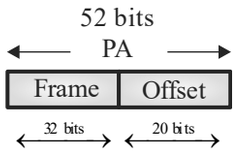
Logical address space $= 2^{64}$ B

Page size = 1 MB $= 2^{20}$ B

$e = 4\text{ B} = 2^2\text{ B}$

Entry size represents the frame bits,

So, number of frame bits $= 32$ bits



Number of pages

$= \frac{\text{LAS}}{\text{PS}} = \frac{2^{64}\text{ B}}{2^{20}\text{ B}} = 2^{64-20} = 2^{44}$ Pages

Inner Page Table size $= 2^{44} \times e$

$= 2^{44} \times 2^2\text{ B}$

$= 2^{46}\text{ B} >$ Page size

Number of pages of inner page Table

$= \frac{2^{46}\text{ B}}{2^{20}\text{ B}} = 2^{26}$ Pages

Layer-2 Page Table size $= 2^{26}$ pages $\times 2^2$ B

$= 2^{28}$ B > Page size

Number of pages of Layer-2 PT

$$= \frac{2^{28} \text{ pages}}{2^{20} \text{ B}} = 2^8 \text{ pages}$$

Outer Page Table size $= 2^8 \times 2^2$ B

$= 2^{10}$ B

Number of searches = number of pages in outer Page Table

$= 2^8$

$\Rightarrow$ 8 bits

55. 181

LAS $= 2^{16}$ B, PAS $= 2^{16}$ B

Let page size $= 2^k$ B

Number of segments $= 8$

(Page Table of segment) size $= 1$ page size

$$\text{One segment size} = \frac{\text{LAS}}{8} = \frac{2^{16} \text{ B}}{2^3} = 2^{13} \text{ B}$$

$$\text{Number of pages/segment} = \frac{2^{13} \text{ B}}{2^k \text{ B}} = 2^{13-k}$$

(Page table of segment) size = number of pages $\times e$

$= 2^{13-k} \times 4$ B

$2^k = 2^{15-k}$ B

$2^k = 2^{15-k}$

$\log_2 2^k = \log_2 2^{15-k}$

$k = 15 - k$

$2k = 15$

$k = 7.5$

Page size 2^k B $= 2^{7.5}$ B $= 181$ Byte

56. (D)

A CPU has two modes-privileged and non-privileged. In order to change the mode from privileged to non-privileged, the next instruction to be executed should be non-privileged instruction.

Hence, the correct option is (D).

57. (D)

Given statements are as follows :

(A) Context switch time is longer for Kernel level threads than for user level threads

It is True, user level threads are managed by users and Kernel level thread managed by OS. There are many overheads involved in Kernel level thread management, which are not present in user level thread, so context switch time is longer for Kernel than for user level threads.

(B) User level threads do not need any hardware support, It is true, As we know user level threads are managed by users, there is no need for hardware support.

(C) Related Kernel level threads can be scheduled on different processors in a multi-processor system.

It is true

(D) Blocking one Kernel level threads blocks all related threads. It is false Kernel level threads are managed by os, If one thread block, it does not cause other threads.

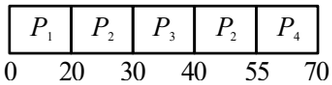
Hence, the correct option is (D).

58. (B)

Given :

Process	Execution time	Arrival time
P_1	20	0
P_2	25	15
P_3	10	30
P_4	15	45

The Gantt chart for SRT scheduling algorithm is



So the waiting time for

$$P_2 = (20-15) + (40-30) = 5 + 10 = 15$$

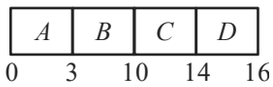
Hence, the correct option is (B).

59. (C)

Given :

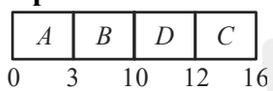
Process	Arrival time	Processing time
A	0	3
B	1	7
C	4	4
D	6	2

(1) FCFS :



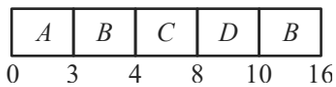
$$\text{Avg TAT} = \frac{3+9+10+10}{4} = \frac{32}{4} = 8$$

(2) Non preemptive SJF :



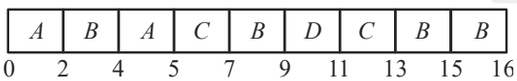
$$\text{Avg TAT} = \frac{3+9+6+12}{4} = \frac{30}{4} = 7.5$$

(3) SRTF :



$$\text{Avg TAT} = \frac{3+15+4+4}{4} = \frac{26}{4} = 6.5$$

(4) RR :



$$\text{Avg TAT} = \frac{5+15+9+5}{4} = \frac{34}{4} = 8.5$$

SRTF has lowest turn around time.

Hence, the correct option is (C).

60. 80

Given :

P1	P2	P3
: : D = D + 20 : :	: : D = D – 50 : :	: : D = D + 10 : :

Initial value of $D = 100$

Minimum value occurs when P_1, P_2, P_3 read and P_1, P_3 update the value

P_3 Update $D = 110$

P_1 Update $D = 120$

And last P_2 will update the $D = 100 - 50 = 50 = X$ maximum value will occur when P_2 and P_3 read the initial value of D and update, first own P_2 and update $D = 50$, P_3 will run and update

$D = 100 + 10 = 110$

Now P_1 will read the value of $D = 110$ and update:

$D = D + 20 = 110 + 20$

$D = 130 = Y$

$Y - X = 130 - 50 = 80$

Hence, the correct option is 80.

61. (A)

In deadlock prevention, the request for *n* resource may not be granted even if the resulting state is safe.

Deadlock prevention scheme handles deadlock by making sure that one of the four necessary conditions don't occur. So, it may be the case that a resource request might be rejected even if the resulting state is safe.

Hence, the correct option is (A).

62. (D)

Let's assume that each process requests 2 resources each. Now there are total 6 identical resources available. Give 1 resources to every process then there will be deadlock because now each process will wait for another resource which is not available. Since there are total 6 resources so for deadlock to be possible there should be 6 process available. Hence, the value of N is 6.

Hence, the correct option is (D).

63. (B)

Given :

Process	Current Allocation	Maximum Requirement	Need
P_1	3	7	4
P_2	1	6	5
P_3	3	5	2

Number of resources = 9

Therefore, Available = 9 – 7 = 2

From current available need of process P_3 can be satisfied, releasing 3 additional resources. After execution of P_3 number of available resources = 5.

Now, form current available need of any of the two processes P_1 or P_2 can be satisfied.

Safe sequence $\Rightarrow P_3 \rightarrow P_1 \rightarrow P_2$

Safe and not deadlock.

Hence, the correct option is (B).

64. B,D

(B) Without indivisible machine instruction critical section can be implemented like using monitors.

(D) Best fit also suffers from fragmental

Hence, the correct option is (B) and (D).

65. (C)

Given :

ROM memory size $= 2m \times n$

number of address lines $= m$

number of data lines $= n$

$$4k \times 16 = 2^2 \times 2^{10} \times 16$$

$$4k \times 16 = 2^{12} \times 16$$

Address lines $= 12$

Data lines $= 16$

Hence, the correct option is (C).

66. (C)

Given :

Physical memory $= 64MB = 2^{26}B$

Size of frame $= 4KB = 2^{12}B$

$$\text{Number of frames} = \frac{\text{physical memory}}{\text{size of frame}}$$

$$= \frac{2^{26}B}{2^{12}B} = 2^{14}$$

Frame number =14 bits

Virtual memory $= 32\,\text{bits} = 2^{32}B$

Size of page = size of frame $= 4KB = 2^{12}B$

$$\text{Number of pages} = \frac{\text{virtual memory}}{\text{size of page}}$$

$$= \frac{2^{32}B}{2^{12}B} = 2^{20}$$

Size of page table

= Number of pages × Size of each entry size of page table

= Number of pages × Page table entry

Size of page table

= Number of pages × Frame number

Assume Frame number = 16bits

Size of page table $= 2^{20} \times 16\,\text{bits} \approx 2MB$

Hence, the correct option is (C).

67. (C)

Incrementing the number of page frames doesn't always decrease the page faults (Belady's Anomaly).

Hence, the correct option is (C).

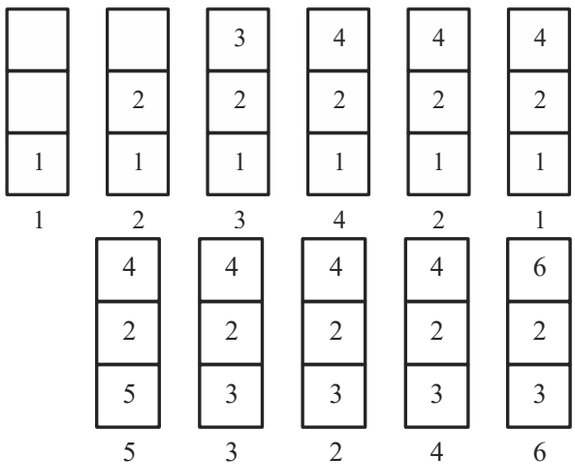
68. 7

Given :

Number of page frame = 3

Reference string 1, 2, 3, 4, 2, 1, 5, 3, 2, 4, 6

Optimal page replacement policy.



$\therefore$ 7 page faults.

Hence, the correct answer is 7.

69. 384

Given :

Page table entry size = 48 bits

Page table size = Number of entries in page table × page table entry size

$$= \left(\frac{2^{40}}{2^{14}}\right) \times 48 \text{ bits } = 2^{26} \times 6 \text{ bytes}$$

$$= 64\,\text{M} \times 6\,\text{B} = 384\,\text{MB}$$

Hence, the correct answer is 384.

70. (B)

Given :

Following statements:

S1 : Random page replacement algorithm (where a page chosen at random is replaced)

Suffers from Belady's anomaly

S2 : LRU page replacement algorithm suffers from Belady's anomaly

Considering each statement

Random page replacement algorithm can behave like only algorithm probably FCFS too, hence it can suffer from Belay's anomaly.

LRU page replacement algorithm doesn't suffer from Belady's anomaly.

Hence, the correct option is (B).

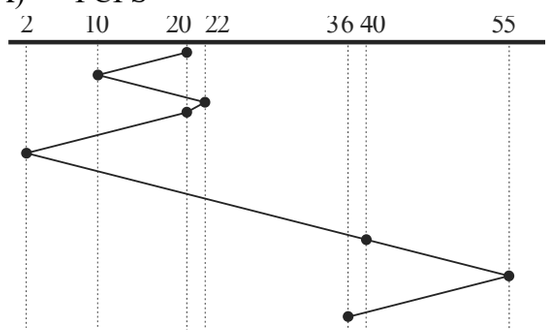
71. (*)

Given :

Disk requests : 10, 22, 20, 2, 40, 55, 36

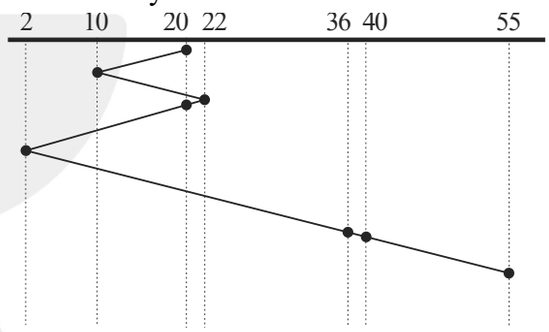
seek time = 6 msec per cylinder

(A) FCFS



$$6 \times (10 + 12 + 2 + 18 + 38 + 15 + 19) = 684$$

(B) Closet cylinder next



$$6 \times (2 + 12 + 18 + 34 + 4 + 19) = 534$$

Hence, the correct answer is (684, 534).

72. (C)

(C) CPU checks for interrupts before executing a new instruction.

Hence, the correct option is (C).

73. (B)

Given :

Number of cylinders = 100

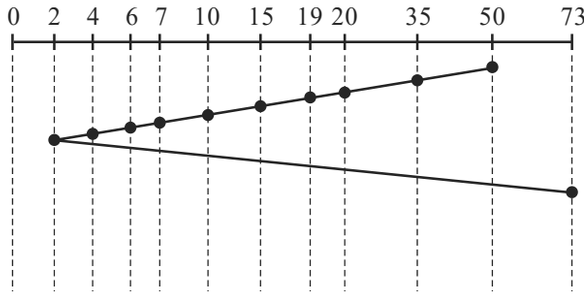
Cylinder access request :

4, 35, 10, 7, 19, 73, 2, 15, 6, 20

Initial position of head = 50

Seek time = 1 ms

Head is currently at cylinder 50



$50-35=15$ $35-20=15$

$20-19=1,$ $19-15=4$

$15-10=5,$ $10-7=3$

$7-6=1,$ $6-4=2$

$4-2=2,$ $2-73=71$

Total move

$=15+15+1+4+5+3+1+2+2+71$

$=119$

Hence, the correct option is (B).

74. (C)

Given :

Seek time = 10 ms

Rotational speed = 5000 rpm

$60\ s \rightarrow 5000$ rotations

$1 \text{ rotation} \rightarrow \frac{60}{5000}\ s$

$\text{Rotational latency} = \frac{1}{2} \times \frac{60}{5000}\ s = 6 \text{ ms}$

Total time to transfer one library

$=10+6=16$ ms

$\therefore$ Total time to transfer 100 libraries

$=100 \times 16 \text{ ms} = 1.6 \text{ s}$

Hence, the correct option is (C).

75. 99.6

Given :

Total overhead of each entry = 4 bytes

Disk size = 100×10^6 bytes

Data block size = 10^3 bytes

Total size for each entry $= 1004$ bytes

Number of entries in FAT

$$= \frac{100 \times 10^6}{1004} = 0.099601$$

Maximum size of a file

$= 0.099601 \times 10^3$ bytes

$= 99.601 \times 10^6$ bytes.

Hence, the correct answer is 99.6.

9 Database Management System

Practice Questions

Key Concepts and functional Dependency

Q.1 The functional dependencies over the attribute set (ABCDEFHT) is

$A \rightarrow E$

$BE \rightarrow D$

$AD \rightarrow BE$

$BDI \rightarrow E$

$AC \rightarrow E$

$F \rightarrow A$

$E \rightarrow B$

$BH \rightarrow F$

$CD \rightarrow A$

How many FD's minimal cover _____.

Q.2 Consider The relation R(A,B,C,D,E) and the following functional dependencies

$A \rightarrow B$

$B \rightarrow C$

$C \rightarrow D$

$D \rightarrow E$

$B \rightarrow A$

How many super key's are possible _____?

Q.3 Consider the following statement about functional dependency

$S_1 : X \rightarrow Y$ is not trivial if $X \cap Y = \phi$

$S_2 : X \rightarrow Y$ is semi trivial if $X \cap Y \neq \phi$

Which of the following statements is/are false?

(A) S_1 only (B) S_2 only

(C) Both S_1 and S_2 (D) None

Q.4 How many candidate keys for the relation $R(A, B, C, D, E)$ and functional dependencies

$A \rightarrow B$

$BC \rightarrow E$

$ED \rightarrow A$

Q.5 Consider the following relation R(A,B,C,D,E)

$A \rightarrow B$

$B \rightarrow C$

$D \rightarrow E$

How many super keys are there _____.

Q.6 Consider Relation $R(A, B, C, D, E, F, G, H)$ with two candidate keys {AB, BE} Find out total number of super keys?

Q.7 Consider Relation R(A,B,C,D,E,F,G) with two candidate keys AB and DE Find out total number of super keys?

Q.8 Consider Relations R(A,B,C,D,E,F,G) with the following candidate keys {A}, {B} and {E}. How many super keys are there?

Q.9 Consider Relation R(A,B,C,D) with the following Functional dependency set $\{A \to B, B \to C, C \to D, D \to A\}$. How many Super keys for Relation R is possible?

Q.10 Consider the following two Relations R(A,B,C,D) and S(D,E,F). Underline in Relation Shows Primary key of respective relation and D is foreign key in R, that references Primary key in S. Which of the following will cause violation? **[MSQ]**

(A) Insertion of record into R
(B) Insertion of record into S
(C) Deletion of record from S
(D) Deletion of record from S

Q.11 Consider Relation $R(A, B, C, D, E)$ with FD set

$\{A \to BC, C \to E, D \to B, B \to C\}$

What are relationship between closures of A (A^+) and closure of C (C^+)?

(A) $A^+ \subseteq C^+$ (B) $A^+ \supseteq C^+$
(C) $A^+ = C^+$ (D) None of these

Q.12 Consider the following Relation R(A,B,C,D) with FD's **[MSQ]**

$AB \to C$
$A \to D$

Assume domain for

$D = \{a, b, c, d, e, f, g\}$
$A = \{h, i, j, k\}$

The missing values inserted Corresponding to Attribute A and D in the table are respectively _____.

A	B	C	D
h	e	e	a
h	i	f	a
j	d	f	
	k	e	c
i	k	e	d

(A) k and a (B) k and d
(C) i and b (D) i and a

Q.13 In a Instance of Relation R(P,Q,R,S,T) shown below Which of the following functional dependencies hold?

P	Q	R	S	T
10	30	20	40	50
10	40	20	40	50
10	30	40	40	10

(I) $PQ \to R$

(II) $Q \to S$

(III) $ST \to P$

(A) I only (B) II only
(C) I and II only (D) II and III

Q.14 The functional dependency $P \to Q$, $SQ \to R$ implies

(A) $PS \to R$ (B) $P \to R$
(C) $Q \to P$ (D) $SQ \to P$

Q.15 Consider the Relation S(A,B,C,D,E) with FD's $AB \to C, B \to D, DE \to A$

How many candidate key of Relation S?

(A) 1 (B) 2
(C) 3 (D) 4

Q.16 Consider the following set of FDs.

$F = \{P \to R, PR \to S, T \to PS, T \to V\}$

$G = \{P \to RS, T \to PV\}$

Which of the following is true

(A) $F \equiv G$ (B) $F \supset G$
(C) $F \subset G$ (D) $F \not\equiv G$

Functional Dependency

Q.17 Consider a relation R(A,B,C,D) with functional dependency set

$\{A \to B, B \to C, CD \to A, CD \to B\}$

Consider the following decompositions:

$D_1 : R_1(A, B, C) R_2(B, C, D)$

$D_2 : R_1(A, B) R_2(B, C) R_3(A, C, D)$

Which of the following statements is/are false? **[MSQ]**

(A) $S_1 : D_1$ is loss less join

(B) $S_2 : D_1$ is lossy join

(C) $S_3 : D_2$ is loss less join

(D) $S_4 : D_2$ is lossy join

Q.18 Consider the following relation $R(\mathrm{A,B,C,D,E,F,G,H,I,J})$ and set of FD's

$\{\mathrm{HI \rightarrow J, H \rightarrow EF, I \rightarrow G, G \rightarrow CD, E \rightarrow AB}\}$ the decomposition of R is (HIJEF), (IGCD) and (EAB)

So the decomposition is

(A) 1 NF (B) 2 NF

(C) 3 NF (D) BCNF

Q.19 Consider the following relation and functional dependencies:

$R(A,B,C,D,E,F,G)$

$A \rightarrow D$

$AE \rightarrow G$

$DF \rightarrow BC$

$E \rightarrow C$

$G \rightarrow E$

Select the highest Normal form for the following 3 decomposition of relation (AD), (EC), (A,B,E,F,G)

(A) BCNF (B) 2NF

(C) 3NF (D) None of these

Q.20 Let relation is $R(A,B,C,D,E)$ and following function dependencies **[MSQ]**

$ABC \rightarrow D$

$ABC \rightarrow E$

$D \rightarrow A$

$E \rightarrow B$

The Normal from satisfied by R is

(A) 1 NF (B) 2 NF

(C) 3 NF (D) BCNF

Q.21 Consider the relation R(A,B,C,D,E) with the following dependencies

$AB \rightarrow D$

$AB \rightarrow E$

$D \rightarrow A$

$D \rightarrow B$

Which of the following is true?

(A) Relation is in BCNF

(B) Relation is in 3NF but not in BCNF

(C) Relation is in 2NF but not in 3NF

(D) None of these

Q.22 Consider Relation $R(A_1, A_2, A_3, A_4, A_5)$ with

$FD's : \{\mathrm{A_1 \rightarrow A_2, \rightarrow A_3\ A_1A_3 \rightarrow A_4}\}$

If the relation decompose into 3Nf relation then how many relations will generate_____.

Q.23 Consider the relation R(ABCDE) and set of functional dependencies are

$A \rightarrow ABCDE$

$B \rightarrow C$

Which of the following is true?

(A) The decomposition in $R_1(ACDE)$ and $R_2(\mathrm{BC})$ are in BCNF, lossless dependency preserving.

(B) The decomposition in $R_1(ABE)$ and $R_2(\mathrm{BC})$ are in BCNF, lossless dependency preserving.

(C) The decomposition in $R_1(ABDE)$ and $R_2(\mathrm{BC})$ are in BCNF, lossless dependency preserving.

(D) None of the above

Q.24 Relation R(A,B,C,D,E) has following FDs $\{A \rightarrow BC, C \rightarrow E, D \rightarrow B, B \rightarrow C\}$

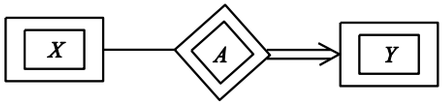
What is highest Normal form of R ?

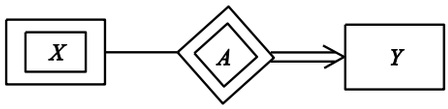
(A) 1 NF (B) 2 NF

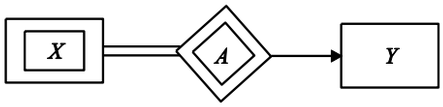
(C) 3 NF (D) BCNF

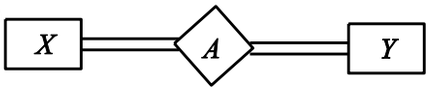
ER Diagram

Q.25 Which of the following ERD does not have an error? **[MSQ]**

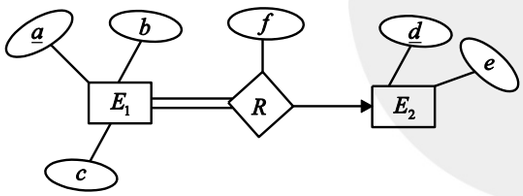
(A) 

(B) 

(C) 

(D) 

Q.26 Consider following ER Diagram



Which of the following attributes can be primary key of relationship R?

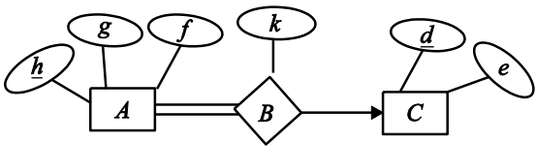
(A) a and d

(B) a, d and f

(C) a and f

(D) None of these

Q.27 Consider following ERD



Which of the following attribute (s) can be primary key for relation A.

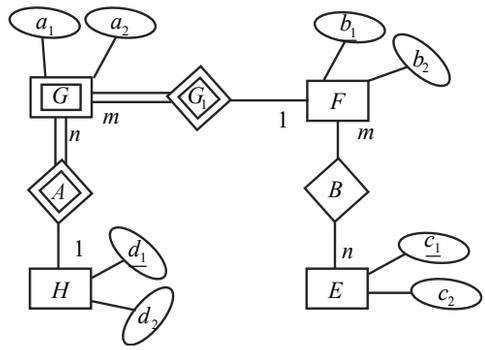
(A) {h,d}

(B) {h,d,k}

(C) {h}

(D) (A) and (B) both

Q.28 Consider the following ERD

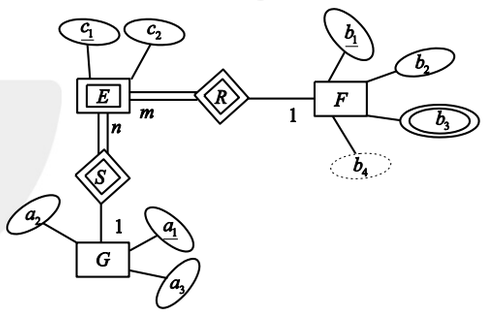


Which of the following is not a key for any table in Relational model.

(A) $\{a_1, b_1, d_1\}$ (B) $\{b_1, c_1\}$

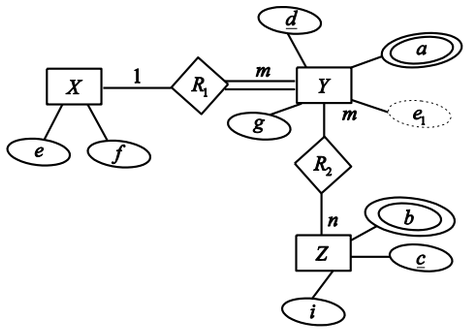
(C) $\{a_1, b_1\}$ (D) $\{c_1\}$

Q.29 Consider the following ERD

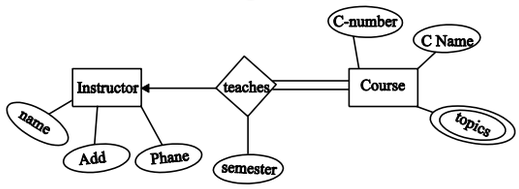


Relational model of above ERD contain total x tables and y attributes then $x + y =$ _____.

Q.30 How many table will have for the following E-R diagram?



Q.31 Consider following ER-Diagram



Which of the following statements is/are true? **[MSQ]**

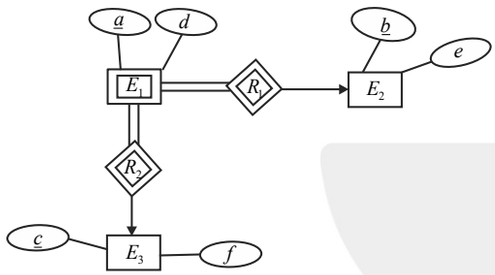
(A) Every course has an instructor

(B) Course is totally participate in the relation

(C) An instructor can teach many courses.

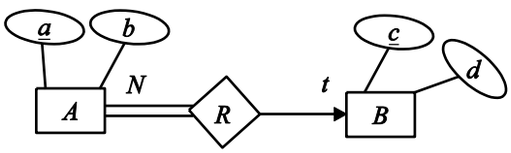
(D) There is no table for Relationship teaches and attribute of teaches added in the table of Entity set course

Q.32 Consider the following E/R diagram.



How many total number of attributes in the relational Schema's if the following E-R diagram is map to relational schema's

Q.33 Which of the following statement is/are false for given E-R diagram **[MSQ]**



(A) Table for Entity A should have a larger number of attributes

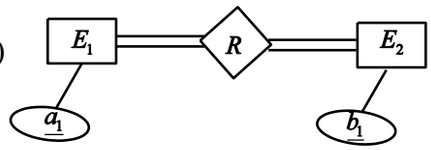
(B) Table for Entity B should have a larger number of attributes

(C) Both table of A and B should have, same number of attributes

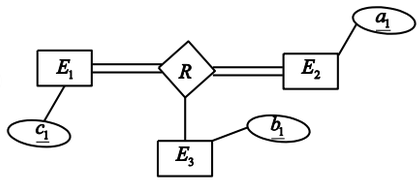
(D) Total number of tables in Relational model for ER Diagram Relational model for Diagram is 2

Q.34 Which of the following is incorrect ERD?

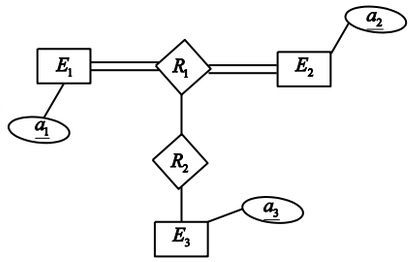
(A)



(B)



(C)



(D) None of these

Q.35 When mapping ER diagram of two Entity type A and B are related by 1:1 relationship which is in total participation at both ends. Then which of the following is True.

(A) Use a primary key which is a composition of primary keys of A and B

(B) Combine A and B together into a single relations

(C) Keep them separate and put foreign key in Both A and B

(D) None of these

Relational Algebra

Q.36 Consider the following three Relation R,S,T

R

A	B
1	2
2	1
3	2
4	2
5	3

S

B	C
2	3
1	4
2	5
2	5
3	6

T

A	C
1	3
3	3
4	5
4	3
5	6

How many tuple selected 'by following Relational Algebra Query ?

$\pi_{A,C}(R \bowtie S) - \pi_{A,C}(T)$

Q.37 Consider relations $P(A,B)$ and $S(B,C)$ where number of tuple in P is 40000 and in S is 20000 where B is key an S. Then the number of tuples in R Natural join S is less then or equal to

(A) 40000 (B) 80000

(C) 20000 (D) None of these

Q.38 Consider following relations P(A,B) and Q (B,C,D) Let. $R = P \underset{P.B=Q.B \wedge P.A<Q.C}{\times} Q$

which of the tuple belongs to "R"?

[MSQ]

P

A	B
2	p
8	r
3	i
5	t
10	r

Q

B	C	D
t	6	7
p	8	9
r	9	10

(A) (8, r, r, 7, 8)

(B) (2, p, p, 8, 9)

(C) (5, t, t, 6, 7)

(D) (8, r, r, r, 9, 10)

Q.39 If A is candidate key of Relation R and B is other number attribute of R Let r be the number of tuples in table R.

Then How many tuple will result from the given the given relational algebra.

$(\pi_A(\sigma_{B<4}(R))) * (\pi_A(\sigma_B >= 4(R)))$

NOTE:- "*" is Natural Join

(A) 0 (B) 1

(C) r (D) 1/r

Q.40 Consider the following relation, P, Q, R

P

A	B
2	3
4	3
6	7
8	9
10	9

Q

B	C
7	3
3	5
9	2
9	4
3	6

R

A	C
8	2
2	3
10	4
6	5
4	6

How many rows in resulting table of $\pi_{A,B}(P*Q) * \pi_{A,C}(Q*R)$ where "*" is Natural join

Q.41 Consider the Following Relations R and S.

R		
X	Y	Z
1	2	3
4	2	3
4	5	6
2	5	3
1	2	6
1	6	2

S			
X	Y	Z	W
2	5	3	5
2	5	4	4
1	2	3	2
4	5	6	1
1	6	2	3

How many tuples selected by following R.A. Query?

$(\pi_{x,y,z}(R) - \pi_{x,y,z}(s)) \cup$

$(\pi_{x,y,z}(S) - \pi_{x,y,z}(R))$

(A) 2 (B) 4

(C) 6 (D) None

Tuple Relational Calculus

Q.42 Consider the following query

$S_1 : \{S \mid S \notin \text{Employee}, S.\text{rating} > 10\}$

$S_2 : \{S \mid S \notin \text{Employee}\}$

$S_3 : \{S \mid S \in \text{Employee} \wedge S \in \text{department}\}$

$S_4 : \{S \mid \sim \exists S \in \text{Employee} \wedge S.\text{rating} = 10\}$

$S_5 : \{S \mid S \notin \text{departmant}\}$

How many queries are unsafe?

Q.43 Consider the following Queries

[MSQ]

S_1 : Select distinct A,B from R where C = 20 and B = 10;

S_2 : $\pi_{A,B}(\sigma_{\substack{C=20 \wedge A \\ B=10}}(R))$

$S_3 : \{t.A, t.B \mid t \in R \wedge t.c = 20 \wedge t.B = 10\}$

$S_4 : \{< a, b > \mid < a, 10, 20, d > \in R\}$

Assume R(A,B,C,D) is a Relation.

Which of the following is/are true?

(A) S_1 and S_2 are Equivalent

(B) S_2 and S_3 are Equivalent

(C) S_3 and S_4 are Equivalent

(D) S_4 and S_1 are Equivalent

Q.44 Consider the following Relational Schema

Student (rollno, name, degree, year, sex, deptNo, advisor)

Department (Deptid, name, hod, mobile)

Which of the following tuple calculus query determine the departments that do not have any girl students

(A) d.name | department (d) $\wedge\neg(\exists S)$ (Student (S) $\wedge$ S.Sex = 'F' $\wedge$ S.deptNO = d.dept id)

(B) d.name | department (d) $\wedge(\exists S)$ (Student (S) $\wedge$ S.Sex = 'F' $\wedge$ S.deptNO = d.dept id)

(C) d.name | department (d) $\wedge\neg$(Student (S) $\wedge\neg$S.Sex = 'F' $\wedge$ S.deptNO = d.dept id)

(D) d.name | department (d) $\wedge$(Student (S) $\wedge\neg$S.Sex = 'F' $\wedge$ S.deptNO = d.dept id)

Q.45 Consider the Relation R(A,B,C) and S(C,D,E) and the Following queries over R and S.

(I) Select distinct A, E from R,S where R.C = S.C;

(II) $\{< A, E > \mid \ni C(< A, B, C > \in R \wedge < C, D, E > \in S)\}$

(III) $\pi_{A,E}(R \infty S)$

Which of the following is/are equivalent?

(A) I, II only (B) I and II Only

(C) II and III only (D) I, II and III

Q.46 Consider relation R with non atomic attributes

A	B	C	D
E1	B1 C1	C1 C2 C3	D1 D2
E2	B2	C1 C2	D1 D3
E3	B1 B2	C4	D1 D4
E4	B5	C1	D1 D3

Above relation is not satisfy the properties of 1 NF. If the above relation is converted to 1NF what will be the number of rows in the resulting relation _____.

Q.47 Consider the Relation R(P,Q) with FD $P \rightarrow Q$ and consist two tuples T1, T2 the following statement is/are true?

[MSQ]

(A) If T1, T2 agree for attribute P then must be agree for attribute Q.

(B) If T1, T2 agree for attribute P then they need not be agree for attribute Q.

(C) If T1, T2 disagree for attribute P then they may or may not be agree for attribute Q.

(D) If T1, T2 agree for attribute P then they need not be agree for attribute Q.

SQL

Q.48 Consider the following tables.

P	
x	$\underline{a}$
1	$\underline{2}$
2	$\underline{3}$

Q	
a	$\underline{c}$
2	$\underline{2}$
3	$\underline{3}$

R	
b	c
1	2
2	3

Here $Q(a)$ refers to P(a) with on delete cascade to preserve referential integrity constraint

Similarly R(c) refers to Q(c) with on delete set Null to preserve referential integrity constraint.

After Executing the following SQL Query Delete from P;

What tuples will R Contain?

(A) (1, null) and (2,3)

(B) (1, null) and (2, null)

(C) (1, null) only

(D) (2, null) only

Q.49 Consider Relation R(A,B,C,D) where A is Primary key.

Q_1 : Select count (*) from R;

Q_2 : Select count (A) from R;

Which of the following is true?

(A) Q_1 and Q_2 Produce same output

(B) Output of Q_1 is subset of output of Q_2

(C) Output of Q_2 is subset of output of Q_1

(D) None of these

Q.50 Consider the relation declared by create table S(name Varchar (30)primary key), salary int check (Salary<= 500000); initially relation has 3 records

Name	Salary
Scott	200000
Smith	300000
Joe	400000

Now we are execute following sequence

(1) Insert into S values ('fred', 150000);

(2) Update S set salary = 600000 where name = 'Joe';

(3) Insert into S values ('Scott', 160000);

(4) Delete from S where name = 'Smith'

At the end of these statements, the sum of the salaries over all table in S is :

(A) 650000 (B) 950000

(C) 750000 (D) 910000

Q.51 Consider following SQL queries to relations $A(a,b), B(b,c)$

Q1: Select * from A Natural Join B;

Q2: Select * from A left outer Join B;

Which of the following is correct?

(A) Both Q1 and Q2 produce same answer

(B) Answer of Q1 always contained in the answer of Q2

(C) Answer of Q2 always contained in the answer of Q1

(D) Both Q1 and Q2 produce different answer.

Q.52 Consider the following SQL **[MSQ]**

Create table P(a varchar(10) primary key , b varchar (2))

Create table Q (c varchar (10) primary key, a varchar (10))

references T (a) on delete cascade)

Create table R(d varchar (10) primary key, C varchar (10) references Q(c) an delete set null);

Suppose table P,Q and R is

P

a	b
10	10
20	10

Q

c	a
10	10
20	10

R

d	c
10	10
20	20

Which of the following will cause an error

(A) Insert into Q values (20, 30);
(B) Insert into R values (20, 30);
(C) Delete from P where a = 20;
(D) Delete from Q where a = 10;

Q.53 Consider the following Relation Schemas:

P

A	B
b	c
b	d
d	e
c	f
b	k

Q

B	C
c	f
e	i
c	g
b	e
b	f

How many number of rows produce by following SQL

Select P.A count (Q.C) as C-count from P,Q where P.A = Q.B group P.A

(A) 1 (B) 3
(C) 2 (D) None

Q.54 The output given SQL is:

Select name from student where name like '% P% S%';

(A) The name of student such that it always contain P and S Simultaneously.
(B) The name of student such that it always contain P and it followed by at least two S.
(C) The name of student such that it always contain P and S
(D) The name of student that start with P and end with S

Q.55 Consider the instance of Relation R and Relation S.

R

A	B
1	10
2	20
3	10
4	10

S

B
10
20
30

3	30
2	10
1	20
1	30
2	30
4	20

How many tuples return by following SQL Query.

Select A from R as r_1 where

not exist ((select S.B from S) Except (select $r_2.B$ from R as $r_2.\mathrm{A} = \mathrm{r}_1.A$));

Q.56 Consider the following Relations **[MSQ]**

Employees (Eno, Ename, Dno)
Project (Pno, Pname)
Wok on (Eno, Pno)

Which of the following query given name of all Employees who work on all projects

(A) $T_1 \leftarrow \pi_{pno}(\text{Project})$

$T_2 \leftarrow \pi_{eno}(\text{Workon} \div T_1)$

$\pi_{ename}(\text{Employee} \rhd\lhd \mathrm{T}_2)$

(B) Select Ename from Employee as e where not Exist ((Select Pro from project)except (select pro from work-on where Eno = e.Eno));
(C) Select Ename from Employee as e where Eno not in (Select W. Eno from (Select W.Eno, Pno from(select pno from project as P cross join (select distinct Eno from work-on)as w) Except (Select Eno, Pno from work-an)as r);
(D) Select Ename from Employee as e where Exist ((Select pro from project) except (Select pno from work-on where Eno = e.Eno));

Q.57 Consider a Relation R(ENO, EName, Age, DNo) Where ENo is primary key and EName with Not NULL Constraint. Consider a status of Relation R at time

[MSQ]

ENo	EName	Age	DNo
1	LUV	25	101
2	KUSH	19	102
3	Rohit	12	103

Which of the following will cause error?

(A) Insertion of (3, Ramesh, 25, 103)

(B) Insertion of (12, Rohit, 12, 103)

(C) Insertion of (5, NULL, 12, 103)

(D) Insertion of (2, Ravi, 8, 105)

Q.58 Which of the following SQL queries is illegal?

(A) Select count (*) from S;

(B) Select A, count (*) from S;

(C) Select A, count (*)from S group by A;

(D) None of these.

Transaction and Serializability

Q.59 Consider the following schedule, S

$S = \{r_1(x), r_2(x), r_3(y)$
$w_1(x), r_2(z), r_2(y), w_2(y), w_1(z)\}$

Is conflict – equivalent to which of the following serial schedules.

(A) T_3, T_1, T_2 (B) T_2, T_3, T_1

(C) T_3, T_2, T_1 (D) T_2, T_1, T_3

Q.60 Consider the following schedule's

$S1: r_1(x), r_2(z), r_1(z), r_3(x)$
$r_3(y), w_1(x), w_3(y), r_2(y)$
$w_2(z), w_2(y)$
$S2: r_1(x), r_2(z), r_3(x), r_3(y)$
$w_1(x), w_3(y), w_1(x)$
$w_2(z), w_3(y), w_2(y)$

Which of the following is conflict serializable?

(A) Only $S1$

(B) Only $S2$

(C) Both $S1$ and $S2$

(D) Neither $S1$ or $S2$

Q.61 Suppose we are using time stamp based concurring control, and there are two transaction T_1 And T_2 with timestamp 10 and 20. They are try to execute following sequence of instruction.

$r_1(x); r_2(y); w_1(y); w_2(x);$

Which of the following is true

(A) Both transaction T_1 and T_2 execute successfully.

(B) T_1 needs to rollback

(C) T_2 needs to rollback

(D) None of these

Q.62 Suppose a transaction T_1 is failed due to system error. Which of the following can be used to recover the schedule.

(A) log file (B) Error file

(C) Both a and b (D) None of these

Q.63 The Schedule

$S = \{W_1(A), R_2(A), W_2(A),$
$W_1(A), R_3(B), W_3(B),$
$W_2(B), R_1(B)\}$

is

(A) Conflict Serializable

(B) View Serializable

(C) Both (A) and (B)

(D) None of these

Q.64 Consider the sequence of instruction of transactions, T_1, T_2 and T_3

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

Assume that read – and write timestamp of x, y, and z are each zero before the execution of given instruction, Transaction abort because of the timestamp rule.

(A) $TS(T_1) = 1000; TS(T_2) = 2000$
$TS(T_3) = 3000$

(B) $TS(T_1) = 3000; TS(T_2) = 2000$
$TS(T_3) = 1000$

(C) $TS(T_1) = 1000; TS(T_2) = 3000$
$TS(T_3) = 2000$

(D) None of these

Q.65 Consider the following schedule

$S = \{R_1(A), W_1(A), R_2(A),$
$R_1(B), W_2(A), W_1(B), C_1,$
$R_2(B), W_2(B)_1, C_2\}$

(i) Schedule S in conflict serializable

(ii) Schedule S is recoverable

(iii) Schedule S is Cascadelers

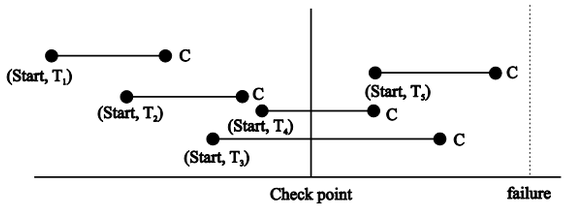
(A) i only

(B) i and ii only

(C) ii and iii only

(D) None of there

Q.66 T_1, T_2, T_3, T_4, T_5 are transactions



How many transaction is in undo list (Note: Using check point Algorithm)

(A) 2 (B) 3

(C) 1 (D) None of these

Q.67 Consider the following schedule

S

T_1	T_2
R(A)	
A = A – 50	
	R(A)
	A = A + 50
W(A)	
	W(A)
Commit	
	W(A)
	Commit

The above schedule is suffer from

(A) Lost update

(B) Dead lock

(C) Unrepeatable read

(D) None of these

Q.68 Consider the following two statements

S_1 : A schedule S is called recoverable if T_i writes a data item whose value T_j reads, then T_i must commit before T_j does.

S_2 : A schedule S is called cascadeless if T_i depends on T_j then T_i should read committed date of T_j

(A) S_1 only

(B) S_2 only

(C) Both A and B

(D) None of these

Q.69 The schedule

$S = \{R_1(A), W_2(A) W_1(A),$
$W_3(A), C_1, C_2, C_3\}$

(A) Conflict Serialzable

(B) View serializable

(C) Recoverable

(D) Cascadelers

Q.70 Consider the following schedules:-

$S_1 : R_1(x)W_2(x)C_2R_1(x)$

$S_2 : W_1(x)R_2(x)R_1$

Note C_2 = Commit by T_2

R_1 = Rollback by T_1

(A) S_1 and S_2 both have lost update problem

(B) S_1 has unrepeatable read and S_2 has dirty Read problem

(C) S_1 and S_2 both have dirty Read Problem

(D) None of these

Q.71 Consider the following Schedules:-

$S_1 : R_1(x)W_2(y)R_2(x)W_1(y)C_1$

$S_2 : R_1(x)R_2(y)W_1(z)C_1R_3(y)$
$R_3(z)W_2(y)W_3(x)C_2C_3$

Which of the following statement is correct

(A) S_1 and S_2 both possible under 2PL

(B) S_1 Possible under 2PL but S_2 not.

(C) S_2 Possible under 2PL S_1 not

(D) None of these

Indexing

Q.72 A B-tree internal node has to be fit in memory block of size 512 bytes. Assuming key size as 8 bytes and record pointer size as 16 bytes and block pointer size as 12 bytes. The order of the tree is _____.

Q.73 Consider a disk with block size 512 bytes suppose that a file has r = 30,000 records, each of size 128 byte, what is the size of index file if we use un-spanned file organization with dense indexing, assume that key of index is 16 byte and pointer of 7 byte.

(A) 1348 blocks for index, file

(B) 1364 blocks for index file

(C) 340 blocks for index file

(D) 336 blocks index file

Q.74 Find the order of lead node in a b+ tree. Let child pointer is 4 byte and record pointer is 8 byte and key field is 10 byte and Block size is 1204 byte

Note : Order of leaf node is max no of keys it can hold.

Q.75 Consider a file consist of 10,000 records each of size 100 byte, each index contain 12 bytes key field and 8 byte pointers. File is ordered on the key field, so how many blocks required for dense index on this file _____.

NOTE: Block Size is 1000 byte.

Q.76 The insertion of a record in a B^+ tree will always cause the height of the tree to increase by one where

(A) The tree consists of only a root node

(B) The record is inserted into full leaf node

(C) All the nodes in the path from the root to the desired leaf node are full before insertion

(D) None of these

Q.77 The order of a non-leaf node in a B^+ tree is maximum number of keys it can hold if the block size is 1 kB, data record pointer is 8 byte the value field is 9 byte long and block pointer is 8 byte long what is the maximum order of Non-leaf node

(A) 60 (B) 59

(C) 61 (D) None of these

Q.78 The order of a non – leaf node in a B^+ tree is maximum number of block size is 1024 byte, data record pointer is 16 byte, the key field is to byte long and block pointer is 8 byte long, what is the minimum number of key a non-root non-leaf node can hold?

(A) 56 (B) 28

(C) 27 (D) 57

Q.79 The difference between dense index and a sparse index is that

(A) A dense index contains keys and pointer for each record where as a sparse index contains keys and for a subject of records.

(B) A dense index contains keys and pointer for a subset of Record where as a sparse record

(C) No. difference

(D) A dense index can only be primary index and a sparse index can only be secondary index

Q.80 For a B^+ tree of order 201 consisting of 2 levels, the maximum number of leaf nodes would be if roof is at level zero

(A) 603 (B) 40000

(C) 40401 (D) None of these

Q.81 The order of a non-leaf node in a B^+ tree is maximum number of block pointer it can hold if the block size is 1024 byte, data record pointer is 16 byte, the value field is 18 byte long and block pointer is 8 byte long, what is the order of Non-leaf node

(A) 22 (B) 41

(C) 40 (D) None of these

Q.82 Consider an unordered file of 100000 records with a record size at 100 byte stored a blocks of 2048 bytes with an un-spanned record organization. We will assume that no system related information is stored within a block. On the average, how many blocks would have to be accessed to find a particular record?

(A) 5000

(B) 2500

(C) 1250

(D) None of these

Q.83 Every department should have a manager and only one employee manages in a department and an manager can manage only one department, then participation of the employee is _____.

Q.84 A database table publisher has 2000 records and occupies 100 disk block. Another table book has 5000 records and occupies 500 disk blocks. These two tables have to be joined as per nested loop join and publisher is in inside of book relationship then what is the cost of nested loop Join

(A) 500500

(B) 50100

(C) 50500

(D) 1000100

Q.85 The given schedule is

S_1:

$R_2(z)R_2(y)W_2(y)R_3(y)R_3(z)R_1(x)W_1(x)$

$W_3(y)\,W_3(z)R_2(x)R_1(y)W_1(y)W_2(x)$

S_2 :

$R_3(y)R_3(z)R_1(x)W_1(x)W_3(y)$

$W_3(z)R_2(z)R_1(y)W_1(y)$

$R_2(y)W_2(y)R_2(x)W_2(x)$

Find which schedule is conflict serializable

(A) S_1 only

(B) S_2 only

(C) Both

(D) None of these

Q.86 The relation R (A, B, C, D) is

$AB \rightarrow C$

$C \rightarrow D$

(A) In 1 NF, but not in 2NF

(B) In 2 NF, but not in 3NF

(C) In 3 NF, but not in BNCF

(D) In BCNF

Q.87 Consider the following relation

Performance

ID	Subject	No. of classes
GA13	DS	80
GA13	TOC	60
GA22	C	70
GA23	DELD	80
GA22	Python	60
GA23	ALGORITIHM	50

Teacher	
ID	Teacher_Name
GA13	Mr. Govind
GA22	Mr.Anish
GA23	Mr.Govind

Consider the following SQL query

Select T. Teacher_Name, sum (P. No. of classes)

From Teacher T, Performance P

Where T. ID = P. ID

GROUP BY T. Teacher_ Name

The number of row that will be returned by the SQL query is

(A) 3 (B) 9

(C) 18 (D) 2

Answers Database Management System

1.	8	2.	24	3.	B	4.	3	5.	8
6.	96	7.	56	8.	104	9.	15	10.	A,C
11.	B	12.	A,B	13.	D	14.	A	15.	A
16.	A	17.	A,D	18.	A	19.	B	20.	A,B,C
21.	D	22.	3	23.	C	24.	A	25.	C,D
26.	D	27.	D	28.	A	29.	18	30	6
31.	A,B,C,D	32.	10	33.	A,D	34.	C	35.	B
36.	3	37.	A	38.	B,C,D	39.	A	40	5
41.	D	42.	3	43.	A,B,C,D	44.	A	45.	D
46.	22	47.	A,C	48.	B	49.	A	50.	C
51.	B	52.	A,B,C,D	53.	C	54.	C	55.	2
56.	A,B,C	57.	A,C,D	58.	B	59.	C	60.	A
61.	B	62.	A	63.	D	64.	C	65.	B
66.	D	67.	A	68.	C	69.	B,C,D	70.	B
71.	B	72.	13	73.	B	74.	56	75.	200
76.	C	77.	B	78.	B	79.	A	80.	C
81.	C	82.	B	83.	0	84.	A	85.	B
86.	B	87.	D						

Explanations Database Management System

1. 8

Minimal cover of given FD's is

$A \rightarrow E$

$BE \rightarrow D$

$BDI \rightarrow E$

$F \rightarrow A$

$E \rightarrow B$

$BH \rightarrow F$

$CD \rightarrow A$

Note $AD \rightarrow BE$, $AC \rightarrow E$ are redundant functional Dependency, So they are not a part of Minimal cover.

The minimal set consist 8 FD's.

Hence, the correct answer is 8.

2. 24

R(A,B,C,D,E)

$A \rightarrow B$

$B \rightarrow C$

$C \rightarrow D$

$D \rightarrow E$

$B \rightarrow A$

Candidate key's are A and B

$(A)^{+} = \{A, B, C, D, E\}$

$(B)^{+} = \{A, B, C, D, E\}$

Total super key's are.

Super key By (A) + Super key By (B) – Super key (AB)

$\Rightarrow \quad 2^{n-1} + 2^{n-1} - 2^{n-2}$

$\Rightarrow \quad 2^{5-1}+2^{5-1}-2^{5-2}$

$\{\because$ n = no. of Attribute in Relation$\}$

$\Rightarrow \quad 16+16-8$

$\Rightarrow \quad 24$

Hence, the correct answer is 24.

3. (B)

$X \to Y$ is non trivial if $X \cap Y = \phi$ and $X \to Y$ is semi trivial if

$X \cap Y \neq \phi$ and $X \not\supseteq Y$

So, S_1 is true but S_2 is false

Hence, the correct option is (B).

4. 3

$A \to B$

$BC \to E$

$ED \to A$

Key's are

$\{CDA\}^+ = \{A, B, C, D, E\}$

$\{CDB\}^+ = \{A, B, C, D, E\}$

$\{CDE\}^+ = \{A, B, C, D, E\}$

3 Candidate keys are three

Hence, the correct answer is 3.

5. 8

Candidate key is AB

So, the number of super keys with two or more than two attributes

$= 2^{n-2}$ where n is the number of attributes in relation

So, $= 2^{5-2} = 8$

Hence, the correct answer is 8.

6. 96

No of super keys:-

Super keys (AB)+ Super keys (BE)– Super keys (ABE)

$2^{8-2}+2^{8-2}-2^{8-3}$

$2^6+2^6-2^5$

$64+64-32' \Rightarrow 96$

Hence, the correct answer is 96.

7. 56

No of super keys are:

$\Rightarrow \quad 2^{7-2}+2^{7-2}-2^{7-4}$

$= 2^5+2^5-2^3$

$= 32+32-8 \Rightarrow 64-8 \Rightarrow 56$

Hence, the correct answer is 56.

8. 104

Number of super key (SK) $\to$

$SK(A)+SK(B)+SK(EF)$

$-SK(AB)-SK(BEF)$

$-SK(AEF)+SK(ABEF)$

$\Rightarrow \quad 2^{7-1}+2^{7-1}+2^{7-2}-2^{7-2}-2^{7-3}-2^{7-3}+2^{7-4}$

$\Rightarrow \quad 64+64+32-32-16-16+8$

$\Rightarrow \quad 104$

Hence, the correct answer is 104.

9. 15

Here {A}, {B}, {C}, {D} are candidate keys then the super keys are

{A, AB, AC, AD, ABC, ABD, ABCD, B, BC, BD, BCD, C, CD, D}

i.e 15 Super keys are possible.

Hence, the correct answer is 15.

10. (A,C)

Insertion in to R and delete from S may cause inconsistency. But insertion into S will not cause any violation.

Hence, the correct option are (A,B).

11. (B)

. $\{A\}^+ = \{A, B, C, E\}$

$\{C\}^+ = \{C, E\}$

So $C^+ \subseteq A^+$

Hence, the correct option is (B).

12. (A,B)

The value in A is any value except i because $A \to D$ is FD

Hence, the correct option are (A,B).

13. (D)

$Q \to S$ and $ST \to P$ is hold in given instance

Hence, the correct option is (D).

14. (A)

$P \to Q$ and $SQ \to R$ then $PS \to R$ by P sides transitivity

Hence, the correct option is (A).

15. (A)

$\{BE\}^+ \Rightarrow \{B, D, E, A, C\}$ only BE is candidate key.

Hence, the correct option is (A).

16. (A)

F and G both generate same type of Functional dependency.

Hence, the correct option is (A).

17. (A, D)

For D_1

	A	B	C	D
R_1	α	α	α	
R_2		α	α	α

Using FD No Modification is done so it is lossy.

For D_2

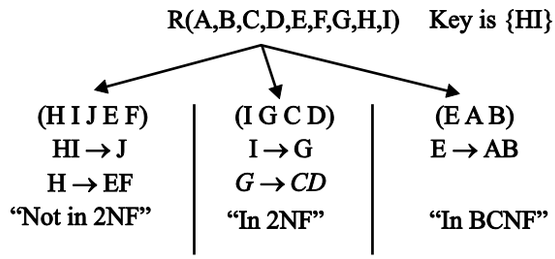
	A	B	C	D
R_1	α	α		
R_2		α	α	
R_3	α	α	α	α

Using R_1 and R_2 $A \to B$ we can put α in $(R_3 B)$ So last row contain all $\alpha's$ hence it is lossless join

So statement S_1 and S_4 is false.

Hence, the correct option are (A,D).

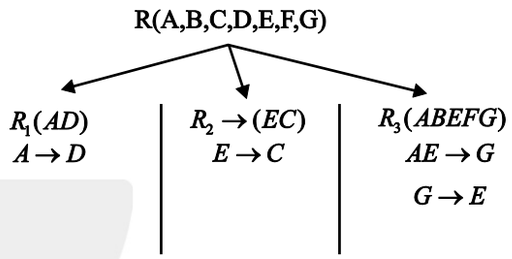
18. (A)



So, the decomposition is in 1 NF

Hence, the correct option is (A).

19. (B)



Here DF → BC is Not preserve in Any of the above Relation So Not in 3NF. So it is 2NF

Hence, the correct option is (B).

20. (A,B,C)

Candidate key of Relation R is ABC and CDE

So all attribute of Relation is Prime Attribute because part of ABC and CDE are A, B,C,D,E.

Hence Relation is in 3NF is also in 2 NF and 1 NF

Hence, the correct option is (A,B,C).

21. (D)

Candidate key $\{De\}^+ = \{D, C, A, B, E\}$ so $D \to A$ and $D \to B$ is PFD So relation is not in 2 NF.

Hence, the correct option is (D).

22. 3

FDs = $\{A_1 \to A_2$

$A_2 \to A_3$

$A_1 A_3 \to A_4$

}

Candidate key is A_1A_5

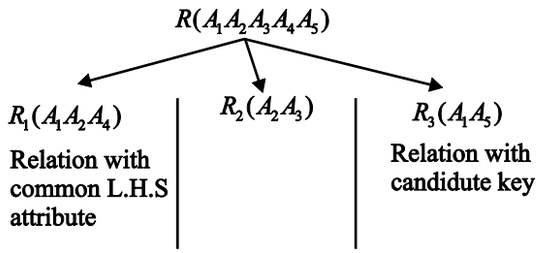
Minimal cover of given FD'S is

$A_1 \to A_2$

$A_2 \to A_3$

$A_1 \to A_4$

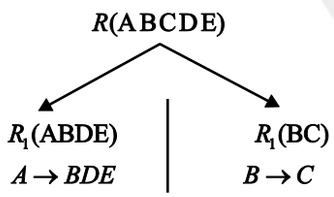
{Remove extra Attribute from L.H.S}



Total 3 Relation

Hence, the correct answer is 3.

23. (C)



In R_1 'A' is Key and

In R_2 'B' is Key So Both in BCNF

And

$R_1 \cap R_2 \Rightarrow (\text{ABDE}) \cap (\text{BC})$

$\Rightarrow$ B (key of R_2 So lossless)

And $F.D'S(R_1) \cup F.D's(R_2)$

$\Rightarrow$ $A \to BDE \cup B \to C$

$$\Rightarrow \left\{\begin{array}{l} A \to B \\ A \to D \\ A \to E \\ B \to C \\ A \to C (\text{By transitive}) \\ \text{A} \to A (\text{By reflexive}) \end{array}\right\} \Rightarrow \text{same as FD's (R)}$$

Hence, the correct option is (C).

24. (A)

$\{\text{AD}\}^+ = \{\text{A}, \text{B}, \text{C}, \text{D}, \text{E}\}$

$\therefore$ AD is candidate key for R.

So $D \to B$ is a partial functional dependency

Hence R is in 1 NF

Hence, the correct option is (A).

25. (C,D)

(C) Week Entity set is always total participation with strong set and relationship is identifying relationship.

(D) Two strong Entity set may be totally participate in Relationship.

Hence, the correct option is (C, D).

26. (D)

There is not any relation for relationship "R" because in one to many primary key of one side and attributes of relation is transfer to many side

Hence, the correct option is (D).

27. (D)

{h,d} is candidate key for A and any extra Attribute with {h,d} is super key. We can also design super key as a primary key for relation A.

Hence, the correct option is (D).

28. (A)

$\{c_1\}$ is key for Relation E.

$\{b_1, c_1\}$ is key for Relation B.

$\{a_1, b_1\}$ is key for Relation G_1.

$\{a_1, d_1\}$ is key for Relation A.

Hence, the correct option is (A).

29. 18

E is week Entity set for F as well as G. So we can say that E is multivalued attribute for F as well as G. i.e there are two table for E as E_1 (as multivalued Attribute of F) and E_2 (as multivalued Attribute of G)

Hence,

$E_1(b_1, c_1, c_2)$

$E_2(a_1, c_1, c_2)$

$F(b_1, b_2)$

$T_{b3}(b_1, b_3)$

$G(a_1, a_2, a_3)$

So x = 5 and y = 13

x + y = 18

Hence, the correct answer is 18.

30. 6

Tables as follows

$X(\underline{e}, f)$

$Y(\underline{d}, g, e)$

$Z(\underline{c}, i)$

$R_2(\underline{d}, \underline{c})$

$T_a(\underline{d}, \underline{a})$

$T_b(b, c)$

Total 6 tables are there.

Hence, the correct answer is 6.

31. (A,B,C,D)

The cardinality ratio is one to many so one instructor can teach many courses and course is totally participate in the relation, So every course has a instructor.

Relation is one to many so. Attribute of Relationship added in many side table

Hence, the correct option are (A,B,C,D).

32. 10

Following table:-

$E_2(b, e)$

$T_{E_1}(\underline{a, b}, d)$ as E_2's weak Entity

$T_{E_3}(\underline{c}, f)$

$T_{E_1}(\underline{a, c}, f)$ as E_3's weak Entity

Total Attributes 2+3+2+3 = 10

Hence, the correct answer is 10.

33. (A,D)

In one to many relation primary key of one side entity is migrate to many side, so number of attributes in many side are more then one side.

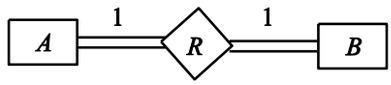
Hence, the correct option is (A,D).

34. (C)

We can't connect two Relationship directly.

Hence, the correct option is (C).

35. (B)



If one – one Relation and Both

Entity total participate in Relation then merge table of AB and make single table.

Hence, the correct option is (B).

36. 3

Given, 3 relation R,S,T

Result of $\pi_{A,C}(R \bowtie S)$ is

A	C
1	3
1	5
2	4
3	3
3	5
4	3
4	5
5	6

Result

$\pi_{A,C}(T)$	
A	C
1	3
3	3
4	5
4	3
5	6

A	C
1	5
2	4
3	5

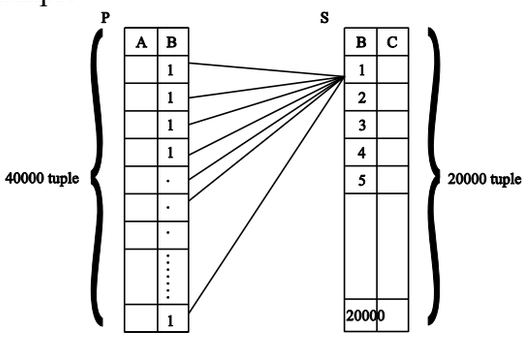
So Answer is 3

Hence, the correct answer is 3.

37. (A)

B is key on S that contain 20000 tuple. So maximum 40000 tuples of table P can be match to table S through attribute B

Example



Hence, the correct option is (A).

38. (B,C,D)

Total 15 tuples in $P \times Q$ than after satisfying condition the

Resultant table is

A	B	B	C	D
2	P	P	8	9
8	r	r	9	10
5	t	t	6	7

Hence, the correct option are (B,C,D).

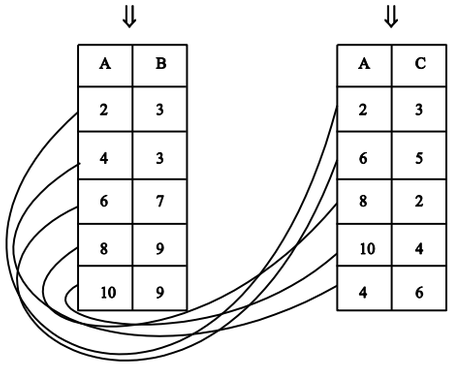
39. (A)

The result of Natural Join is zero because key, So, result of both set are different.

Hence, the correct option is (A).

40. 5

$$\pi_{A.B}(P * Q) * \pi_{A,C}(Q * R)$$



A	B
2	3
4	3
6	7
8	9
10	9

A	C
2	3
6	5
8	2
10	4
4	6

$\Rightarrow$

A	B	C
2	3	3
6	7	5
8	9	2
4	3	6
10	9	4

So the total number of tuples in the Result is 5.

Hence, the correct answer is 5.

41. (D)

$\pi_{x,y,z}(R) - \pi_{xyz}(S)$ given uncommon tuple of Relation R

$\pi_{x,y,z}(S) - \pi_{xyz}(R)$ given uncommon values of set (x,y,z) from S so

X	Y	Z
4	2	3
1	2	6

$\cup$

X	Y	Z
2	5	4

So total 3 tuples.

Hence, the correct option is (D).

42. 3

S_1, S_2, S_5 are unsafe Query

Hence, the correct answer is 3.

43. (A,B,C,D)

All are Equivalent Output of all are Same.

Hence, the correct option are (A,B,C,D).

44. (A)

Given the name of department that do not have any girl student.

Hence, the correct option is (A).

45. (D)

The output of All Overs are same

They perform equal join operation.

Hence, the correct option is (D).

46. **22**

A		B		C		D		
E1	1×	B1	2×	C1	3×	D1	2	⇒12
		C1		C2		D2		
				C3				
E2	1	B2	×1	C1	×2	D1	2	⇒4
				C2		D3		
E3	1	B1	×2	C4	1×	D1	2	⇒4
		B2		×		D4		
E4	1×	B5	1×	C1	1×	D1	2	⇒2
						D3		
								22

Hence, the correct answer is 22.

47. **(A,C)**

R

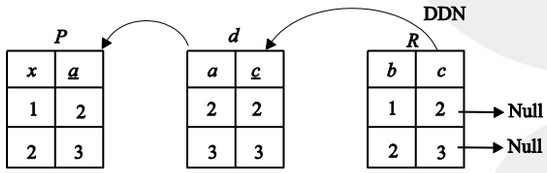
	P	Q
T_1	a	b_1
T_2	a	b_2

R

	P	Q
T_1	a_1	b_1
T_2	a_2	b_1 *or* b_2

Hence, the correct option is (A,C).

48. **(B)**



Delete from P Cause deletion from Q also now deleting from Q also now deleting Q(c) put null in R(c)

So resultant R will be

R	
b	**c**
1	Null
2	Null

Hence, the correct option is (B).

49. **(A)**

Here A is primary key so count of A is same as count of record in R.

Hence, the correct option is (A).

50. **(C)**

2 and 3 statements are not going to execute. So total sum of salaries are.

200000+400000+150000 = 750000

Hence, the correct option is (C).

51. **(B)**

Natural Join produce the matched, row of both table

But left outer Join produce both matched as well as unmatched row of left table

So query Q2 contain the result of Q2 as well as the unmatched row of relation A

Hence, the correct option is (B).

52. **(A,B,C,D)**

(A) Insertion in Q cause error. Q(a) refer P(a) and 30 is not in P(a).

(B) Insertion in R cause error because R(c) refer Q(c) 30 is not in Q(c).

(C) P is base table for Q so deleting the value will cause referential integrity error.

(D) Q is base table for R. So Deletion given Error have.

Hence, the correct option are (A,B,C,D).

53. **(C)**

P

A	B
b	c
b	d
d	e
c	f
b	k

Q

B	C
c	f
e	i
c	g
b	e
b	f

P.A = Q.B then

P.A	P.B	Q.B	Q.C
b	c	b	e
b	c	b	f
b	d	b	e
b	d	c	f
c	f	c	f
c	f	c	g
b	k	b	e
b	k	b	f

O/P ⇒

P.A	C-count
b	6
c	2

Hence, the correct option is (C).

54. (C)

Given SQL print all the name of student's, that contain single P and S in their name.

Hence, the correct option is (C).

55. 2

The give SQL is implementation of division operation of Relational Algebra $(R \div S)$. So it find the value of A corresponding to all value of B is S.

So,

A
1
2

Is o/p

The number of tuple return is 2

Hence, the correct answer is 2.

56. (A,B,C)

Employee		
Eno	**Ename**	**Dno**
1	A	10
2	B	20
3	C	30

Project	
Pno	**Pname**
101	x
102	y

Work-on	
Eno	**Pno**
1	101
1	102
2	102
3	103

So according to question we need to find the name of employee who work on all project means. Work on 101 and 102. i.e Eno 1.

(a)

T_1
Pno
101
102

T_2
Eno
1

Result

Ename
A

(b) If inner correlated sub Query gives false result i.e null then outer Query given O/p.

So only for Eno = 1 it gives o/p hence

Ename
A

(c) We can also implement division of RA using option (C)

A,B,C are Equivalent

Hence, the correct option is (A,B,C).

57. (A,C,D)

In Option (A) Eno is 3 and in option (D) Eno in 2 Both Entries already present in table and Eno is Primary key So both cause error and in option (C) Ename is null but the is constraint Ename Can't null So it cause Error.

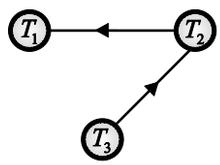
Hence, the correct option is (A,C,D).

58. (B)

We cannot select any column with aggregate function directly, for these we must use group by So, option B is illegal.

Hence, the correct option is (B).

59. (C)



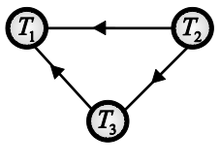
If we apply Topological sort then order of execution T_3, T_2, T_1

Hence, the correct option is (C).

60. (A)

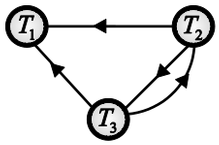
Only $S1$ is conflict serializable. The precedence graph of S_1 and S_2 is

S_1 :



Not any cycle so conflict serializable

S_2 :



Cycle in graph so not conflict serializable

Hence, the correct option is (A).

61. (B)

$T_1^{(10)}$	$T_2^{(20)}$
$r(x)$	
	$r(y)$
$w(y)$	
	$w(x)$

Initially Read and write Time stamp as x is 10 and Read and write the stamp of y is 20

So, $r_1(x)$ and $r_2(y)$ Execute but $w_1(y)$ fail because Time of $T_1 = 10$ and write T.S of y $T.S(T_1) <$ Write –T.S (y)

Hence, the correct option is (A).

62. (A)

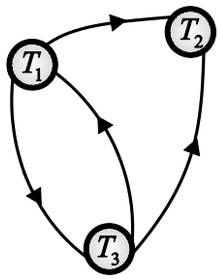
Error file : only tell as what went wrong. It is not useful for recovery.

Log file:- It is used for recovery.

Hence, the correct option is (A).

63. (D)

T_1	T_2	T_3
W(A)		
	R(A)	
	W(A)	
W(B)		
		R(B)
		W(B)
	W(B)	
R(B)		



Graph contain cycle So not conflict Serialzable

Now,

There does Not Exist any serial schedule which is view equivalent to S. It is not view serializable

Hence, the correct option is (D).

64. (C)

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

If we consider $TS(T_1) = 1000; TS(T_2) = 3000$ and $TS(T_3) = 2000$ then all Transactions successfully execute without abort

$T_1 = 1000$	$T_2 = 3000$	$T_3 = 2000$
r(x) read – TS(x)=1000		
	r(y) read- TS(y)=3000	
w(z) write – TS (z) =1000		r(y) read – TS(y)=3000 r(z) read TS(z)=2000
	w(y) write TS-(Y) = 3000	
		w(x) write – TS (x) = 2000

NOTE :-

Read operation of "item" by Transaction T_i is perform successfully if

$$TS(T_i) \geq Write\text{-}TS(item)$$

And read – TS (item) = max (read – TS (item), TS (T_i))

T_i is perform successfully if

{

$$T_s(T_i) \geq read - TS\ (item)$$

And $T_s(T_i) \geq write - TS\ (item)$

}

And

Write – TS (item) = TS (Ti)

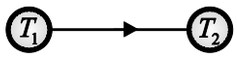
Hence, the correct option is (C).

65. (B)

S

T_1	T_2
R(A)	
W(A)	
	R(A)
R(B)	
	W(A)
W(B)	
C;	
	R(B)
	W(B)
	C;

S_1 : Precedence graph



No cycle Hence it is conflict serializable

S_2 : T_2 dependry on T_1 and commit of T_1 before T_2 So it is recoverable.

S_3 : T_2 reads uncommitted date of T_1. Hence pt is no cascadless schedule.

Hence, the correct option is (B).

66. (D)

All transactions are committed So none transaction is in undo list undo list is Empty.

Hence, the correct option is (D).

67. (A)

Both T_1 and T_2 reads and modify it. The net effect of T_1 and T_2 should be change on A. Only T_2's change is seen, however, the final value of A has increased by 50, causing lost update done by T_1.

Hence, the correct option is (C).

68. (C)

Both S_1 and S_2 are true

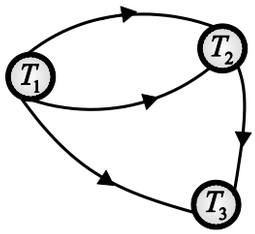
Hence, the correct option is (C).

69. (B,C,D)

S

T_1	T_2	T_3
R(A)		
	W(A)	
W(A)		
		W(A)
C_1		
	C_2	
		C_3

There No update Read So it is recoverable as well as cascade less.



Graph Contain cycle So Not Conflict Serializable

S			S		
T_1	T_2	T_3	T_1	T_2	T_3
$R(A)$			$R(A)$		
	$W(A)$		$W(A)$		
$W(A)$			C_1	$W(A)$	
		$W(A)$		C_2	
C_1					$W(A)$
	C_2				C_3
		C_3			

S is view equivalent to its serial schedule (S_1).

Hence it is view serializable.

Hence, the correct option are (B,C,D).

70. (B)

S_1	
T_1	T_2
R(X)	
	W(X)
	Commit
R(X)	

↑

Unrepeatable read

S_2	
T_1	T_2
W(X)	
	R(X)
Rollback	

↑

Dirty read

Hence, the correct option is (B).

71. (B)

Apply lock on S_1

S_1	
T_1	T_2
S(X)	X(Y)
R(X)	S(X)
	W(Y)
	R(X)
X(Y)	Unlock(Y)
W(Y)	Unlock(X)
Commit	
Unlock(X)	Commit
Unlock (Y)	

So,

S_1 Possible in 2PL

Apply lock on S_2

S_2			
T_1	T_2	T_3	
S(X)			
R(X)	X(Y)		
	R(Y)		
X(Z)			
W(Z)		S(Y)	← Can't Apply because exclusive Apply by T_2
Commit		R(Y)	
	W(Y)	R(Z)	
		W(X)	
	Commit		
		Commit	

S_2 Not Possible Under 2PL

Hence, the correct option is (B).

72. 13

Each block consist (n – 1) keys, (n – 1) record pointer and n child pointer

Where n is order of B tree.

$$(n-1)\times 8+(n-1)\times 16+n\times 12\le 512$$

$$36n-24\le 512$$

$$36n\le 512-24$$

$$n\le 13.55$$

So $n=13$

Hence, the correct answer is 13.

73. (B)

In case of dense indexing

Total number of index = No. of recodes in a file

= 30,000

No. of Index in one block

$$=\frac{\text{Block size}}{\text{index size}}=\frac{512\,\text{byte}}{23\,\text{byte}}$$

$$=22.26$$

$$\approx 22\,(\text{for unspanned})$$

$$\text{No.of Block for index file}=\frac{\text{Total index}}{\text{index in one block}}$$

$$=\frac{30,000}{22}$$

$$=1363.63\approx 1364 \text{ blocks}$$

Hence, the correct option is (B).

74. 56

In B^+ tree leaf node

$(n-1)\rightarrow$ key pointer

$(n-1)\rightarrow$ record pointer

$1\rightarrow$ child pointer

So, $(n-1)\times 10+(n-1)\times 8+1\times 4\le 1024$

$$18n\le 1024+14$$

$$n\le 57.66$$

$$n=57$$

So, $n-1=56$

Order of leaf node is 56

Hence, the correct answer is 56.

75. 200

Size of index = 1248 = 20 byte

Size of block = 1000 byte

$$\text{No. of index in one block}=\frac{\text{Block size}}{\text{index size}}$$

No. of index for dense index = No. of record's in file = 10000

So,

$$\text{No. of Block for index file}=\frac{\text{No.of index}}{\text{index in one block}}$$

$$=\frac{10,000}{50}=200$$

Hence, the correct answer is 200.

76. (C)

77. (B)

Assume Maximum number of keys node can hold is n then (n+1) child pointer and 0 record pointer for non leaf node

So $n\times 9+(n+1)\times 8\le 1024$

$$n\cong 59$$

Hence, the correct option is (B).

78. (B)

If n is order of B^+ tree then max n child pointer (n-1) key and 0 Record pointer |for non-leaf node|

So, $n*8+(n-1)*10\le 1024$

$$18n\le 1034$$

$$n\le 57.44$$

$$n\approx 57$$

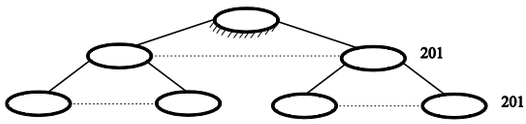
$$\text{Minimum key } \frac{n-1}{2}\Rightarrow\frac{57-1}{2}$$

$$\frac{56}{2}=28$$

Hence, the correct option is (B).

79. (A)

80. (C)



Then maximum leaf node $201 \times 201 = 40401$

Hence, the correct option is (C).

81. (C)

Non-leaf node of B^+ tree contain max (n) child pointer (block pointer) (n-1) keys. 0 record pointer

$$n*8+(n-1)*18 \le 1024$$
$$26n \le 1024+18$$
$$n = 40.0768$$
$$n \cong 40$$

Hence, the correct option is (C).

82. (B)

According un-spanned file organization an block of size 2048 can contain 20 Record of 100 byte

So, for storing 100,000 record we required

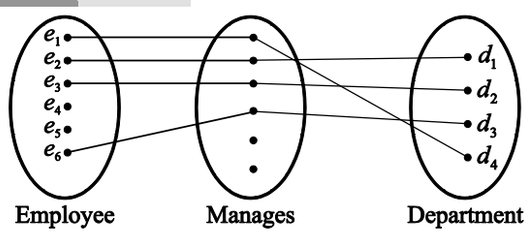
$$\Rightarrow \frac{100,000}{20} \Rightarrow 5000 \text{ blocks.}$$

So, for accessing a data we required an average Half of block

So, $\frac{5000}{2} \Rightarrow 2500$

Hence, the correct option is (B).

83. 0



Participation or minimum number of relationship in employee is = 0

Because there can be many employees who cannot manager.

84. (A)

Cost of nested loop join = $b_R + n_R * b_S$

Where $b_R \rightarrow$ blocks for outer relation

$n_R \rightarrow$ number of tuples for outer relation

$b_S \rightarrow$ number of blocks for inner relation.

n_s = number of tuples for inner relation

And here book is an outer relation

So, $n_R = 5000$

$b_r = 500$

$n_S = 2000$

$b_S = 100$

So cost $= 500 + 5000 * 100$

$= 500 + 500000$

Cost $= 500500$

Option A is the correct option

85. (B)

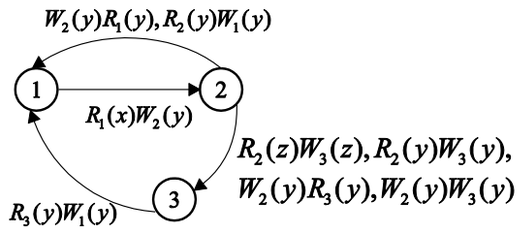
S_1

Find number of nodes = 3

Conflict operations are

$$R_2(z)W_3(z), R_2(y)W_3(y),$$
$$R_2(y)W_1(y), W_2(y)R_3(y),$$
$$W_2(y)W_3(y), W_2(y)R_1(y), R_3(y)$$
$$W_1(y), R_1(x)W_2(x)$$
$$W_1(x)R_2(x), W_1(x)W_2(x),$$
$$W_3(y)R_1(y), W_3(y)W_1(y)$$

Draw the graph



In the point 2 we get a cycle so it is not conflict serializable

S_2

no. of nodes = 3

Conflict operations are

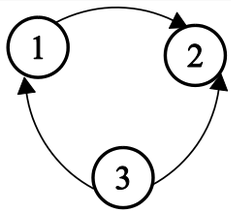
$R_3(y)W_1(Y), R_3(y)W_2(y), R_1(x)W_2(x), W_1(x)R_2(x), W_1(x)W_2(x),$

$W_3(y)R_1(y), W_3(y)W_1(y), W_3(y)R_2(y), W_3(y)W_2(y), W_3(z)R_2(z),$

$R_1(y)W_2(y), W_1(y)R_2(y), W_1(y)W_2(y)$

Draw the graph

Teacher_Name	No. of Classes
Mr. Govind	270
Mr. Anish	130



In this precedence graph there is no cycle so, S_2 is conflict serializable so option B is correct

86. (B)

First we find its candidate key

$AB^+ = \{A, B, C, D\}$

So, AB is a candidate key

(1) First we check for BCNF [For BCNF

A ⟶ B

↓

A must be super key

$AB \to C$ [AB is super key]

$C \to D$ (C is not a super key)

So it is not in BCNF

(2) Now we check for 3NF [$X \to a$]

[X is either super key or A is prime attribute]

$AB \to C$ (true because AB is a super key)

$C \to D$ (False because C is not a super key or D is not a prime attribute)

(3) Now we check for 2NF [$X \to a$ is not in 2NF if X is proper subset of some candidate key and a is non prime or non key attribute]

$AB \to C$ [False because AB is not proper subset & C is a non prime attribute]

$C \to D$ [False because C is not proper subset and D is non prime attribute]

So it is in 2NF so option B is correct

87. (D)

When we perform GROUP BY T.Teacher_name, then if more than one ID have same name then we write only one time so out final table is

So only 2 rows are returned in the table

10 Computer Network

Practice Questions

Q.1 Match the following

OSI Layer

1. Network Layer
2. Transport Layer
3. Data Link Layer
4. Session Layer
5. Presentation Layer
6. Physical Layer

Responsibilities

p. Encoding & Translation
q. Feedback Messaging
r. Transmission Modes
s. Segmentation and Reassembly
t. Dialogue Control
u. Access Control

(A) 1-s, 2-t, 3-u, 4-r, 5-p, 6-q
(B) 1-q, 2-s, 3-u, 4-t, 5-p, 6-r
(C) 1-s, 2-u, 3-p, 4-r, 5-q, 6-t
(D) 1-q, 2-u, 3-p, 4-t, 5-s, 6-r

Q.2 Let a cluster of stations share 48 kbps of pure Aloha channel. Every station outputs frames of length 1024 bits on an average of every 50 seconds. Then what is the maximum value of number of stations?

(A) 413 (B) 431
(C) 453 (D) 435

Q.3 An IPV_4 Packet has the first hexadecimal digits as show below

$0\times4500005C000300005906\ldots$

How many hops can this packet take before being dropped?

(A) 30 (B) 59
(C) 89 (D) 90

Q.4 Consider a 8 Mbps token LAN with a ring latency of 256 μsec. A host need to transmit seizes the token, and then it sends a frame of 1024 bytes removes the frame after it has circulated all around the ring and finally releases the token. This process is repeated for every frame. Assuming that only a single host wishes to transmit, then the effective data rate in Mbps is? _____.

Q.5 In an IPv4 Packet, the value of HLEN is 15, and the value of the total length field is 0×0064. How many bytes of data are being carried by this packet?

(A) 85 bytes (B) 49 bytes
(C) 40 bytes (D) 20 Bytes

Q.6 An IPv4 datagram has arrived in which the offset value is 800, the value of HLEN is 8, and the value of the total length field is 500 and the *M* bit is 0, what are the numbers of the first byte,

the last byte and the position of the datagram?

(A) 6400, 6887 and Last fragment

(B) 6400, 6867 and First fragment

(C) 6400, 6867 and Last fragment

(D) 801, 1268 and First fragment

Q.7 A sliding window protocol of 4 Mbps point to point Link has propagation delay of 0.5 sec. Assume that each frame carries 2 KB of data. What is the maximum number of bits used for the sequence number field?

(A) 10 (B) 9

(C) 12 (D) 8

Q.8 The following is a dump of UDP header in hexadecimal format

5EFA00FD001C3297

What is the total length of user datagram? Is the packet from client to server or vice versa?

(A) 30 bytes and packet is going from client to server

(B) 28 bytes and packet is going from client to server

(C) 30 bytes and packet is going from server to client

(D) 28 bytes and packet is going from server to client

Q.9 If size of a TCP segment is 1 kB and header length value is 6, the sequence number $= 3500$. Given that URG Flag $= 1$ and URG pointer $= 45$. How many of them are urgent

Give the sequence numbers of urgent data.

(A) 45 bytes of urgent data, sequence number 3500 – 3544

(B) 45 bytes of urgent data, sequence number 1024 – 1069

(C) 46 bytes of urgent data, sequence number 1024 – 1070

(D) 46 bytes of urgent data, sequence number 3500 – 3545

Q.10 If the initial sequence number is 1 and it increment the counter by 256000 for every 2 sec, how long does it take for the counter to wrap around

(A) 33, 554 seconds

(B) 44, 554 seconds

(C) 33, 455 seconds

(D) 44, 455 seconds

Q.11 If IRTT $= 45$ sec, NRTT $= 60$ sec, $\alpha = 0.9$ and initial deviation is 8 sec then calculate Time out.

(A) 80.5 (B) 81.3

(C) 82.5 (D) 80.0

Q.12 Which of the following is/are true about TCP? **[MSQ]**

(A) It is a byte oriented port to port communication

(B) It uses a combination of SR and Go-Back *N* for flow control

(C) It connections are Link to Link and full duplex

(D) It uses piggybacking-whenever possible

Q.13 IP packets whose total length (data plus header) is 16 kb basting out of a router live for 15 seconds. The maximum line speed (in Mbps) of the router can operate at without cycling through the IP datagram identification number space is?

(A) 68.266 (B) 57.233

(C) 8.533 (D) 10.333

Q.14 A building running CSMA-CD Protocol is having a bandwidth of 512 Mbps and distance of 2 km then determine the

minimum data size in order to detect a collision. Assume that the signal speed is 2×10^5 km/s.

(A) 1000 Bytes

(B) 1250 bytes

(C) 1280 bytes

(D) 1024 bytes

Q.15 A system user the sliding window protocol is having a bandwidth of 10 Mbps with a window size of 100. What is the size of data if the distance between the Sender and receiver is 72000 km and the propagation speed is 3×10^8 m/sec? Given Utilization is 0.5

(A) 2048 bytes

(B) 3015 bytes

(C) 4096 bytes

(D) 3072 bytes

Q.16 Given the maximum lifetime of a segment is 30 sec and link capacity is 500 Mbps, find the number of bits required to avoid wrap around during this time?

(A) 10 bits (B) 23 bits

(C) 30 bits (D) 31 bits

Q.17 Determine the efficiency of token ring with a data rate of 250 Mbps, a ring latency of 120 μsec and 5000-bit packets. Assume N hosts wants to transmit and each host holds the token for a maximum of frame transmission time.

(A) $\frac{N}{7N+6}$ (B) $\frac{50N}{7N+6}$

(C) $\frac{50N}{N+6}$ (D) $\frac{N}{N+6}$

Q.18 If bandwidth of a token ring is 48 Mbps and token holding time is 5 ms then find the minimum and maximum payload in bytes?

(A) 46, 240000 (B) 0, 30000

(C) 21, 19982 (D) 0, 29979

Q.19 Suppose that the flag pattern in framing protocol is given as 01111. If the transmitted data is 101110100111001101. The what is the number of stuff bits in transmitted data X?

Q.20 Calculate the effective throughput for transferring a 1000 KB file assuming TCP using slow start congestion control technique. Given the round-trip time 100 ms, and maximum segment size is 1460 Bytes. Assume there are no losses and both the bandwidth and the receiver window size is infinite.

(A) 5 Mbps (B) 10 Mbps

(C) 1 Mbps (D) 1 Mbps

Q.21 An organization is granted the block 150.36.0.0/16

The administrator wants to create 512 Subnets.

What is the Subnet mask?

(A) 255.255.255.128

(B) 255.255.255.192

(C) 255.255.255.224

(D) 255.255.255.240

Q.22 Which of the following uses UDP as the transport layer protocol?

(A) HTTP (B) Telnet

(C) SMTP (D) DNS

Q.23 In Ethernet, when Manchester Encoding is used, the bitrate is

(A) Half the Band Rate

(B) Twice the Band Rate

(C) Same as Baud Rate

(D) None of the above

Q.24 Station A need to send a message consisting of 15 Packets to Station 'B' Using a sliding window $(W_S = 4)$ and go-back-N error control strategy. All Packets are ready and immediately available for transmission. If every 6th Packet that 'A' transmits gets lost (but no Acks from 'B' ever gets lost), then what is the number of Packets that 'A' will transmit for sending the message to 'B'?

(A) 29 (B) 21
(C) 27 (D) 25

Q.25 Suppose a CSMA/CD Network is operating 1 Gbps, and suppose there are no repeaters and the length of cable is 1 km. Determine the minimum frame size is the signal propagation speed is 200 km/ms.

Q.26 A 25 Kbps satellite link has a propagation delay of 400 s. The transmitter employs "Selective Repeat" Scheme with *N* set to 8. Assume each frame is 100 Bytes long. What is maximum bandwidth Utilization? (Where *N* is window size).

(A) 5 Kbps (B) 7.7 Kbps
(C) 15 Kbps (D) 10 Kbps

Q.27 A channel has a bit rate of 4 Kbps and one-way propagation delay of 20 ms. The channel uses stop-&-wait protocol. The transmission time of acknowledgement frame is negligible. To get a channel efficiency of atleast 75%, the minimum frame size should be

(A) 480 B (B) 480 bits
(C) 160 Bytes (D) 160 bits

Q.28 Which of the following is/are an application Layer service?

[MSQ]

(A) Remote login
(B) Mail service
(C) File transferred access
(D) None

Q.29 Column Matching

A.	Bridge	(i)	Optical wire
B.	Ethernet	(ii)	CSMA/CD
C.	FTP	(iii)	Layer 2
D.	Light	(iv)	Out of Bond
E.	HTTP	(v)	Port No. 80

Which of the following options match correctly?

(A) A-iii, B-i, C-v, D-ii, E-iv
(B) A-iii, B-ii, C-iii, D-iv, E-v
(C) A-iv, B-ii, C-v, D-iv, E-ii
(D) A-iii, B-ii, C-iv, D-i, E-v

Q.30 Which one of the following can't be a broadcast ID with subnet mask 255.255.255.240?

(A) 201.201.201.159
(B) 201.201.201.199
(C) 201.201.201.207
(D) 201.201.201.143

Q.31 The routing table of a router is shown as below :

Destination	Subnet mask	Interface
128.75.43.0	255.255.255.0	Eth0
128.75.43.0	255.255.255.128	Eth1
192.12.17.5	255.255.255.255	Eth2
Default		Eth3

On which interface will the router forward Packets addressed to destination 128.75.43.16 and 192.12.17.10 respectively?

(A) Eth1 and Eth3
(B) Eth0 and Eth3
(C) Eth0 and Eth2
(D) Eth1 and Eth2

Q.32 The Subnet mask for a particular network is 255.255.252.0. Which of the following pairs of IP addresses could belong to this network?

(A) 172.57.88.62 and 172.57.87.233
(B) 10.35.28.2 and 10.35.29.4
(C) 191.203.31.87 and 191.234.31.88
(D) 128.8.129.43 and 128.8.131.42

Q.33 In a Network of LANs connected by bridges, Packets are sent from one LAN to another through intermediate bridges. Why is the spanning free algorithm used for bridge routing?

(A) For shortest path routing between LANs
(B) For avoiding Loops in the routing paths
(C) For fault tolerance
(D) For minimizing collisions

Q.34 What is the Primary Purpose of ARP?

(A) Translate URLs to IP address.
(B) Resolve IPV4 addresses to MAC Address
(C) Provide dynamic IP configuration to Network devices.
(D) Convert interval private addresses to external public addresses.

Q.35 A 3000 km Long trunk operates at 1.536 Mbps and it is used to transmit 64 Bytes frames. If it uses sliding window protocol then what is the number required of bit for sequence numbers. Assume propagation speed of 8 km/microsec?

(A) 3 (B) 5
(C) 2 (D) 4

Q.36 Consider a MAN with server and destination of 20 km apart and one way delay is 2 minutes. At what data rate does RTT equals to transmission delay for 2 KB data?

(A) 41 bits/sec (B) 68.2 bps
(C) 69 bps (D) 40 bps

Q.37 Let Computer A and B have IP addresses 72.195.126.113 and 72.195.126.91 respectively and both uses Subnet mask '*N*'. Then what is the value of '*N*' that should not be used out of following. If both belong to same network?

(A) 255.255.255.0
(B) 255.255.255.128
(C) 255.255.255.192
(D) 255.255.255.224

Q.38 Resource Reservation is a feature of :

(A) Circuit switching
(B) Packet switching
(C) Both (A) and (B)
(D) None

Q.39 Two popular routing algorithm are Distance Vector (DV) and Link State (LS) routing. Which of the following are true?

(a) Count-to-infinity is a problem only with DV, not LS.
(b) In LS, Shortest Path algorithm, run only at one node.
(c) In DV, the shortest path algorithm, run only at one node.
(d) DV requires Less number of messages then LS.

(A) a, b and d (B) a, c and d
(C) b and c only (D) a and d only

Q.40 The transport Layer Protocols used for real time multimedia, FTP, DNS and email respectively are :

(A) TCP, UDP, UDP and TCP
(B) UDP, TCP, TCP and UDP
(C) UDP, TCP, UDP and TCP
(D) TCP, UDP, TCP and UDP

Q.41 Consider TCP connection in a state where there are no outstanding Acks. The sender sends two segments back to back. The seque numbers of first and second segments are 750 and 870 respectively, The first segment was lost, but second was received correctly by the receiver. Let X be the amount of data carried in first segment (in Bytes). Y be the Ack number sent by the receiver. The value of X and Y are :

(A) 120 and 870 (B) 120 and 990
(C) 750 and 990 (D) 120 and 750

Q.42 What is the maximum size of data that the application Layer can pass on to the TCP Layer below?

(A) Any size
(B) 2^{16} B to Header size
(C) 2^{16} Byte
(D) 1500 Bytes

Q.43 Packets of same session may be routed through different paths in.

(A) TCP but not UDP
(B) TCP and UDP
(C) UDP but not TCP
(D) Neither TCP nor UDP

Q.44 Which of the following is a private address :

(A) 11.1.2.3 (B) 100.10.0.1
(C) 192.168.1.1 (D) 255.255.0.0

Q.45 Trace route program is implemented using which concept(s) **[MSQ]**

(A) feedback messaging (ICMP)
(B) time to Live
(C) spanning tree
(D) None of these

Q.46 In the checksum calculation at TCP, which of the following are used **[MSQ]**

(A) TCP header
(B) TCP data
(C) Pseudo header from IP
(D) None

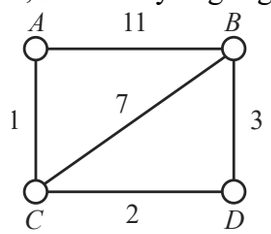
Q.47 If 'k' is the maximum number of bits available in sequence number field, then what is the maximum sender window size in GBN.

(A) $2^k - 1$ (B) 2^{k-1}
(C) 2^k (D) $2^k + 1$

Q.48 If Bandwidth of an Ethernet cable is 100 Mbps, distance of the LAN is 1 km, velocity of signal in cable is $2 * 10^8$ m/sec. Then what is minimum size of a frame in this Ethernet to detect collisions.

(A) 10, 000 bits
(B) 1000 bits
(C) 100 bits
(D) 10000 bytes

Q.49 In the following graph, if DVR is applied, how many edges go unused?



(A) 1 (B) 2
(C) 3 (D) 4

Q.50 If a Class B network is divide into Subnets and the Subnet mask is 255.255.192.0, then how many Subnets and hosts per Subnet are possible.

(A) $4, 2^{14}$ (B) 4,16
(C) 16,16 (D) $4, 2^{14} - 2$

Q.51 In IPv4 packet format, the value of HLEN is 10 and offset value is 200. The total length of packet is 300 bytes. Find first and last byte number of payload/ data packet?

(A) 200, 460 (B) 200, 459
(C) 1600, 1860 (D) 1600, 1859

Q.52 What will be the total number of host in a network with subnet mask 200.200.248.0 _____?

Q.53 In a subnetted classful network with broadcast ID 200.156.76.95. What is the possible subnet mask in the same network?

(A) /24 (B) /25
(C) /26 (D) /27

Q.54 Which of the following subnet mask can't be used if two host H(A): 200.145.75.155 and H(B): 200.145.75.162 belongs to the same network?

[MSQ]

(A) /25 (B) /26
(C) /27 (D) /28

Q.55 Which of the following fields does not change while movement of IP-Packet?

[MSQ]

(A) Total Length
(B) Identification No.
(C) Protocol
(D) Checksum

Q.56 Suppose an ISP needs to create 200 subnets, each with 200 usable host address per subnet. What network mask will you assign using a class B network address?

(A) 255.255.255.252
(B) 255.255.255.128
(C) 255.255.255.0
(D) 255.255.254.0

Q.57 Which of the following fields of IP Header is/are definitely changed on visiting each router?

[MSQ]

(A) Checksum (B) TTL
(C) Offset (D) Total Length

Q.58 Which of the following is NOT address resolution technique?

(A) BOOTP (B) DHCP
(C) ARP (D) RARP

Q.59 Which of the following statement is FALSE regarding Distance Vector (DV) and Link State (LS) routing protocols?

[MSQ]

(A) In DV, every nodes share it's routing table with it's neighbor periodically.
(B) In LS, only one node builds it's own minimum spanning tree (MST).
(C) In DV, every node broadcast it's routing table to get distance of other.
(D) In LS, every node broadcast it's query message to get distance of other.

Q.60 Suppose a Host(A) with IP-address 200.200.200.175 belongs to a network with subnet mask 255.255.255.63. What is the fourth octed of network ID in which Host(A) belongs_____?

Q.61 Which of the following options is/are FALSE about Internet Protocol (IP)?

[MSQ]

(A) IP Packet from source to destination can take different route in the path.
(B) The checksum filed in IP Header help to detect error of IP Packet.
(C) The length of IP Packet remains same throughout it's journey.
(D) TTL inside IP Header prevents it to goes into infinite loop.

Q.62 A IP Packet of size 1000 bytes is visiting to a router having maximum transmission unit (MTU) is 200 bytes. What is the maximum overhead inside IP Packet if size of network header is 40 bytes_____(Bytes)?

Q.63 Suppose an ISP assigned a IP-address 200.200.200.200/24 to org-A. Now org-A wants to create a subnets of different number of addresses in each subnet.
Which one of the following assignment is NOT possible?
(A) 100, 50, 20, 25
(B) 60, 60, 60, 25, 10, 14
(C) 40, 40, 40, 20, 20, 10, 10
(D) 100, 60, 20, 10, 14

Q.64 Suppose routers R1, R2….Rn are connected in a full binary tree form. Initially routers R1 only knows the distance of R2 and R3. Find number of updates required by distance vector routing protocol runs over R1 to get distance of router Rn?
(A) 1 (B) n-2
(C) Ceil(logn)-1 (D) floor(logn)-1

Q.65 IP address with subnet is given as 200.200.200.103/28. Find last octed of broadcast ID in this network_____?

Q.66 The subnet mask for a particular network is 255.255.248.0. Which of the following pair of IP-Address could belongs to this network?
(A) 200.156.128.17 & 200.156.132.18
(B) 200.156.128.17 & 200.157.130.18
(C) 200.156.128.17 & 200.156.136.18
(D) 200.156.128.17 & 200.156.135.18

Q.67 What is the range of IP-addresses that can be assigned to the Hosts by IP address with subnet mask:
200.200.200.200/27?
(A) 200.200.200.129
to 200.200.200.190
(B) 200.200.200.160
to 200.200.200.254
(C) 200.200.200.1
to 200.200.200.254
(D) 200.200.200.193
to 200.200.200.222

Q.68 Suppose Host A wants to send a packet of size 5020 bytes at network layer to Host B. The maximum transmission unit (MTU) of underlying layer of Host A is 1420 bytes. If size of header at network layer is 20 bytes, Suppose number of fragments are x and offset field value of 3rd fragment is y. Then find the value of xy that Host B will receive_____?

Q.69 Suppose an organization wants to create sub-network containing 35,20,15 hosts in each sub-networks. What is the maximum length of subnet mask that organization should use?
(A) /22 (B) /24
(C) /25 (D) /26

Q.70 What is the maximum length of subnet mask if two host belongs to the same network
Host A: 200.200.200.97
Host B: 200.200.200.110
(A) /24 (B) /25
C) /27 (D) /28

Q.71 The transport layer passes a packet size of 4228 to networks layer. The size of header at network layer is 20 bytes and maximum transmission unit (MTU) at underlying layer (DDL) is 1420 bytes. Which of the following options is/are TRUE? **[MSQ]**
(A) Number of fragments are 3
(B) Offset value of last fragment at IPv4 packet is 350?
(C) Size of last fragmented IP packet is 28 bytes.
(D) Sum of offset value of all fragments is 1050.

Q.72 Which of the following statements is / are FALSE?

S_1: TCP Provides end to end connection.

S_2: TCP ensures that data is delivered reliably in sequence and without error.

(A) S_1 Only

(B) S_2 Only

(C) Both S_1 & S_2

(D) Neither S_1 and S_2

Q.73 In TCP, sequence number is used for

(A) Rearranging the data of receiver end before passing to the application.

(B) Detecting duplicate data

(C) Both

(D) None of these.

Q.74 Which of the following statements is FALSE about TCP?

(A) It uses sequence number field for in order delivery of data segments

(B) It is connection oriented protocols so all packets follow same path.

(C) It is responsible for end to end delivery of data segments

(D) It is used in an application in which reliability is must.

Q.75 Which of the following is NOT part of UDP header?

(A) Checksum

(B) Source Port

(C) Sequence Number

(D) Total Length

Q.76 Which of the following statement is NOT True?

(A) TCP assigns sequence number to each byte

(B) TCP assign sequence number only to the first byte of segment

(C) TCP uses 32- bits for sequence number field.

(D) Byte numbering is used for flow control

Q.77 Consider following assertion:-

S1: TCP connection establishment is the three-way handshaking process

S2: TCP Connection termination is two-way handshaking process

Which of above assertions are true?

(A) S1 only (B) S2 only

(C) Both (D) None

Q.78 Which of the following field is NOT included in TCP Header?

(A) Sequence Number

(B) Acknowledgement Number

(C) Checksum

(D) Protocol

Q.79 Consider the following assertions:-

S1: TCP uses checksum field for error control

S2: TCP uses sequence number field for flow control

S3: TCP window size is varying depending upon congestion of networks.

Which of the following is/are TRUE?

(A) S1, S2 (B) S2, S3

(C) S1, S3 (D) All

Q.80 Suppose size of receiver window is 20KB and size of congestion window is 10KB. What should be the size of sender window to maintain flow control?

(A) 30KB

(B) 20KB

(C) 10KB

(D) Could be 10KB or 20KB

Q.81 Suppose size of current window of sender is 2MSS (Maximum segment size) and sender is using Slow Start congestion control protocol. If threshold value of networks is 8MSS then find the sender window size after 5 RTT_____?

Q.82 Suppose size of each segment is 2000 bytes and current sender window size is 6000 bytes. Sender received three ACK subsequently then what is the sender window size if Slow Start protocol is used?

(A) 6000 byes
(B) 8000 bytes
(C) 10000 bytes
(D) 12000 bytes

Q.83 Initially sender detected that size of receiver window is 6 MSS and congestion window size is 4 MSS. After one RTT, what will be the sender window size if Slow Start protocol is used_____ (in MSS)?

Q.84 Which of the following statements is/are TRUE about UDP?

S1: It uses three way handshaking process to established connection.
S2: Header size of UDP packet is fixed and of 8 bytes.
S3: It is used for application layer where reliability is not required.

A) S1, S2 B) S3
C) S2, S3 D) All

Q.85 What is the maximum transmission time required to transmit a single UDP packet if channel bandwidth is 10 Mbps_____(in ms)?

Q.86 In Go-back-3 flow control protocol every 5^{th} packet is lost. If we have send 11 packets. _____ transmissions will be needed?

Q.87 Consider a scenario with two hosts, *X* and *Y*. A web server running on *X* is trying to send data to a browser on *Y*. For each TCP connection, *X*'s TCP stack maintains a buffer of 1024 bytes and *Y*'s TCP stack maintains a buffer of 2048 bytes. For simplicity assume TCP sequence number began at '0'. *Y*'s stack received upto byte 1084 in order from *X*, although its browser has only read up to the first 40 bytes. The window size in the TCP headers that *Y* next sends to *X* is _____ Bytes.

Q.88 Suppose sender is using sliding window protocol with propagation delay of 25 ms. If frame size is 1000- bits and bottleneck bandwidth is 1 Mbps then what should be the sender window size of channel efficiency of 80 %?

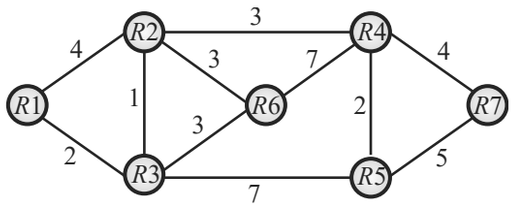
Q.89 Suppose sender is transmitting data with data rate of 20 Mbps. What is the link utilization (in percentage) if throughout of channel is 5 Mbps.

(A) 100 (B) 75
(C) 50 (D) 25

Q.90 Suppose sender is using stop and wait protocol with round trip delay of 30 ms. If frame size is 1000 bits and transmission rate is 1 Mbps then what is the link utilization (roundoff to two decimal places) assuming processing delay of 0.75 ms and acknowledgement transmission time 1.25 ms?

Q.91 Suppose two stations sharing a common medium involves in collision four times. What is the probability of success in next transmission by any one of them? (Round off to two decimal places)

Q.92 Consider following network implementing Distance vector routing :-



After route stabilization, how many links remains unused _____?

Q.93 Two stations 'A' and 'B' are on a Ethernet. Both A and B attempt to transmit their frames, collide, and 'A' wins first backoff race. At the end of successful transmission by 'A', again both attempts to transmit and collide. The probability that either A or B wins next backoff race is.

(A) 0.625 (B) 0.5
(C) 0.75 (D) 1

Q.94 Consider the cyclic redundancy check (CRC) based error detecting scheme having CRC generating polynomial is $x^4 + x^2 + x + 1$. Suppose the data 100110 is to be transmitted. Check bits $C_3C_2C_1C_0$ are appended at the end of the data by the transmitter using the above CRC scheme. The decimal value of the code word is_____(consider unsigned value).

Q.95 A block of addresses is granted to a small origanization. If one of the addresses is 210.32. 64.79/26, then which of the following is/are True?

[MSQ]

(A) First address is 210.32.64.64
(B) Last address is 210.32.64.127
(C) Subnet mask is 255.255.255.192
(D) Total number of IP address is 64

Q.96 Suppose an 1P – packet is created by source host having HLEN =12. How many record route address can be placed inside header of 1P- packet?

Q.97 In CSMA/CD propagation time is 1 msec and bandwidth is 10 Mbps then what should be the packet minimum length to detect the collision.

(A) 250 bytes
(B) 400 bytes
(C) 2500 bytes
(D) 325 bytes

Q.98 In the IPV4 addressing format, the number of networks allowed under class C addresses is ____

Q.99 In go back 5, if every 7th packet that is being transmitted is loss and if we have to send 10 packets, then how many transmissions are required_____.

Q.100 In a packet switching network, packets are routed from source to destination along a single path having two intermediate nodes. If the message size is 42 bytes and each packet contain a header of 6 bytes, then the optimum packet size is

(A) 8 (B) 10
(C) 14 (D) 12

Q.101 An IP address is 120.140.5.128/22 it is the____ IP address of the block.

Answers Computer Network

1.	B	2.	B	3.	C	4.	5.36	5.	C
6.	C	7.	D	8.	B	9.	D	10.	A
11.	B	12.	A,B,D	13.	C	14.	C	15.	B
16.	D	17.	D	18.	D	19.	2	20.	C
21.	A	22.	D	23.	A	24.	B	25.	10000000
26.	B	27.	D	28.	A,B,C	29.	D	30	B
31.	A	32.	B	33.	B	34.	B	35.	A
36.	B	37.	D	38.	A	39.	D	40	C
41.	D	42.	A	43.	B	44.	C	45.	A,B
46.	A,B,C	47.	A	48.	B	49.	B	50.	D
51.	D	52.	2046	53.	D	54.	C,D	55.	B,C
56.	C	57.	A,B	58.	B	59.	B,C	60.	47
61.	B,C	62.	240	63.	C	64.	D	65.	111
66.	C	67.	D	68.	4350	69.	C	70.	D
71.	C,D	72.	A	73.	A	74.	B	75.	C
76.	B	77.	A	78.	D	79.	D	80.	C
81.	11	82.	D	83.	4	84.	C	85.	52.4
86.	20	87.	1004	88.	40	89.	D	90.	0.03
91.	0.94	92.	3	93.	C	94.	609	95.	A,B,C,D
96.	6	97.	C	98.	*	99.	14	100.	C
101.	384								

1. (B)

1. Network Layer take of feedback messaging through ICMP.
2. Application Layer sends data of any size to transport Layer. Now transport layer will know the MTU of the network, so it will segment the data into smaller parts and these segments are reassembled at the transport Layer of the receiver. So, Transport Layer taken care of Segmentation and Reassembly.
3. When more than one system is connected to a shared Link, Data Link Layer protocols are required to determine which device has the control over the link at a given time. It is implemented by Protocols Like CSMA/CD, CSMA/CD, CSMA/CA, ALOHA and Token Passing
4. Dialogue Control is using the full duplex link as half duplex. It sends out dummy packets from the client to the server when the client in ideal. This is done by the session Layer.
5. Presentation Layer translates a message from common form to encoded format which will be understood by the receiver.
6. Physical Layer chooses which type of transmission mode is to be selected for the transmission. The transmission modes are simplex, Half Duplex and Full duplex.

Hence, the correct option is (B).

2. (B)

Throughput of Pure Aloha $= G * e^{-2G}$ Where G is the average number of frames generated by the system during one frame Transmission time.

The maximum throughput is achieved when $G = \frac{1}{2}$. So, maximum through put $= 0.5 \times e^{-1} = 0.184$

This is the maximum utilization of the band width.

Therefore total utilization of bandwidth $= 0.184 *$ Bandwidth of channel

Number of stations $*$ Capacity of each station

$= 0.184 *$ Capacity of channel

$N * b = 0.184 * B$

$N = 0.184 * B/b$

Given channel capacity is B

$= 48$ kbps $= 48 * 1000$ bps

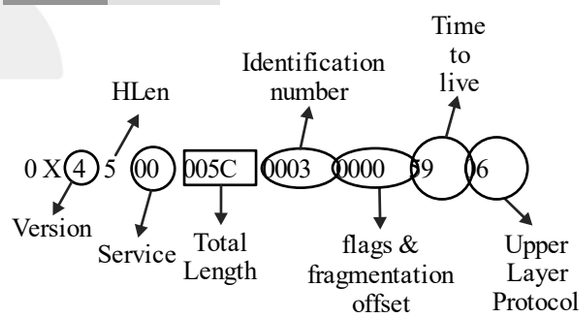
Capacity of each station is $b = 1024$ bits/50 sec $= 20.48$ bps

$\Rightarrow \quad N = 0.184 * 48 * 1000$ bps/20.48 bps

$= 431$

Hence, the correct option is (B).

3. (C)



From the above figure, the time to live (TTL) field is 0×59 in Hexadecimal $= 5 * 16 + 9 = 89$ in decimal. Therefore, the packet will be dropped after taking 89 hopes from the source.

Hence, the correct option is (C).

4. 5.36

Given $B = 8$ Mbps

Ring latency or propagation delay $= 256$ μsec

Length of the frames $= 1024$ B

Number of stations $N = 1$

Given that token is held until the frame reaches the source and then releases the token.

So, this is delayed token reinsertion strategy.

$$\eta = \frac{N}{N + (N+1)a},$$

Where, $a = \dfrac{\text{Propagation delay}}{\text{Transmission delay}}$

$$T_{trans} = \frac{L}{B} = \frac{1024 * 8 \text{ bits}}{8 \times 10^6 \text{ bits}} = 1024 \text{ μsec}$$

$$a = \frac{T_p}{T_t} = \frac{256 \text{ μs}}{1024 \text{ μs}} = 0.25$$

$$\eta = \frac{1}{1 + (1+1)0.25} = 0.67$$

Therefore Effective data rate = Efficiency * Bandwidth

$= 0.67 * 8 \text{ Mbps} = 5.36 \text{ Mbps}$

Hence, the correct answer is 5.36.

5. (C)

The HLEN value is 15, which means the total number of bytes in the header is $15 * 4 = 60$ bytes. Given the total length is 0×0064 in hexadecimal $= 100$ bytes including header size. So, the data carried by this Packet = total length – header length $= 100 - 60 = 40$ bytes

Hence, the correct option is (C).

6. (C)

M bit is 0, means this datagram is the last fragment, there are no datagram after this offset is 800 i.e., there are $800 * 8 \text{ bytes} = 6400$ bytes before this fragment.

Total Length field is 500 bytes.

Given HLEN is 8, So header Length is $8 * 4 = 32$ bytes.

Therefore the data present in this fragment is $500 - 32 = 468$ Bytes.

The sequence number of the first byte of this fragment is 6400, since there are 6400 bytes, before this datagram and sequence number starts from 0. The sequence number of the last byte of this fragment is $6400 + 468 * 1 = 6867$

Hence, the correct option is (C).

7. (D)

Propagation delay $= 0.5$ sec

RTT $= 2 \times 0.5 = 1$ sec, $B = 4$ Mbps, $L = 2$ kB

$$T_{trans} = \frac{L}{B} = \frac{2 * 1024 \times 8 \text{ bits}}{4 \times 10^6 \text{ b/sec}}$$

$$= 4.096 * 10^{-3} \text{ sec}$$

Window size

$$= \frac{T_{trans} + 2 * T_{prop}}{T_{trans}}$$

$$= \frac{(4.096 \times 10^{-3}) + (1000 \times 10^{-3})}{4.096 \times 10^{-3}} = 245.14$$

Therefore, number of sequence bits

$$= \lceil \log_2 W_5 \rceil = \lceil 245.14 \rceil = 8$$

Hence, the correct option is (D).

8. (B)

UDP header is 64 bits has parts each containing 16 bits.

1st 16 bits for source port number

2nd 16 bits for destination port number

3rd 16 bits for total length

Last 16 bits for Checksum.

Given header is $5EFA00FD001C3297$ in hexadecimal form. $0 \times 5EFA$ is source port number and the value is 24, 314 in decimal

$0 \times 00FD$ is destination port number and the value is 253 in decimal

$0 \times 001C$ is for total length

0×3297 is for checksum.

Datagram total length is $001C$ H bytes which is 28 bytes.

Now if port value is > 1023 then it's a client and if < 1023 then it's server.

Clearly source port number is $5EFA$ H which is 24314 > 1023. So it's a client.

Destination port number is $00FDH$ i.e. 253 < 1023.

So it's a server. So, packet is going from client to server.

Hence, the correct option is (B).

9. (D)

(Given size of TCP segment

$= 1 \text{ kB} = 1024 \text{ Bytes}$

Header length field is 6, so header size

$= 6 * 4 = 24$ bytes

Total data size = Size of segment – Header size

$= 1024 - 24 = 1000$ bytes of data

Starting sequence number is 3500

So the range of sequence number of the data is 3500 to 4499

URG pointer $= 45$ so data from 0^{th} byte till 45^{th} byte are urgent So 46 bytes are urgent data.

Therefore, the urgent data is 1000 to 1045 and its sequence number range is 3500 – 3545.

Hence, the correct option is (D).

10. (A)

For every 2 secs, counter is incremented by 2, 56, 000

So for every 1 sec, counter increments by $\frac{2,56,000}{2} = 1,28,000$

The sequence number is 32 bit long and it can hold only $2^{32} - 1$.

So, it takes $\frac{(2^{32} - 1)}{(128000)} = 33,554,431$ sec.

Hence, the correct option is (A).

11. (B)

From the Jacobson's algorithm,

Next Deviation

$$D_N = |\text{IRTT} - \text{NRTT}| = |45 - 60| \text{ sec}$$

$$= 15 \text{ sec}$$

Expected deviation $D_E = \alpha D_I + (1 - \alpha) D_N$

$$= 0.9 * 8 + 0.1 * 15$$

$$= 8.7$$

Expected Roundtrip time ERTT

$$= \alpha * \text{IRTT} + (1 - \alpha)\,\text{NRTT}$$

$$= 0.9 * 45 + (1 - 0.9) * 60$$

$$= 46.5$$

Time out $T_0 = \text{ERTT} + 4 * D_E$

$$= 46.5 + 4 * 8.7$$

$$= 81.3$$

Hence, the correct option is (B).

12. (A,B,D)

TCP connections are end to end. Data Link Layer is Link to Link.

Hence, the correct option are (A,B,D).

13. (C)

IP datagram identification number space is 16 bits.

So number of packets $= 2^{16}$

Packet life time $= 15$ sec

So, 2^{16} packets will be sent in 15 secs

In 1 second, $\frac{2^{16}}{15}$ will be sent

Since each packet size $= 16 \text{ k bits} = 2 \text{ k Bytes}$

So line speed $= \frac{2^{16} * 2048 \text{ byte}}{15 \text{ sec}} = 8.533 \text{ MBps}$

Hence, the correct option is (C).

14. (C)

Bandwidth $B = 512 \text{ Mbps} = 512 * 10^6$ bits/sec

Distance $d = 2$ km

Speed $= 2 \times 10^8$ m/s

For CSMA-CD, to detect collision, $T_t \geq 2T_p$

$$T_p = \frac{d}{V} = \frac{2\times10^3 \text{ m}}{2\times10^8 \text{ m/s}} = 10^{-5} \text{ sec}$$

$$T_t = \frac{L}{B} = \frac{L}{512*10^6 \text{ b/s}}$$

$$L = 2*10^{-5} \text{ sec} \times 512\times10^6 \text{ bits/sec}$$

$$L = 1024\times10 \text{ bits} = 128\times10 \text{ bytes}$$

$$L = 1280 \text{ bytes}$$

Hence, the correct option is (C).

15. (B)

$$\eta = \frac{W}{1+2a} \qquad a = \frac{T_p}{T_t}$$

$$\eta = \frac{W*T_{trans}}{T_{trans}+2*T_p} \quad \Rightarrow \quad \frac{1}{2} = \frac{W*T_{trans}}{T_{trans}+2T_p}$$

$$L = 2*B*\frac{T_{prop}}{(2W-1)}$$

$$T_p = \frac{d}{V} = \frac{72*10^6 \text{ m}}{3\times10^8 \text{ m/sec}} = 0.24 \text{ sec}$$

Therefore,

$$L = 2*\frac{(10*10^6 \text{ bits/sec})*(0.24 \text{ sec})}{(2*100-1)}$$

$$= 3015 \text{ bytes}$$

Hence, the correct option is (B).

16. (D)

Given time $= 30$ sec

$B = 500$ Mbps

$1 \text{ sec} = 500$ Mb

$$30 \text{ sec} \rightarrow 30*500*\frac{10^6}{8 \text{ bytes}} = 1.875*10^9$$

Number of bits required to avoid wrap around

$$= \left\lceil \text{Log}_2(1.875*10^9) \right\rceil \text{ bits} = 31$$

Hence, the correct option is (D).

17. (D)

Given

$B = 250$ Mbps, $RL = 120$ μsec, $L = 5000$ bits

Number of hots present is N.

In early token reinsertion Efficiency

$$= N*\frac{T_{trans}}{NT_{trans}+RL}$$

$$T_{trans} = \frac{L}{B} = \frac{5000 \text{ bits}}{250*10^6 \text{ bits/s}} = 20 \text{ μs}$$

$$\text{Efficiency} = \frac{20N}{N*20+120} = \frac{N}{N+6}$$

Hence, the correct option is (D).

18. (D)

Given $B = 48$ Mbps

Token Holding Time (THT) $= 5$ ms

In token ring, minimum frame size can be anything since there are no collisions. So, it is applicable to interactive applications. In order to avoid monopolization there is a limit on the time for which a station should hold a token, Token Holding Time (THT)

Therefore max frame size $= B*T$

$= 48 \text{ Mbps} * 5 \text{ ms} = 240000$ bits

$= 30000$ bytes

Data size or payload = frame size – 21

$= 29979$ bytes

Hence, the correct option is (D).

19. 2

Since, the flag pattern used as 01111.

And, transmitted data is 101110100111001101

In transmitted data we have stuff bits after every 0111.

10111[0]100111[0]01101

So, number of stuff bits = 2

Hence, the correct answer is 2.

20. (C)

Given slow start congestion protocol, so size of the sender window starts from 1 MSS and increase exponentially.

So, for the 1st transmission, 1 MSS $= 1 * 1460$

2nd transmission, 2 MSS $= 2 * 1460$

3rd transmission, 4 MSS $= 4 * 1460$

$\vdots$

N^{th} transmission, N MSS $= N * 1460$

Sum of all the data send in N transmission should be equal to 1000 KB

$$1460(1+2+4+8+\ldots+N)\text{ Bytes} = 1000\text{ KB}$$

$$1+2+4+8+\ldots+N = \frac{1024000\text{ B}}{1460\text{ B}} = 701.369$$

It is in Geometric progression so sum of N terms in G.P is

$$\frac{1(2^N-1)}{2-1} = 701.369$$

$$2^N - 1 = 701.369$$

$$2^N = 702 \text{ (approx)}$$

$$\Rightarrow \quad N = \lceil \text{Log}_2 702 \rceil = 10$$

So we need to transmit 10 times to send all the 1000 KB data file.

Therefore we need 10 RTT time

$$10 * 100 \text{ ms} \rightarrow 1000 \text{ KB}$$

$$1 \text{ sec} \rightarrow \frac{1000 \text{ KB}}{1000 \text{ ms}} = 1 \text{ Mbps}$$

Hence, the correct option is (C).

21. (A)

Given address is class B, we need 512 Subnets so we require 9 bits to be borrowed from host id i.e., 8 bits from 3rd Octet and 1 bit from 4th Octet.

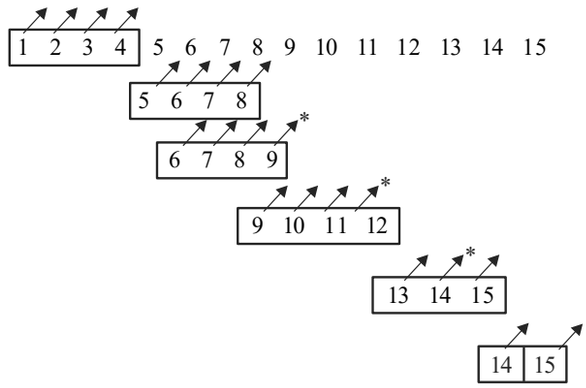
So, the Subnet mask is 255.255.255.128

Hence, the correct option is (A).

22. (D)

23. (A)

24. (B)



Total number of transmissions required to send message = 21

Hence, the correct option is (B).

25. 10000000

$$L_{\min} = R \times 2t_p$$

$$= 1 \times 10^9 \text{ bits/sec} \times 2 \times \frac{10^3 \text{ meter}}{200 \times 10^3 \text{ met/sec}}$$

$$= 10^7 \text{ bits}$$

Hence, the correct answer is 1000000.

26. (B)

$$L = 100 \text{ bytes}$$

$$t_p = 400 \text{sec}, \; R = 25 \text{ kbps} \; N = 8$$

$$R_E = \eta . R$$

$$t_t = \frac{L}{R} = \frac{100 \times 8}{25 \times 10^3} = 32 \text{ ms}$$

$$\text{(maximum bandwidth utilization)} = \frac{N.t_t.R}{t_t + 2t_p}$$

$$= \frac{8 \times 32}{32 + 2 \times 400} \times 25 \text{ kbps}$$

$$= \frac{256}{832} \times 25 \text{ kpbs} \simeq 7.7 \text{ kbps}$$

Hence, the correct option is (B).

27. (D)

$$\eta = \frac{t_t}{t_t + 2t_p}; \quad t_t = \frac{L}{R}, \; t_p = 20 \text{ ms}$$

$$75\% = \frac{\frac{L}{R}}{\frac{L}{R} + 2 \times 20 \text{ ms}} \Rightarrow 4L = 3L + 160 \text{ bits}$$

$$\Rightarrow \quad \frac{3}{4}=\frac{L}{L+2\times 20\times 10^{-3}\times 4\times 10^{3}} \text{ bits}$$

$$\Rightarrow \quad L=160 \text{ bits}$$

Hence, the correct option is (D).

28. (A,B,C)

29. (D)

A- (iii)
B- (ii)
C- (iv)
D- (i)
E- (v)

Hence, the correct option is (D).

30. (B)

(A) $\dfrac{201.201.201.1001}{\text{masked by/28}}\Big|^{1111} \Longleftrightarrow$ all 1s ,

so broadcast id

(B) $\dfrac{201.201.201.1100}{\text{masked by/28}}\Big|^{0111} \Longleftrightarrow$ not all 1s,

so not a broadcast id

(C) $\dfrac{201.201.201.1100}{\text{masked by/28}}\Big|^{1111} \Longleftrightarrow$ all 1s ,

so broadcast id

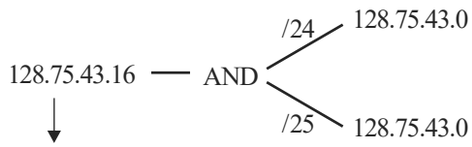
(D) $\dfrac{201.201.201.1000}{\text{masked by/28}}\Big|^{1111} \Longleftrightarrow$ all 1s ,

so broadcast id

Hence option (B) is true.

Hence, the correct option is (B).

31. (A)



It will be forwarded through interface having longest mask matched

So,

/25	Eth1

$$192.12.17.10 \xrightarrow[/32]{AND} 192.12.17.10$$

$$\downarrow$$

So by defaut network – Eth 3

Hence, the correct option is (A).

32. (B)

Subnet mask = /22

$$\left.\begin{array}{l} 10.35.28.2 \text{ AND/22= } 10.35.28.0 \\ 10.35.29.4 \text{ AND /22=}10.35.28.0 \end{array}\right\} \text{Same Net} - 1\text{D}$$

So, both the host belongs to same network.

Hence, the correct option is (B).

33. (B)

Since, in a spanning tree, there is a unique path from a source to the destination, which avoids loops, since it is a tree, and contains all the nodes, since it is a spanning tree.

Hence, the correct option is (B).

34. (B)

35. (A)

$d=3000$ km $R=1.536$ Mbps

$h=64$ Bytes, Speed $=8$ km/sec

$$t_p=\frac{d}{\text{speed}}=\frac{3000\times 10^{-6}}{8}\text{ sec}$$

$$t_p=375\text{ ms}$$

$$t_f=\frac{64\times 8}{1.536\times 10^{6}}\text{ sec}$$

$$t_f=\frac{256}{1.536}\text{ ms}=166\text{ ms}$$

We know,

$$N\le\frac{t_t+2t_p}{t_t}\text{, for max utilization}$$

$$N\le\frac{167+2\times 375}{167}$$

$$N\simeq 5$$

So, sequence No. bits $=[\log_2 N]=[\log_2 5]=3$

Hence, the correct option is (A).

36. (B)

$$RTT = 2t_p = 2\times 2\times 60\,\text{sec} = \frac{2\,\text{KB}}{R}$$

$$R = \frac{2\times 1024\times 8\text{ bits}}{4\times 60\text{ sec}}$$

$$R = 68.2\,\text{bps}$$

Hence, the correct option is (B).

37. (D)

For the subnet mask N = 255.255.255.22 both the host belongs to different network

Hence, the correct option is (D).

38. (A)

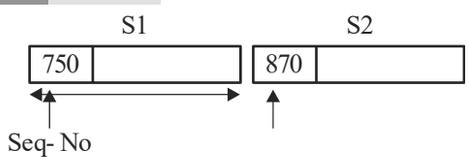
39. (D)

Count to infinity problem is associated with only DV and it requires lesser no. of network message in compare to LS, as LS uses flood: technique to get distance of other.

Hence, the correct option is (D).

40. (C)

41. (D)



Size of segment = 120 byte

Since 1st segment is lost

So, Ack- No $(Y) = 120$

Hence, the correct option is (D).

42. (A)

Its transport layers responsibility to divide data in to fragments/ packets. Application layer need not worry about it.

Hence, the correct option is (A).

43. (B)

As path is decided by routing protocols.

Hence, the correct option is (B).

44. (C)

192.168.1.1 is a private address in class C

Hence, the correct option is (C).

45. (A,B)

46. (A,B,C)

47. (A)

In GBN, $SW < 2^k$

So, $(SW)_{\max} = 2^k - 1$

Hence, the correct option is (A).

48. (B)

$$T_{trans} \geq 2 * T_{prop}$$

$$\frac{L}{B} \geq 2 * \frac{d}{\text{v}}$$

$$\Rightarrow \quad L = 2 * \frac{d}{v} * B = \frac{2*1000}{2*10^8} * 100 * 10^6$$

$$= 1000 \text{ bits}$$

Hence, the correct option is (B).

49. (B)

The edges *AB* and *CB* will not be used. If we consider the edge *AB*, there is a shorter path than *AB*.

It is $A \to C \to D \to B$

Similarly, for *CB*, better path is *C-D-B*

Hence, the correct option is (B).

50. (D)

Numbers of 1's $=$ NID $+$ SID

In class *B*, NID $= 16$

255.255.192.0

$= 11111111.11111111.11000000.00000000$

$\therefore$ 1's $= 18$

$18 =$ NID $+$ SID

$\to \quad 16 + \text{SID} = 18 \to \text{SID} = 2$

$\therefore$ Number of Subnets $= 2^2 = 4$

Number of 0's in Sm indicates HID part,

In the Sm given, number of 0's $= 14$

Hence, the correct option is (D).

51. (D)

HLEN field value $= 10$

So, actual header length $= 10 \times 4 = 10 \times 4$

$= 40$ bytes

Offset $= 200$

$TL = 300$

So, Payload size $= TL -$ Header length

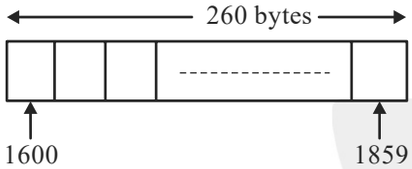
$= 300 - 40 = 260$

1st byte Number $= 8 \times$ offset $= 8 \times 200 = 1600$

Last byte Number $= (1600 + 260) - 1$

{Since starting from '0'}

$= 1859$



Hence, the correct option is (D).

52. 2046

Subnet mask $= 255.255.248.0$

$= /21$

So, number of host $= 2^{32-21} - 2$

$= 2^{11} - 2$

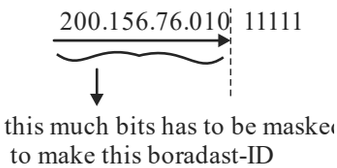
$= 2048 - 2$

$= 2046$

Hence, the correct answer is 2046.

53. (D)

Broadcast-ID $= 200.156.76.95$



So, possible Subnet mask $= /27$

Hence, the correct option is (D).

54. (C,D)

$H_A : 200.145.75.155$

$H_B : 200.145.75.162$

AND

AND

/27

/27

Net-ID $= 200.145.75.128$

$= 200.145.75.160$

Since Host 'A' and 'B' have different Subnet-ID for Subnet mask /27. So belongs to differential network.

Some thing will happen for Subnet mask = /28

Hence, the correct option are (C,D).

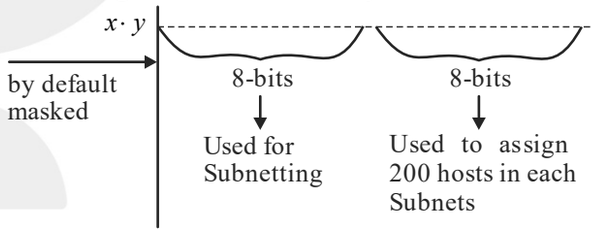
55. (B,C)

Identification no and protocol set by source node never changed during the movement of IP-packet.

Hence, the correct option are (B,C).

56. (C)

In Class-B, we have 16-bits accessible remaining 16-bits are fixed by ISP.



So, we need to consume 8-bits from host-ID to create 200 Subnets.

So, Subnet mask $= /16 + 8 = /24$

$/24 = 255.255.255.0$

Hence, the correct option is (C).

57. (A,B)

Offset and Total length field are only changed whenever fragmentation is done by router.

Hence, the correct option are (A,B).

58. (B)

DHCP is used to dynamically allocate IP-address in wireless network. It is not Address resolution technique.

Hence, the correct option is (B).

59. (B,C)

Option (C) is false, because every node only shares its routing table to its neighbors.

Option (B) is false, because every nodes creates their own MST.

Hence, the correct option are (B,C).

60. 47

Host-ID = 200.200.200.175

Subnet mask = 255.255.255.63 AND (bitwise)

Net-ID = 200.200.200.47

↑ Fourth octed of Net-ID

Hence, the correct answer is 47.

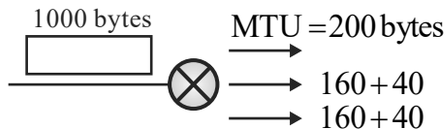
61. (B,C)

Checksum field only defect error inside header not data

Length will differ when fragmentation occurs

Hence, the correct option are (B,C).

62. 240



Header size = 40 byte

Payload size = 200 – 40 = 160

No. of fragment $= \frac{1000-40}{160} = 6$

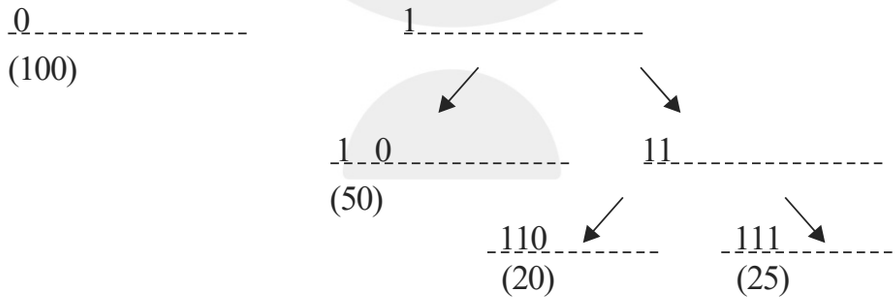
So, Oren bead $= 6 \times 40 = 240$ byte

Hence, the correct answer is 240.

63. (C)

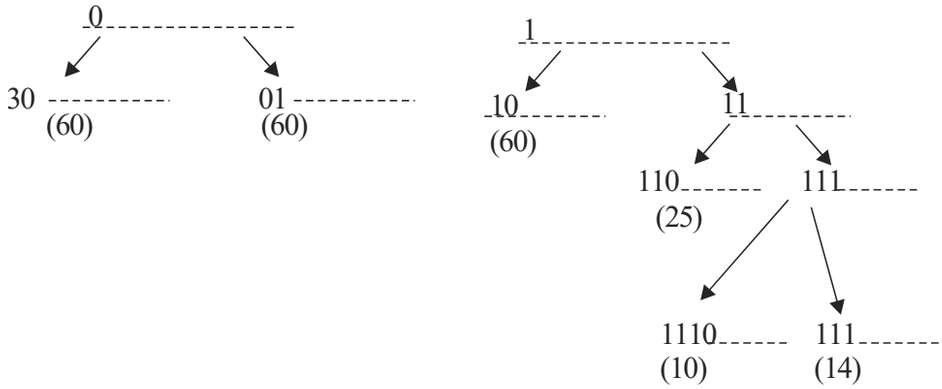
Since host bits $= 8$, Lets start fixing the bits one by one for the last octet starting from left to right.

(A)



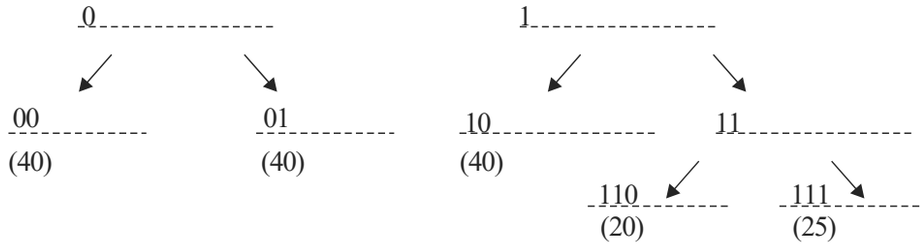
Hence A is possible

(B)



Hence B is possible

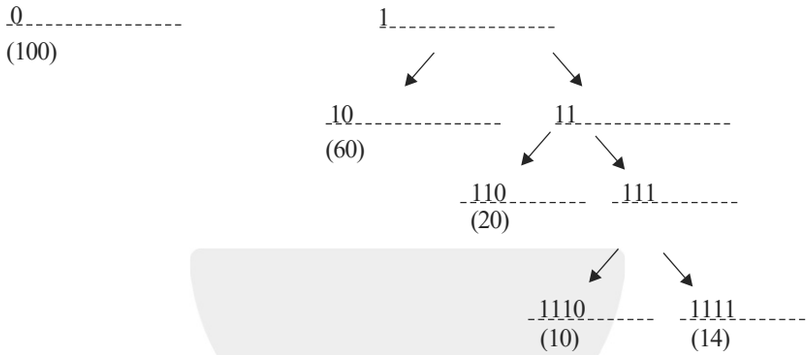
(C)



10,10 are left

Hence C is not possible

(D)



Hence D is possible

Only C is not possible

Hence, the correct option is (C).

64. (D)

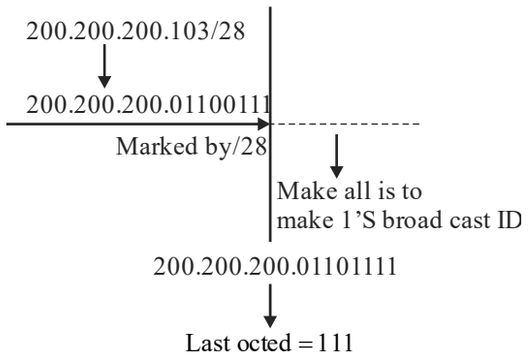
So, no. of up data required to get distance

$= \lceil \log n' - 1 \rceil$

Note : Just imagine 7 – node no. of updata required is 1.

Hence, the correct option is (D).

65. 111



Hence, the correct answer is 111.

66. (C)

Subnet mask = 255.255.248.0

Take Subnet Mask and do AND operation with pair of IP address and if Net ID is same then they belong to same network.

Hence, the correct option is (C).

67. (D)

200.200.200.200 / 27

Net ID = IP AND /27

= 200.200.200.200. AND/27

= 200.200.200.192

$= 200.200.200, \underline{1}\,\underline{1}\,\underline{0}\,\frac{0}{0}\,\frac{0}{0}\,\frac{0}{0}\,\frac{0}{0}\,\frac{0}{1}$

Masked by /27

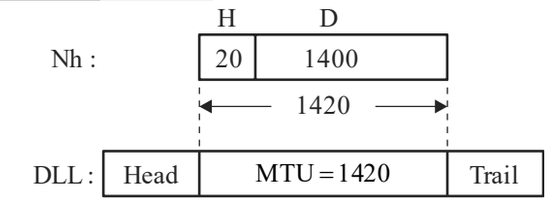
Host range $\frac{1}{1}\,\frac{1}{1}\,\frac{1}{1}\,\frac{1}{1}\,\frac{0}{1}$

So, Range of host IP

$= 200.200.200.193$ to
$200.200.200.222$

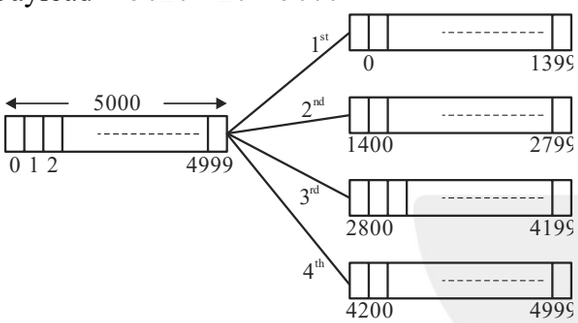
Hence, the correct option is (D).

68. 4350



IP packet size = 5020

Payload $= 5020 - 20 = 5000$



Fragment $= 4 (x = 4)$

Offset of 3rd fragment $= \frac{2800}{8} = 350$

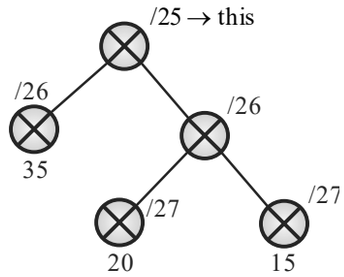
So, $xy = 4350$

Hence, the correct answer is 4350.

69. (C)

Subnets container no. of Host $= 35, 20, 15$

This is the possible subnet mask.



Hence, the correct option is (C).

70. (D)

$H_A = 200.200.200.97$

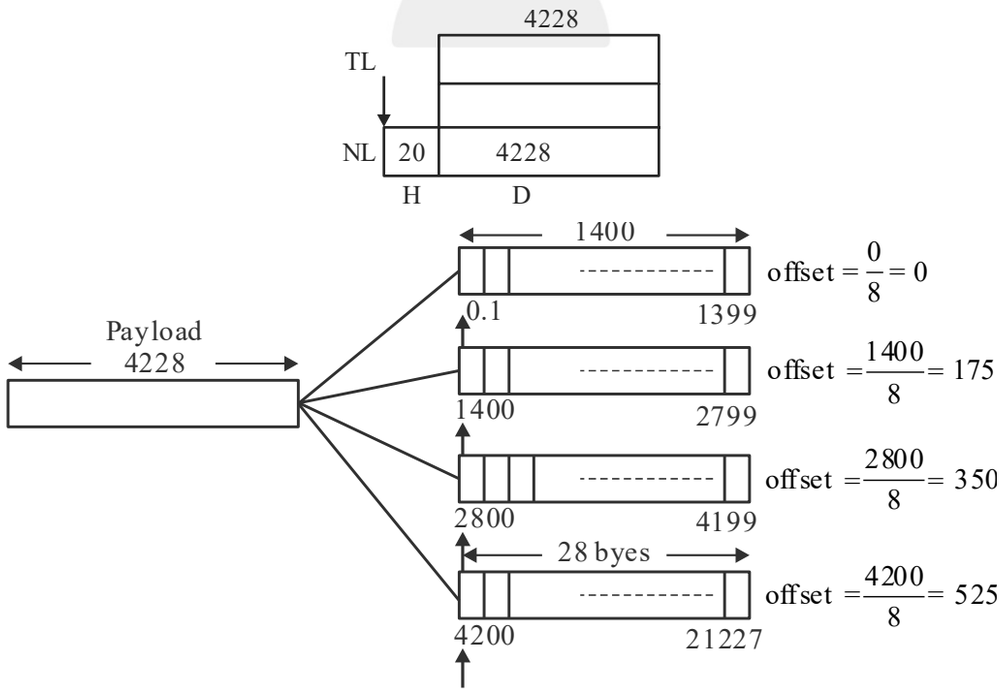
$H_B = 200.200.200.110$

For the subnet mask /24, / 25/, / 27, / 28 these hosts belongs to the same network.

So, $\max^m$ subnet mask possible is = /28.

Hence, the correct option is (D).

71. (C,D)



Size of last fragment = 28 byte

Sum of offsets of all fragments $= 0+175+350+525 = 1050$

Hence, the correct option are (C,D).

72. (A)

Only SI is correct so ans. (A)

Hence, the correct option is (A).

73. (A)

Seq. No. in TCP is assigned to each byte of segment & it helps to identify whether segment are reaching in order or not.

Hence, the correct option is (A).

74. (B)

TCP only provide end to end communication. Routes of packets are decided by underlying dyer

Hence, the correct option is (B).

75. (C)

Sequence no. is associated with TCP header not UDP.

Hence, the correct option is (C).

76. (B)

Option (B) is not true, because sequence no. is assigned to each byte of segment.

Hence, the correct option is (B).

77. (A)

Statement SI is only is only correct because connection establishment is a three-way handshaking process.

Hence, the correct option is (A).

78. (D)

Protocol is not included in TCP Header.

Hence, the correct option is (D).

79. (D)

All are True.

Hence, the correct option is (D).

80. (C)

Sender window size $= \min(rwnd, cwnd)$

$= \min(20,10)$

$= 10$ KB

Hence, the correct option is (C).

81. 11

$CW = 2$ MSS

$1st\ RTT = 4$ MSS

$2^{nd}\ RTT = 8$ MSS(threshold = 8 MSS)

$3^{rd}\ RTT = 9$ MSS

$4^{th}\ RTT = 10$ MSS

$5^{th}\ RTT = 11$ MSS

Hence, the correct answer is 111.

82. (D)

Segment size $= 2000$ byte(MSS)

$CW = 6000$ byte $= 3$ MSS

On 1st ACK $CW = CW + segment\ size$

$= 6000 + 2000 = 8000$

On 2nd $ACK = 8000 + 2000 = 10,000$

ON 3rd $ACK = 10,000 + 2000 = 12000$ byte

Hence, the correct option is (D).

83. 4

$r_{wnd} = 6$ MSS, $c_{wnd} = 4$ MSS

Sender window $= \min(r_{wns}, e_{wnd})$

$= \min d(6, 4)$

$= 4$ MSS

We can't increase sender window size more than 4 MSS, because it can't be supported by network.

So, in next RTT it will remains same.

Hence, the correct answer is 4.

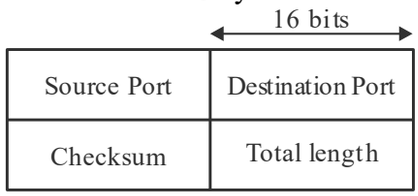
84. (C)

UDP is connection less protocol so no handshaking happen

Hence, the correct option is (C).

85. 52.4

Size of UDP header = 8 byte



Total length = 16 bits

So, $\max^m$ data UDP packet $= 2^{16}$ bytes can have

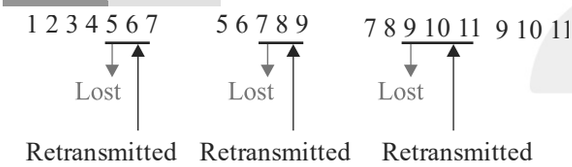
$\max^m$ Time required to Send one UDP packet

$$= \frac{2^{16}\text{ bytes}}{10\times10^6\text{ bits/sec}}$$

$$= \frac{2^{16}\times8}{10\times10^6} = 0.0524\text{ sec} = 52.4\text{ ms}$$

Hence, the correct answer is 52.4.

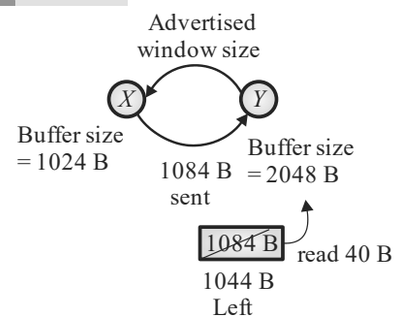
86. 20



Total transmissions $= 20$

Hence, the correct answer is 20.

87. 1004



Y's advertised window size $= 2048 - 1044$ B

$= 1004$ B

Hence, the correct answer is 1004.

88. 40

$t_p = 25$ ms

$$t_t = \frac{L}{R} = \frac{1000}{10^6} = 1\text{ ms}$$

$$\eta_N = \frac{N.t_t}{t_t + 2t_p} \Rightarrow \frac{80}{100} = \frac{N+1}{1+2\times25}$$

$$\Rightarrow \quad N \le \frac{80\times51}{100}$$

$$\Rightarrow \quad N \le \frac{204}{5}$$

$$\Rightarrow \quad N \le 40.8$$

$$\Rightarrow \quad N \simeq 40$$

Hence, the correct answer is 40.

89. (D)

$$R_E = \eta_N.R \Rightarrow \eta = \frac{5}{20}\times100 = 25\ \%$$

Hence, the correct option is (D).

90. 0.03

$2t_p = 30$ ms, $t_t = \dfrac{1000}{1\times10\text{^}6} = 1$ ms

$$\eta = \frac{t_t}{t_t + 2t_p + t_{pm} + t_{Ack}}$$

$$= \frac{1}{1+30+0.75+1.25} = \frac{1}{33}$$

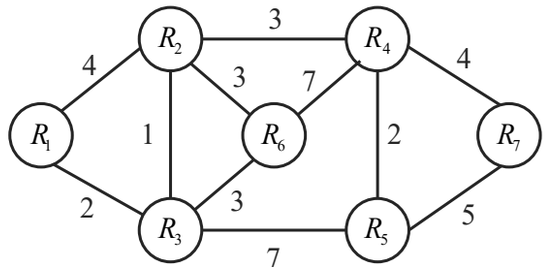
Hence, the correct answer is 0.03.

91. 0.94

$$P(A\cup B) = 1 - \frac{1}{2^4} = 0.94$$

Hence, the correct answer is 0.94.

92. 3



The links which remain unused are:

(1) $R_1 - R_2$

(2) $R_4 - R_6$

(3) $R_3 - R_5$

Hence, the correct answer is (3).

Hence, the correct answer is 3.

93. (C)

Since frame of 'B' involve in collision twice and A's frame once

$r_A r_B$

$0 \quad 0 \quad -C$

$0 \quad 1 \quad -A$

$0 \quad 2 \quad -A$

$0 \quad 3 \quad -A$

$1 \quad 0 \quad -B$

$1 \quad 1 \quad -C$

$1 \quad 2 \quad -A$

$1 \quad 3 \quad -A$

$$P(A \cup B) = \frac{6}{8} = 0.75$$

Hence, the correct option is (C).

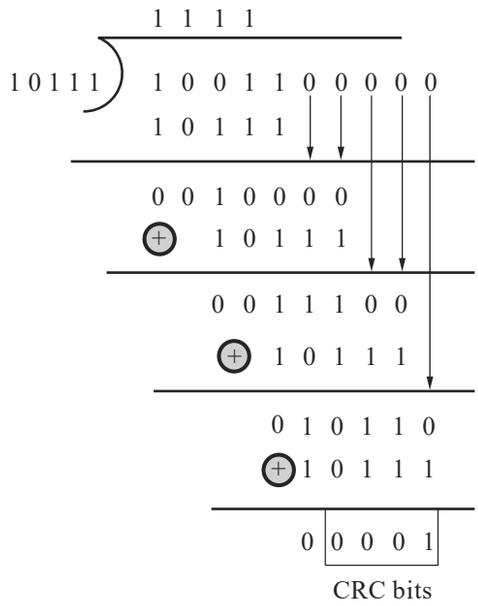
94. 609

divisor : $x^4 + x^2 + x + 1$

$1x^4 + 0x^3 + 1x^2 + 1x + 1$

$= 10111$

CRC generator bits $= 4$



Code word : $\underset{2^9}{1}\,00\,\underset{2^6}{1}\,\underset{2^5}{1}\,0000\,\underset{2^0}{1}$

decimal value $= 2^9 + 2^6 + 2^5 + 2^0$

$= 512 + 64 + 32 + 1$

$= 609$

Hence, the correct answer is 609.

95. (A,B,C,D)

Given:

IP address is 210.32.64.79/25 comparing with a. b. c. d/n where n is number of bits in network id.

$0 \le a, b, c, d \le 255$

Network ID + Host ID = 32

$\therefore$ Host ID $= 32 - 26 = 6$

Subnet mask:-

11111111. 11111111. 11111111.11000000

In decimal form $= 255.255.255.192$

First address :

First address is obtained by making right most $32 - n$ to 0. Here n is 26, so

$32 - 26 = 6$, make right most 6 bits to 0.

210.32.64.79 =

11010010.00100000.01000000.01001111

First address

= 11010010.00100000.01000000.01000000

In decimal form $= 210.32.64.64$

Last address :

It is obtained by making right most 32-n bits to 1. Make right most 6 bits to l. It becomes: 11010010.00100000.01000000. 01111111

In decimal form $= 210.32.64.127$

Total number of address :

Total number of addresses possible are : 2^{32-n}

$= 2^{32-26} = 2^6 = 64$

Hence, the correct option are (A,B, C, D).

96. 6

Header length $= 12 \times 4 = 48$ bytes

Optional field $= 48 - 20 = 28$ bytes

Out of 28 bytes optional field 3 bytes are reserve for special purpose.

So, available bytes

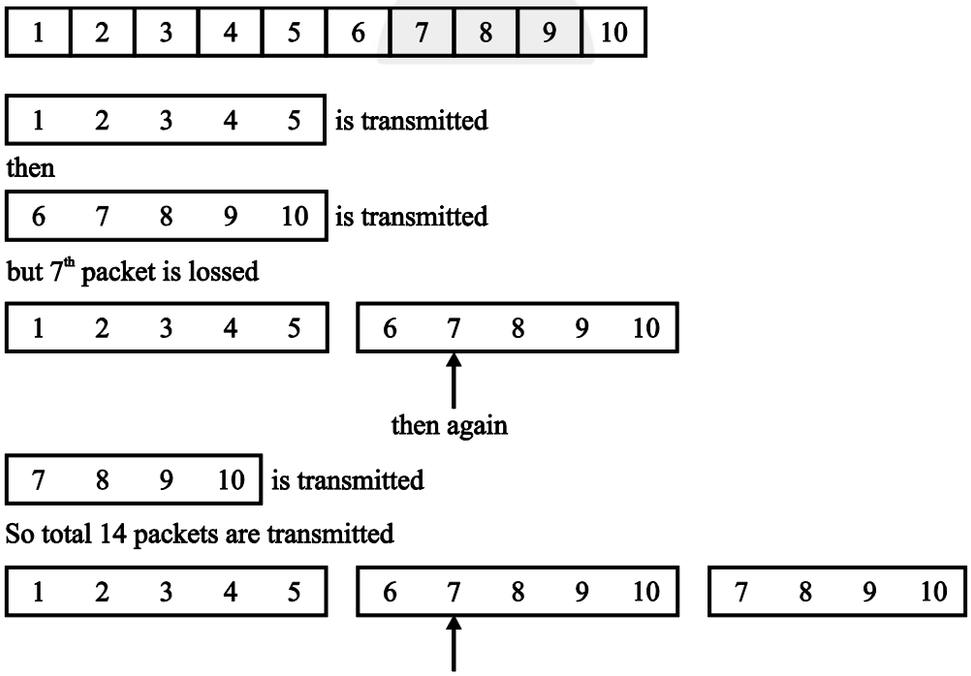
In optional field $= 28 - 3 = 25$ bytes

route address $= \frac{25}{4} = 6.25$

Where size of one 1P- address = 4 bytes.

Hence, the correct answer is 6.

99. 14



97. (C)

In CSMA/CD

$L \geq B \times 2 \times T_P$

[This is the condition for detect the collision]

$L \geq 10 \times 10^6 \times 2 \times 1 \times 10^{-3}$

$L \geq 20 \times 10^3$

$L \geq 20000$ bit

$L \geq 2500$ byte

So the correct option is C

98. $2^{21} = 2097152$

A class C address consist of a 24 bit network address, the first 3 bits in the network address indicate the network class, leaving 21 bits for the actual network address i.e.,

$2^{21} = 2097152$ n/w

100. (C)

Let S denotes the source station and D denotes the destination station P & Q are two intermediate nodes between S & D.

S P Q D

. . . .

Message size =48 bytes

Header (control information) = 6 bytes

Option (A)

Packet size = 8, then message size = $8-6=2$ bytes, so it requires $\frac{48}{2}=24$ packets each containing 6 bytes so the transmission time for header overhead increases.

Option (B)

Packet size = 10, then message size = 10–6 = 4 Bytes (required 12 packets)

Option (C)

Packet size = 14, then message size = 14–6 = 8 byte

(required 6 packets)

Option (D)

Packet size = 12 then message size = 12–6= 6 byte

Byte (required 8 packet)

So 6 packet is the optimum message size and 14 is the optimum packet size option C is correct.

101. 384

120.140.5.128/22

22- Network id, 10- Host id

So, 120.140, 00000100. 00000000 1st block

!

120.140.00000111.11111111 last block

So, the 1st address is 120.140.4.0

& the last address is 120. 140. 7.255

So, 120.140.5.128 is which block starting address are 120.140.4.0

So the block position is = 120.140.5.128

–120.140.4.0

0.0.1.128

0.0.1.0 required 256 address

So block positions are = 256+128=384

11 Engineering Mathematics

Practice Questions

Q.1 If $P=\begin{bmatrix}\frac{\sqrt{3}}{2} & \frac{1}{2}\\ -\frac{1}{2} & \frac{\sqrt{3}}{2}\end{bmatrix}\cdot A=\begin{bmatrix}1 & 1\\ 0 & 1\end{bmatrix}$ and $Q=PAP^T$. Then $P(Q^{2005})P^T$ equal to

(A) $\begin{bmatrix}1 & 2005\\ 0 & 1\end{bmatrix}$ (B) $\begin{bmatrix}\frac{\sqrt{3}}{2} & 2005\\ 1 & 0\end{bmatrix}$

(C) $\begin{bmatrix}1 & 2005\\ \frac{\sqrt{3}}{2} & 1\end{bmatrix}$ (D) $\begin{bmatrix}1 & \frac{\sqrt{3}}{2}\\ 0 & 2005\end{bmatrix}$

Q.2 The system of linear equation

$x+y+z=2$

$2x+3y+2z=5$

$2x+3y+(a^2-1)z=a+1$

(A) Has infinitely many solution for $a=4$

(B) Is inconsistent when $|a|=\sqrt{3}$

(C) Is inconsistent when $a=4$

(D) Has a unique solution for $|a|=\sqrt{3}$

Q.3 For 3×3 matrices M and N, which of the following statement(s) is/are not correct **[MSQ]**

(A) N^TMN is symmetric or skew symmetric, according as M is symmetric or skew symmetric

(B) $MN-NM$ is skew symmetric for all symmetric matrices M and N

(C) MN is symmetric for all symmetric matrices M and N

(D) $(adj\ M)(adj\ N)=adj(MN)$ for all invertible matrices M and N

Q.4 Let $P=[a_{ij}]$ be a 3×3 matrix and let $Q=[b_{ij}]$, where $b_{ij}=2^{i+j}a_{ij}$ for $1\le i, j\le3$. If determinant of P is 2, then the determinant of the matrix Q is

(A) 2^{10} (B) 2^{11}

(C) 2^{12} (D) 2^{13}

Q.5 X_1, X_2, X_3 and X_4 are vectors of length.

$X_1=[a_1,a_2,a_3,a_4]$

$X_2=[b_1,b_2,b_3,b_4]$

$X_3=[c_1,c_2,c_3,c_4]$

$X_4=[d_1,d_2,d_3,d_4]$

It is known that X_2 is not a scalar multiple of X_1. Also, X_3 is linearly independent of X_1 and X_2. Further $X_4=3X_1+2X_2+X_3$. The rank of the matrix

$\begin{bmatrix} a_1 & a_2 & a_3 & a_4 \\ b_1 & b_2 & b_3 & b_4 \\ c_1 & c_2 & c_3 & c_4 \\ d_1 & d_2 & d_3 & d_4 \end{bmatrix}$ is _____. (in integer)

Q.6 Which of the following is the characteristic equation of

$$\begin{bmatrix} a & 0 & 0 & 0 \\ 0 & a & 0 & 0 \\ 0 & 0 & a & 0 \\ 0 & 0 & 0 & a \end{bmatrix}$$

(A) $\sum_{k=1}^{4}(-1)^k.{}^4C_k.a^{k-4}.\lambda^k = 0$

(B) $\sum_{k=0}^{4}{}^4C_k.a^{k-4}.\lambda^k = 0$

(C) $\sum_{k=1}^{4}(-1)^k.{}^4C_k.a^{4-k}.\lambda^k = 0$

(D) $\sum_{k=0}^{4}(-1)^k.{}^4C_k.a^{4-k}.\lambda^k = 0$

Q.7 If the characteristic values of $A = \begin{bmatrix} 3 & -1 \\ 5 & 6 \end{bmatrix}$ are λ_1 and λ_2 and that of $B = \begin{bmatrix} 1 & 2 \\ -1 & 5 \end{bmatrix}$ are μ_1 and μ_2, the equation whose roots are $\frac{1}{\lambda_1}+\frac{1}{\lambda_2}$ and $\frac{1}{\mu_1}+\frac{1}{\mu_2}$ is

(A) $201x^2 - 161x + 54 = 0$

(B) $161x^2 - 201x + 54 = 0$

(C) $201x^2 + 161x - 54 = 0$

(D) $161x^2 + 201x - 54 = 0$

Q.8 If $(1+3p)/3$, $(1-p)/4$ and $(1-2p)/2$ are the probabilities of three mutually exclusive events, then the set of all values of p is

(A) $\frac{1}{3} \le p \le \frac{1}{2}$ (B) $\frac{1}{3} < p < \frac{1}{2}$

(C) $\frac{1}{2} \le p \le \frac{2}{3}$ (D) $\frac{1}{2} < p < \frac{2}{3}$

Q.9 An unbiased coin is tossed. If the result is a head, a pair of unbiased dice is rolled and the number obtained by adding the numbers on the two faces is noted. If the result is a tail, a card from a well shuffled pack of eleven cards numbered 2, 3, 4, and 12 is picked and the number on the card is noted. The probability that the noted number is either 7 or 8, is

(A) 0.24 (B) 0.244

(C) 0.024 (D) None of these

Q.10 In sampling a large number of parts manufactured by a machine, the mean number of defectives in a sample of 20 is 2. Out of 1000 such samples, how many would be expected to contain at least 3 defective parts

Q.11 The value of $\lim_{y\to 0}\frac{\sqrt{1+\sqrt{1+y^4}}-\sqrt{2}}{y^4}$ is

(A) Exists and equals $\frac{1}{4\sqrt{2}}$

(B) Does not exist

(C) Exists and equals $\frac{1}{2\sqrt{2}}$

(D) Exists and equals $\frac{1}{2\sqrt{2}(\sqrt{2}+1)}$

Q.12 The value of

$$\lim_{x\to 0}\frac{x+2\sin x}{\sqrt{x^2+2\sin x+1}-\sqrt{\sin^2 x-x+1}}$$ is

(A) 3 (B) 2

(C) 6 (D) 1

Q.13 Let α and β are roots of the quadratic equation $x^2+bx+c=0$. Then the value of $\lim\limits_{x\to\alpha}\dfrac{1-\cos(x^2+bx+c)}{(x-\alpha)^2}$ is

(A) b^2+4c (B) b^2-4c

(C) $\dfrac{1}{2}(b^2-4c)$ (D) None of these

Q.14 Which of the following functions is differentiable at $x=0$

(A) $\cos(|x|)+|x|$ (B) $\cos(|x|)-|x|$

(C) $\sin(|x|)+|x|$ (D) $\sin(|x|)-|x|$

Q.15 The value of

$$\lim_{x\to0}\frac{x(1+a\cos x)-b\sin x}{x^3}=1$$

then, the value of $a+b$ is _____. (in integer)

Q.16 $I=\lim\limits_{x\to\frac{\pi}{4}}\dfrac{\int_2^{\sec^2 x} f(t)\,dt}{\left(x^2-\frac{\pi^2}{16}\right)}$ at $f(2)=\pi$ is

_____. (in integer)

Q.17 For $f(x)$, which of the following statements is/are True **[MSQ]**

$$f(x)=\begin{cases}0; & x=0\\ \frac{1}{2}-x; & 0<x<\frac{1}{2}\\ \frac{1}{2} & x=\frac{1}{2}\\ \frac{3}{2}-x; & \frac{1}{2}<x<1\\ 1: & x=1\end{cases}$$

(A) $f(x)$ is discontinuous at $x=0$.

(B) $f(x)$ is discontinuous at $x=\dfrac{1}{2}$

(C) $f(x)$ is discontinuous at $x=1$

(D) None of these

Q.18 The value of k and m so that $f(x)$ is differentiable at $x=3$;

$$f(x)=\begin{cases}k\sqrt{x+1}; & 0\le x\le3\\ mx+2; & 3<x\le5\end{cases}$$

(A) $\dfrac{8}{5},\dfrac{2}{5}$ (B) $\dfrac{5}{8},\dfrac{5}{2}$

(C) $\dfrac{5}{8},\dfrac{5}{5}$ (D) $\dfrac{5}{8},\dfrac{4}{5}$

Q.19 The total number of maxima and minima points of function $f(x)=\sin^4 x+\cos^4 x$ occur between interval $[0,2\pi]$ is _____. (in integer)

Q.20 A book of 600 pages contain 40 printing mistakes. Let these errors are randomly distributed throughout the book and r is the number of errors per page has a Poisson distribution. Then, the probability that 10 pages selected at random will be free from error is

(A) 0.50 (B) 0.49

(C) 0.97 (D) 0.51

Q.21 Players A and B, playing the game by tossing a coin with a dice, one who gets head and 6 will win the game. If A start the game, probability of winning of A is _____. (rounded upto two decimal places)

[Note : They played it alternatively]

Q.22 A bag contains 3 red and n white balls. Miss A draws two balls together from the bag. The probability they have the same color is $\dfrac{1}{2}$. Miss B draws one ball from bag, notes its color and replace it. She then draws a second ball from bag and find both have same color with probability $\dfrac{5}{8}$. The possible value of n is

(A) 9 (B) 6
(C) 5 (D) 1

Q.23 If 'x' is a zero mean, unit variance Gaussian random variable, then expected value $E(|5x|)$ is _____. (rounded upto two decimal places)

Q.24 $$f(x)=\begin{cases}\frac{x}{2}, & 0>x\le 1\\ \frac{1}{2}, & 1<x\le 2\\ \frac{3-x}{3}, & 2<x\le 3\end{cases}$$

Let 'x' be Random variable having probability density function $f(x)$, then the probability $P(1.5<x\le 2.5\,|\,x>1)$ is _____. (rounded upto one decimal place)

Q.25 If $A=\begin{bmatrix}1 & 2 & -3\\ 0 & 4 & 5\\ 0 & 0 & 6\end{bmatrix}$, then determinant of A^3+A^2+2A is _____. (in integer)

Q.26 The value integral $I=\int_1^3 e^{3x}\left(\log x+\frac{1}{x}\right)dx$ is

(A) $e^9\log 3$ (B) $e^9\log 2$
(C) $e^9\log 4$ (D) $e^9\log 5$

Q.27 The number of linearly independent solution in matrix $A=\begin{bmatrix}1 & 2 & 3 & 2\\ 2 & 3 & 5 & 1\\ 1 & 3 & 4 & 5\end{bmatrix}_{3\times 4}$ is _____. (in integer)

Q.28 If x, y are independent binomial random variables $\in\left\{3,\frac{1}{3}\right\}$. The probability that the matrix $P=\begin{bmatrix}\frac{x}{\sqrt{2}} & \frac{y}{\sqrt{2}}\\ \frac{-1}{\sqrt{2}} & \frac{1}{\sqrt{2}}\end{bmatrix}$ is orthogonal is _____. (rounded upto three decimal places)

Q.29 Consider the matrices $X_{4\times 3}$, $Y_{4\times 3}$ and $P_{2\times 3}$. The order of $(P(X^TY)^{-1}P^T)^T$ will be $p\times q$, then $p-q$ is _____. (in integer)

Q.30 If $|A|_{3\times 3}=5$ and $B=\text{adj}(5A)$ then the value of $\sqrt[8]{|B|_{3\times 3}}$ is _____. (in integer)

Q.31 If $\lim_{x\to 0}\frac{a\sin x+b\cos x+cx}{x^3}=\frac{-1}{6}$ then $\frac{a+b}{c}$ is _____. (in integer)

Q.32 The function $f(x,y)=x^2+y^2+4x+8$ **[MSQ]**

(A) Has minimum value at point $(-2,0)$
(B) Has maximum value at point $(-2,0)$
(C) Minimum value of function is 4
(D) Maximum value of function is 4

Q.33 Matrix $P=\begin{bmatrix}1 & -3 & 4\\ 0 & -4 & 8\\ 0 & 0 & 5\end{bmatrix}$ then **[MSQ]**

(A) Eigen value of P^{-1} are $\frac{1}{2},\frac{-1}{8},\frac{1}{25}$
(B) Determinant of $5P^T$ is -2500
(C) P is an orthogonal matrix
(D) Eigen value of P^{2022} are $1, 2^{4044}, 5^{2022}$

Q.34 If 'P' is a non-singular matrix, then which of the following is/are not true about its Eigen value **[MSQ]**

(A) All the Eigen value of 'P' are non-zero.
(B) The Eigen value of 'P' may or may not be zero.
(C) Only one Eigen value can be zero and above should be negative.
(D) Nothing can be said about their Eigen value.

Q.35 For the function $f(x)=\int_{x^2}^{x^3} t\,dt$ **[MSQ]**

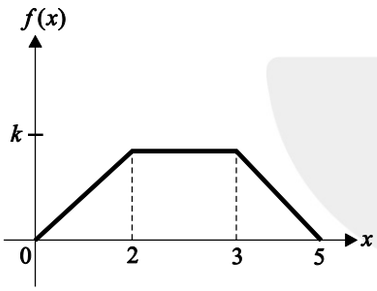
(A) Total number of extremum points are '3'.

(B) Total number of extremum points are '5'.

(C) Point of minimum value is $\sqrt{\frac{2}{3}}$.

(D) Point of inflection is at $x=0$.

Q.36 If 'x' is a Random variable then the expected value of $f(x)$, for the their given graph is _____. (rounded upto one decimal place)



Q.37 The value of $\lim_{x\to\infty}\frac{\ln(x^2-4x+8)}{\ln(x^{12}+x^6+6)}$ is _____. (rounded upto three decimal places)

Q.38 If $A=\begin{bmatrix}\frac{1}{2} & \frac{1}{2} & 4\\ \frac{-7}{2} & 2 & -2\\ \frac{\beta}{2} & 4 & \frac{\alpha}{2}\end{bmatrix}$, then '$A$' is an orthogonal matrix for **[MSQ]**

(A) $\alpha=1$ (B) $\beta=\frac{8}{9}$

(C) $\alpha=\frac{1}{9}$ (D) $\beta=\frac{27}{8}$

Q.39 Person on a trip has a choice between private car and public transport. The probability of using a private car is 0.45. While using public transport, further choice available are bus and metro. Out of which the probability of commuting by a bus is 0.55. In such a situation, the probability of using a car, bus and metro respectively would be

(A) 0.45, 0.30 and 0.25

(B) 0.45, 0.25 and 0.30

(C) 0.45, 0.55 and 0

(D) 0.45, 0.35 and 0.20

Q.40 A husband and wife appear in an interview for two vacancies for same post. The probability of husband getting selected is $\frac{1}{5}$ while the probability of wife getting selected is $\frac{1}{7}$. Then the probability that anyone of them getting selected is _____. (rounded upto three decimal places)

Q.41 The value of $\int_0^{\infty} e^{-y^3} y^{\frac{1}{2}}\,dy$ is

(A) $\frac{1}{2}\sqrt{\pi}$ (B) $\frac{1}{3}\sqrt{\pi}$

(C) $\frac{\sqrt{\pi}}{2}$ (D) $3\sqrt{\pi}$

Q.42 The value of the following definite integral $\int_{\frac{-\pi}{2}}^{\frac{\pi}{2}} \frac{\sin 2x}{1+\cos x}\,dx$ is,

(A) $-2\ln 2$ (B) 2

(C) 0 (D) $(\ln 2)^2$

Q.43 $\int_0^{\frac{\pi}{4}}\left(\frac{1-\tan x}{1+\tan x}\right)dx$ evaluates to

(A) 0 (B) 1

(C) $\ln 2$ (D) $\frac{1}{2}\ln 2$

Q.44 Let X and Y be two independent random variables. Which one of the relations between expectation (E), variance (Var) and covariance (Cov) given below is False?

(A) $E(XY) = E(X)\,E(Y)$

(B) $\text{Cov}(X, Y) = 0$

(C) $\text{Var}(X+Y) = \text{Var}(X) + \text{Var}(Y)$

(D) $E(X^2Y^2) = \left(E(X)\right)^2 \left(E(Y)\right)^2$

Q.45 Let A be $n \times n$ real matrix such that $A^2 = I$ and y be an n-dimensional vector.

Then the linear system of equations $Ax = y$ has

(A) no solution

(B) a unique solution

(C) more than one but finitely many independent solutions

(D) infinitely many independent solutions.

Q.46 $P_x(x) = Me^{-2|x|} + Ne^{-3|x|}$ is the probability density function for the real random variable X over the entire x axis. M and N are both positive real numbers. The equation relating M and N is

(A) $M + \frac{2}{3}N = 1$

(B) $2M + \frac{1}{3}N = 1$

(C) $M + N = 1$

(D) $M + N = 3$

Q.47 Real matrices $[A]_{3\times1}$, $[B]_{3\times3}$, $[C]_{3\times5}$, $[D]_{5\times3}$, $[E]_{5\times5}$ and $[F]_{5\times1}$ are given. Matrices $[B]$ and $[E]$ are symmetric. Following statements are made with respect to these matrices.

I. Matrix product $[F]^T[C]^T[B][C][F]$ is a scalar.

II. Matrix product $[D]^T[F][D]$ is always symmetric.

With reference to above statements, which of the following applies?

(A) Statement I is true but II is false.

(B) Statement I is false but II is true.

(C) Both the statement are true.

(D) Both the statements are false.

Q.48 If $A = \begin{bmatrix} 1 & 1 \\ 0 & i \end{bmatrix}$ and $A^{2024} = \begin{vmatrix} a & b \\ c & d \end{vmatrix}$ then $a + d$ is _____. (rounded upto one decimal place)

Q.49 The integral $I = \int \frac{dx}{|6x|\sqrt{36x^2 - 36}}$ is $f(x)$ then value of $f(\sqrt{2})$ if $f(1) = 0$ is _____.

Q.50 For two independent events A, B;

$$P(B) = \frac{3}{4},\ P(A \cup B^C) = \frac{1}{2}$$

then $P(A)$ is _____.

Q.51 $I = \lim\limits_{x \to \frac{\pi}{4}} \dfrac{\int_{2}^{\sec^2 x} f(t)\,dt}{\left(x^2 - \frac{\pi^2}{16}\right)}$ at $f(2) = \pi$ is _____.

Q.52 For events A, B and C

P (exactly one of A or B) = P (Exactly one of B or C) = P (Exactly one of C or A) = $\frac{1}{4}$; P (all events) = $\frac{1}{16}$; P (at least one event) is _____.

Q.53 In the matrix equation $PX = Q$ which of the following is a necessary condition for the existence of at least one solution for the unknown vector X

(A) Augmented matrix $[P:Q]$ must have the same rank as matrix P.

(B) Vector Q must have only non-zero elements.

(C) Matrix P must be singular.

(D) Matrix P must be square.

Q.54 Consider a 3×3 real symmetric matrix S such that two of its Eigen values are $a\neq0$, $b\neq0$ with respective Eigen vectors $\begin{bmatrix}x_1\\x_2\\x_3\end{bmatrix},\begin{bmatrix}y_1\\y_2\\y_3\end{bmatrix}$.

If $a\neq b$ then $x_1y_1+x_2y_2+x_3y_3$ equals

(A) a (B) b

(C) ab (D) 0

Q.55 Consider the matrix $A=\begin{bmatrix}2&1&1\\2&3&4\\-1&-1&-2\end{bmatrix}$ whose Eigen values are $1,-1$ and 3.

The trace of (A^3-3A^2) is _____.

Q.56 A box has a 8 red balls and 8 green balls. Two balls are drawn randomly in succession from the box without replacement. The probability that the first ball drawn is red and the second ball drawn is green is

(A) $\frac{4}{15}$ (B) $\frac{7}{16}$

(C) $\frac{1}{2}$ (D) $\frac{8}{15}$

Q.57 If each element of a matrix is either 0 or 1 then the number of such different $n\times n$ symmetric matrix will be possible for **[MSQ]**

(A) 2^{10} for $n=4$ (B) 2^6 for $n=3$

(C) 2^{36} for $n=8$ (D) 2^{21} for $n=6$

Q.58 A real $n\times n$ matrix $A=[a_{ij}]$ is defined as follows :

$a_{ij}=i$; if $i=j$

$=0$; otherwise

The summation of all elements of A is

(A) $n\frac{(n+1)}{2}$ (B) $n\frac{(n-1)}{2}$

(C) $\frac{n(n+1)(2n+1)}{6}$ (D) n^2

Q.59 Given that X is a random variable in the range $[0,\infty)$ with a probability density function $\frac{e^{\frac{-x}{3}}}{G}$, the value of the constant G is _____.

Q.60 Given a real-valued continuous function $f(y)$ defined over $[0,1]$,

$$\lim_{y\to0}\frac{1}{y}\int_0^y f(x)\,dx$$

(A) ∞ (B) 0

(C) $f(1)$ (D) $f(0)$

Answers Engineering Mathematics

1.	A	2.	B	3.	C, D	4.	D	5.	3
6.	D	7.	B	8.	A	9.	B	10.	323
11.	A	12.	B	13.	C	14.	D	15.	– 4
16.	8	17.	A, B, C	18.	A	19.	8	20.	D
21.	0.52	22.	D	23.	3.99	24.	0.5	25.	92928
26.	A	27.	1	28.	0.197	29.	0	30.	4
31.	– 1	32.	A, C	33.	B, D	34.	B, C, D	35.	B, C, D
36.	2.5	37.	0.167	38.	A, D	39.	A	40.	0.314
41.	B	42.	C	43.	D	44.	D	45.	B
46.	A	47.	A	48.	2	49.	0.021	50.	0.33
51.	8	52.	0.44	53.	A	54.	D	55.	– 6
56.	A	57.	A,B,C,D	58.	A	59.	3	60.	D

Explanations Engineering Mathematics

1. (A)

Given : $Q = PAP^T$

and $X = P^T Q^{2005} P$

where $P = \begin{bmatrix} \frac{\sqrt{3}}{2} & \frac{1}{2} \\ \frac{-1}{2} & \frac{\sqrt{3}}{2} \end{bmatrix}_{2\times 2}$ and $A = \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}_{2\times 2}$

$$P^T = \begin{bmatrix} \frac{\sqrt{3}}{2} & \frac{-1}{2} \\ \frac{1}{2} & \frac{\sqrt{3}}{2} \end{bmatrix}_{2\times 2}$$

$$P^T P = \begin{bmatrix} \frac{\sqrt{3}}{2} & \frac{-1}{2} \\ \frac{1}{2} & \frac{\sqrt{3}}{2} \end{bmatrix} \begin{bmatrix} \frac{\sqrt{3}}{2} & \frac{1}{2} \\ \frac{-1}{2} & \frac{\sqrt{3}}{2} \end{bmatrix}$$

$$= \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} = 1$$

Thus, $P^T P = I$

We begin our analysis with $Q = PAP^T$

Then, $Q^2 = Q.Q = (PAP^T)(PAP^T)$

$= PA(P^T P)AP^T$

$= PA(I)AP^T$

$Q^2 = PA^2 P^T$

Similarly, we can prove $Q^3 = PA^3 P^T$

$Q^{2005} = PA^{2005} P^T$

Similarly, $A = \begin{vmatrix} 1 & 1 \\ 0 & 1 \end{vmatrix}$

Thus, $A^2 = A.A = \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}\begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 2 \\ 0 & 1 \end{bmatrix}$

Similarly, $A^3 = \begin{bmatrix} 1 & 3 \\ 0 & 1 \end{bmatrix}$

So, $A^{2005} = \begin{bmatrix} 1 & 2005 \\ 0 & 1 \end{bmatrix}$

$Q^{2005} = PA^{2005} P^T$

So, $X = P^T Q^{2005} P = P^T PA^{2005} P^T P$

$= IA^{2005} I = A^{2005} = \begin{bmatrix} 1 & 2005 \\ 0 & 1 \end{bmatrix}$

Hence, the correct option is (A).

2. (B)

Given : Augmented matrix

$$C = [A : B]$$

$$C = \begin{bmatrix} 1 & 1 & 1 & : & 2 \\ 2 & 3 & 2 & : & 5 \\ 2 & 3 & (a^2-1) & : & a+1 \end{bmatrix}$$

$R_3 \to R_3 - R_2$,

$$C = \begin{bmatrix} 1 & 1 & 1 & : & 2 \\ 2 & 3 & 2 & : & 5 \\ 0 & 0 & (a^2-3) & : & a-4 \end{bmatrix}$$

From option (A), $a = 4$

$$C = \begin{bmatrix} 1 & 1 & 1 & : & 2 \\ 2 & 3 & 2 & : & 5 \\ 0 & 0 & 13 & : & 0 \end{bmatrix}$$

$P(A) = P(A:B) = 3$ Unique solution

From option (B), $|a| = \sqrt{3}$

$$C = \begin{bmatrix} 1 & 1 & 1 & : & 2 \\ 2 & 3 & 2 & : & 5 \\ 0 & 0 & 0 & : & \sqrt{3}-4 \end{bmatrix}$$

$P(A) = 2,\ P(A:B) = 3$

$P(A) \neq P(A:B)$

Inconsistent at $|a| = \sqrt{3}$

Hence, the correct option is (B).

3. (C), (D)

Given : 3×3 matrices M and N

Checking from options :

(A) $(N^T MN)^T = N^T M^T N$ is symmetric if M is symmetric and skew-symmetric if M is skew-symmetric.

(B) $(MN - NM)^T = (MN)^T - (NM)^T$

$= NM - MN$

$= -(MN - NM)$

Skew symmetric

(C) $(MN)^T = N^T M^T$

$= NM$

$\neq MN$ hence NOT correct

(D) Standard result is

$adj(MN) = [(adjN)(adjM)]$

$\neq (adjM)(adjN)$

Hence, the correct options are (C) and (D).

4. (D)

Given : $P = [a_{ij}]_{3\times3}$, $b_{ij} = 2^{i+j} a_{ij}$, $Q = [b_{ij}]_{3\times3}$

$$P = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}$$

$$Q = \begin{bmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \end{bmatrix}$$

$$Q = \begin{bmatrix} 4a_{11} & 8a_{12} & 16a_{13} \\ 8a_{21} & 16a_{22} & 32a_{23} \\ 16a_{31} & 32a_{32} & 64a_{33} \end{bmatrix}$$

Determinant of $Q = \begin{vmatrix} 4a_{11} & 8a_{12} & 16a_{13} \\ 8a_{21} & 16a_{22} & 32a_{23} \\ 16a_{31} & 32a_{32} & 64a_{33} \end{vmatrix}$

$$= 4\times8\times16 \begin{vmatrix} a_{11} & a_{12} & a_{13} \\ 2a_{21} & 2a_{22} & 2a_{23} \\ 4a_{31} & 4a_{32} & 4a_{33} \end{vmatrix}$$

$$= 4\times8\times16\times2\times4 \begin{vmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{vmatrix}$$

$= 2^2.2^3.2^4.2^1.2^2.2^1 = 2^{13}$

Hence, the correct option is (D).

5. 3

Given : X_2, X_3 are linearly independent of X_1

X_4 is linearly dependent of X_1, X_2, X_3

Number of linearly independent vectors = 3

Rank of matrix = Number of linearly independent vectors = 3

Hence, the correct answer is 3.

6. (D)

Given : $A=\begin{bmatrix} a & 0 & 0 & 0 \\ 0 & a & 0 & 0 \\ 0 & 0 & a & 0 \\ 0 & 0 & 0 & a \end{bmatrix}$

Characteristic equation is $|A-\lambda I|=0$

$$\begin{vmatrix} (a-\lambda) & 0 & 0 & 0 \\ 0 & (a-\lambda) & 0 & 0 \\ 0 & 0 & (a-\lambda) & 0 \\ 0 & 0 & 0 & (a-\lambda) \end{vmatrix}=0$$

$$(a-\lambda)\left[(a-\lambda)(a-\lambda)^2\right]=0$$

$$(a-\lambda)^4=0$$

$$a^4-4a\lambda^3+6a^2\lambda^2-4a^3\lambda+\lambda^4=0$$

$$\sum_{k=0}^{4}(-1)^k.{}^4C_k.a^{4-k}.\lambda^k=0$$

Hence, the correct option is (D).

7. (B)

Given : $A=\begin{bmatrix} 3 & -1 \\ 5 & 6 \end{bmatrix}$, $B=\begin{bmatrix} 1 & 2 \\ -1 & 5 \end{bmatrix}$

We have,

$$\lambda_1+\lambda_2=\text{trace of } A=9$$

$$\lambda_1\lambda_2=|A|=18+5=23$$

$$\frac{1}{\lambda_1}+\frac{1}{\lambda_2}=\frac{9}{23}$$

Again, $\mu_1+\mu_2=6,\ \mu_1\mu_2=|B|=7$

$$\frac{1}{\mu_1}+\frac{1}{\mu_2}=\frac{6}{7}$$

Sum of the roots $=\frac{9}{23}+\frac{6}{7}=\frac{201}{7\times23}$

Product of the roots $=\frac{54}{7\times23}$

Required equation is,

$$x^2-\frac{201}{7\times23}x+\frac{54}{7\times23}=0$$

$$161x^2-201x+54=0$$

Hence, the correct option is (B).

8. (A)

Given : $\frac{(1+3p)}{3}$, $\frac{(1-p)}{4}$ and $\left(\frac{1-2p}{2}\right)$ are the probabilities of three events, we must have

$$0\le\frac{1+3p}{3}\le1,\ 0\le\frac{1-p}{4}\le1 \text{ and } 0\le\frac{1-2p}{2}\le1$$

$$-1\le3p\le2,\ -3\le p\le1 \text{ and } -1\le2p\le1$$

$$-\frac{1}{3}\le p\le\frac{2}{3},-3\le p\le1 \text{ and } -\frac{1}{2}\le p\le\frac{1}{2}$$

Also as $\frac{1+3p}{3}$, $\frac{1-p}{4}$ and $\frac{1-2p}{2}$ are the probabilities of three mutually exclusive events

$$0\le\frac{1+3p}{3}+\frac{1-p}{4}+\frac{1-2p}{2}\le1$$

$$0\le4+12p+3-3p+6-12p\le1$$

$$\frac{1}{3}\le p\le\frac{13}{3}$$

Thus, the required value of p are such that

$$\text{Max}\left\{-\frac{1}{3},-3,-\frac{1}{2},\frac{1}{3}\right\}\le p\le\text{Min}\left\{\frac{2}{3},1,\frac{1}{2},\frac{13}{3}\right\}$$

$$\frac{1}{3}\le p\le\frac{1}{2}$$

Hence, the correct option is (A).

9. (B)

Given : Let E_1, E_2 denote the events that the coin shows a head, tail and A be the event that the noted number is either 7 or 8.

We have, $P(E_1)=\frac{1}{2}$ and $P(E_2)=\frac{1}{2}$

Now, $7\to\{(1,6),(6,1),(2,5),(5,2),(3,4),(4,3)\}$

and $8\to\{(2,6),(6,2),(3,5),(5,3),(4,4)\}$

Thus, $P(A/E_1)=\frac{11}{36}, P(A/E_2)=\frac{1}{11}$

Hence, the required probability,

$$P(A)=P(E_1)P(A/E_1)+P(E_2)P(A/E_2)$$

$$= \left(\frac{1}{2}\right)\left(\frac{11}{36}\right) + \left(\frac{1}{2}\right)\left(\frac{2}{11}\right) = \frac{193}{792}$$
$$= 0.244$$

Hence, the correct option is (B).

10. 323

Given : Mean number of defectives $= 2 = np$

$$n = 20$$

The probability of a defective part is,

$$p = 2/20 = 0.1$$

And the probability of a non-defective part = 0.9

The probability of at least three defectives in a sample of 20.

$$= 1 - \text{(Probability that either none, or one, or two are non-defective parts)}$$
$$= 1 - \left[{}^{20}C_0(0.9)^{20} + {}^{20}C_1(0.1)(0.9)^{19} + {}^{20}C_2(0.1)^2(0.9)^{18}\right]$$
$$= 1 - (0.9^{18} \times 4.51) = 0.323$$

Thus, the number of samples having at least three defective parts out of 1000 samples

$$= 1000 \times 0.323 = 323$$

Hence, the correct answer is 323.

11. (A)

Given : $\lim\limits_{y\to 0} \dfrac{\sqrt{1+\sqrt{1+y^4}} - \sqrt{2}}{y^4}$

$$= \lim_{y\to 0} \frac{1+\sqrt{1+y^4}-2}{y^4\left(\sqrt{1+\sqrt{1+y^4}}+\sqrt{2}\right)}$$
$$= \lim_{y\to 0} \frac{\left(\sqrt{1+y^4}-1\right)\left(\sqrt{1+y^4}+1\right)}{y^4\left(\sqrt{1+\sqrt{1+y^4}}+\sqrt{2}\right)\left(\sqrt{1+y^4}+1\right)}$$
$$= \lim_{y\to 0} \frac{1+y^4-1}{y^4\left(\sqrt{1+\sqrt{1+y^4}}+\sqrt{2}\right)\left(\sqrt{1+y^4}+1\right)}$$
$$= \lim_{y\to 0} \frac{1}{\left(\sqrt{1+\sqrt{1+y^4}}+\sqrt{2}\right)\left(\sqrt{1+y^4}+1\right)} = \frac{1}{4\sqrt{2}}$$

Hence, the correct option is (A).

12. (B)

Given : $\lim\limits_{x\to 0} \dfrac{x+2\sin x}{\sqrt{x^2+2\sin x+1}-\sqrt{\sin^2 x-x+1}}$

$$\lim_{x\to 0} \frac{(x+2\sin x)(\sqrt{x^2+2\sin x+1}+\sqrt{\sin^2 x-x+1})}{x^2+2\sin x+1-\sin^2 x+x-1}$$
$$\lim_{x\to 0} \frac{(x+2\sin x)(2)}{x^2+2\sin x-\sin^2 x+x} \quad \left(\frac{0}{0}\text{ form}\right)$$

Using L' Hospital rule,

$$\lim_{x\to 0} \frac{(1+2\cos x)\times 2}{2x+2\cos x-2\sin x\cos x+1} = \frac{2\times 3}{(2+1)} = 2$$

Hence, the correct option is (B).

13. (C)

Given : The equation $x^2+bx+c=0$ has roots α and β

$$\alpha+\beta = -b$$
$$\alpha\beta = c$$

So, $x^2+bx+c = (x-\alpha)(x-\beta)$

$$\lim_{x\to\alpha} \frac{1-\cos(x^2+bx+c)}{(x-\alpha)^2}$$
$$= \lim_{x\to\alpha} \frac{2\sin^2\left[\dfrac{x^2+bx+c}{2}\right]}{(x-\alpha)^2}$$
$$= \lim_{x\to\alpha} \frac{2\sin^2\left[\dfrac{(x-\alpha)(x-\beta)}{2}\right]}{(x-\alpha)^2}$$
$$= 2\lim_{x\to\alpha}\left[\frac{\sin\left[\dfrac{(x-\alpha)(x-\beta)}{2}\right]}{\dfrac{1}{2}(x-\alpha)(x-\beta)}\right]^2 \times \frac{1}{4}(x-\beta)^2$$
$$= \frac{2}{4}(\alpha-\beta)^2 = \frac{1}{2}\left[(\alpha+\beta)^2-4\alpha\beta\right]$$
$$= \frac{1}{2}\left[(-b)^2-4\times c\right]$$
$$= \frac{b^2-4c}{2}$$

Hence, the correct option is (C).

14. (D)

Checking from options :

Option (A) : $f(x)=\cos(|x|)+|x|=\cos x+|x|$ is not-differentiable at $x=0$ as $|x|$ is non-differentiable at $x=0$.

Option (B) :

Similarly, $f(x)=\cos(|x|)-|x|=\cos x-|x|$ is non-differentiable at $x=0$.

Option (C) :

$$f(x)=\sin|x|+|x|=\begin{cases}-\sin x-x, & x<0\\ +\sin x+x, & x\geq 0\end{cases}$$

$$f'(x)=\begin{cases}-\cos x-1, & x<0\\ +\cos x+1, & x>0\end{cases}$$

$$f'(0^-)=-2,\ f'(0^+)=2$$

Hence, $f(x)$ is not differential at $x=0$.

Option (D) :

$$f(x)=\sin|x|-|x|=\begin{cases}-\sin x+x, & x<0\\ +\sin x-x, & x\geq 0\end{cases}$$

$$f'(x)=\begin{cases}-\cos x+1, & x<0\\ +\cos x-1, & x>0\end{cases}$$

$$f'(0^-)=f'(0^+)=0$$

Therefore, f is differentiable at $x=0$.

Hence, the correct option is (D).

15. – 4

Given : $\lim\limits_{x\to 0}\dfrac{x(1+a\cos x)-b\sin x}{x^3}=1$

$$\lim_{x\to 0}\frac{x+ax\cos x-b\sin x}{x^3}=1$$

$$x+ax\left(1-\frac{x^2}{2!}+\frac{x^4}{4!}+\ldots\right)$$

$$\lim_{x\to 0}\frac{-b\left(x-\dfrac{x^3}{3!}+\dfrac{x^5}{5!}+\ldots\right)}{x^3}=1$$

$$\lim_{x\to 0}\frac{x+ax-\dfrac{ax^3}{2!}+\dfrac{ax^5}{4!}\ldots-bx+\dfrac{bx^3}{3!}-\dfrac{bx^5}{5!}}{x^3}=1$$

$$\lim_{x\to 0}\frac{x(1+a-b)+x^3\left(\dfrac{b}{3!}-\dfrac{a}{2!}\right)+x^5\left(\dfrac{a}{4!}-\dfrac{b}{5!}\right)}{x^3}=1$$

$$\lim_{x\to 0}\frac{1+a-b}{x^2}+\left(\frac{b}{3!}-\frac{a}{2!}\right)=1$$

By comparing, $1+a-b=0$ …(i)

and $\dfrac{b}{3!}-\dfrac{a}{2!}=1$ …(ii)

Solving equations (i) and (ii),

$$a=\frac{-5}{2},b=\frac{-3}{2}$$

$$a+b=-4$$

Hence, the correct answer is – 4.

16. 8

Given : $I=\lim\limits_{x\to\frac{\pi}{4}}\dfrac{\int_2^{\sec^2 x}f(t)\,dt}{\left(x^2-\dfrac{\pi^2}{16}\right)}$

The given limit can be solved by Leibnitz Rule,

$$I=\lim_{x\to\frac{\pi}{4}}\frac{\int_2^{\sec^2 x}f(t)\,dt}{\left(x^2-\dfrac{\pi^2}{16}\right)}=\frac{0}{0}\text{ form}$$

$$I=\lim_{x\to\frac{\pi}{4}}\frac{\dfrac{d}{dx}\left(\int_2^{\sec^2 x}f(t)\,dt\right)}{\dfrac{d}{dx}\left(x^2-\dfrac{\pi^2}{16}\right)}=\frac{0}{0}$$

$$=\lim_{x\to\frac{\pi}{4}}\frac{2\sec^2 x\tan x\times f(\sec^2 x)}{2x}$$

$$=\lim_{x\to\frac{\pi}{4}}\frac{\sec^2\dfrac{\pi}{4}\tan\dfrac{\pi}{4}\times f\left(\sec^2\dfrac{\pi}{4}\right)}{\dfrac{\pi}{4}}$$

$$=\lim_{x\to\frac{\pi}{4}}\frac{\sec^2\dfrac{\pi}{4}\tan\dfrac{\pi}{4}\times f\left(\sec^2\dfrac{\pi}{4}\right)}{\dfrac{\pi}{4}}$$

Hence, the correct answer is 8.

17. (A), (B), (C)

Given : $f(x)=\begin{cases} 0; & x=0 \\ \frac{1}{2}-x; & 0<x<\frac{1}{2} \\ \frac{1}{2} & x=\frac{1}{2} \\ \frac{3}{2}-x; & \frac{1}{2}<x<1 \\ 1: & x=1 \end{cases}$

For continuity,

$$f(x^-)=f(x^+)=f(0)$$

Lets check the point

At $x=0$,

$$f(0)\neq f(0^+)$$

$$0\neq\frac{1}{2}$$

So, discontinuous at $x=0$

At $x=\frac{1}{2}$,

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

$$0\neq\frac{1}{2}=\frac{1}{2}$$

So, discontinuous at $x=\frac{1}{2}$

At $x=1$,

$$f(1^-)=f(1^+)=f(1)$$

$$\frac{1}{2}\neq 1$$

So, discontinuous at $x=1$

Hence, the correct options are (A), (B) and (C).

18. (A)

Given : $f(x)=\begin{cases} k\sqrt{x+1}; & 0\le x\le 3 \\ mx+2; & 3<x\le 5 \end{cases}$

For differentiable at $x=3$

So, $f(3^-)=f(3^+)=f(3)$

$$2k=3m+2 \qquad \ldots(i)$$

For differentiability,

$$f'(x)=\begin{cases} \frac{k}{2\sqrt{x+1}}; & 0\le x\le 3 \\ m; & 3<x\le 5 \end{cases}$$

$$f'(3^+)=f'(3^-)$$

$$m=\frac{k}{4} \qquad \ldots(ii)$$

From equation (i) and (ii),

$$m=\frac{2}{5} \text{ and } k=\frac{8}{5}$$

Hence, the correct option is (A).

19. 8

Given : $f(x)=\sin^4 x+\cos^4 x$

Since, the function is smooth curve

So, $x\in R$

For maxima and minima $f'(x)=0$

$$f'(x)=4\sin^3 x\cdot\cos x+4\cos^3 x(-\sin x)$$

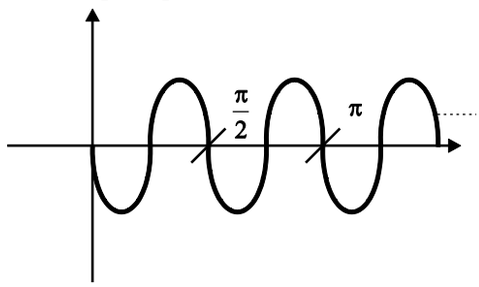
$$=4\sin x\cos x(\sin^2 x-\cos^2 x)$$

$$=-2(2\sin x\cos x)(\cos^2 x-\sin^2 x)$$

$$=-2(\sin 2x)(\cos 2x)$$

$$=-\sin 4x$$

$-\sin 4x$ $[0, 2\pi]$



$$f'(x)=-\sin 4x=0$$

$$\sin 4x=0$$

$$4x=n\pi$$

$$x=\frac{n\pi}{4}$$

Total 8 points of maxima and minima occur between $[0,2\pi]$.

Hence, the correct answer is 8.

20. (D)

Given : $p = \frac{40}{600} = \frac{1}{15}$ and $n = 10$

So, $\lambda = np = \frac{1}{15} \times 10 = \frac{2}{3}$

$$P(r) = \frac{e^{-\lambda}\lambda^r}{r!} = \frac{e^{-2/3} \times \left(\frac{2}{3}\right)^r}{r!}$$

$$P(0) = \frac{e^{-2/3} \times \left(\frac{2}{3}\right)^0}{0!} = e^{-2/3} = 0.51$$

Hence, the correct option is (D).

21. 0.52

Fair $\rightarrow$ Coin $\rightarrow \{H, T\} \rightarrow \frac{1}{2} = P(H)$

Biased $\rightarrow$ Dice $\rightarrow \{1, 2, 3, 4, 5, 6\} \rightarrow \frac{1}{6} = P(6)$

Prob (H and 6) $= P(H) \cdot P(6) = \frac{1}{2} \times \frac{1}{6} = \frac{1}{12}$

$$P(W) = \frac{1}{12}$$

$$P(L) = 1 - \frac{1}{12} = \frac{11}{12}$$

Now, P (winning at A)

$$= P(W_A) + P(L_A) \times P(L_B) \times P(W_A) + P(L_A) \times P(L_B) \times P(L_A) \times P(L_B) \times P(W_A) + ...\infty$$

$$= \frac{1}{12} + \left(\frac{11}{12}\right)^2 \times \frac{1}{12} + \left(\frac{11}{12}\right)^4 \times \frac{1}{12} + ...\infty$$

$$= \frac{1}{12}\left[1 + \left(\frac{11}{12}\right)^2 + \left(\frac{11}{12}\right)^4 + ...\infty\right]$$

It is in G.P series $\left\{\because S_\infty = \frac{a}{1-r}\right\}$

$$\therefore \quad P(\text{Winning of A}) = \frac{1}{12}\left[\frac{1}{1 - \frac{121}{144}}\right] \approx 0.52$$

Hence, the correct answer is 0.52.

22. (D)

Miss A : P (2 balls same color)

$$= P(2\,\text{Red}) + P(2\,\text{White})$$

$$P(\text{Miss A}) = \frac{{}^3C_2 + {}^nC_2}{{}^{n+3}C_2} = \frac{1}{2} \quad \left[{}^nC_r = \frac{n!}{r!(n-r)!}\right]$$

$$n^2 - 7n + 6 = 0$$

$$n = 1, 6$$

$$P(\text{Miss B}) = \left[\frac{3}{n+3} \times \frac{3}{n+3}\right] + \left[\frac{n}{n+3} \times \frac{n}{n+3}\right]$$

$$= \frac{5}{8}$$

$$n^2 - 10n + 9 = 0$$

$$n = 9, 1$$

In both cases, common value of $n = 1$

Therefore, the possible of value of n is 1

Hence, the correct option is (D).

23. 3.99

Given : Gaussian random variable function is

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}$$

Mean $\mu = 0$

Variance $\sigma^2 = 1$

So, $E(|5x|) = \int_{-\infty}^{\infty} |5x| f(x) dx$

$$= \int_{-\infty}^{\infty} |5x| \frac{1}{\sqrt{2\pi}} e^{-\frac{x^2}{2}} dx$$

$$= \int_0^{\infty} \frac{2}{\sqrt{2\pi}} \times 5x e^{-\frac{x^2}{2}} dx$$

$$= \frac{10}{\sqrt{2\pi}} \int_0^{\infty} e^{-\frac{x^2}{2}} .x dx = \frac{10}{\sqrt{2\pi}} = 3.99$$

Hence, the correct answer is 3.99.

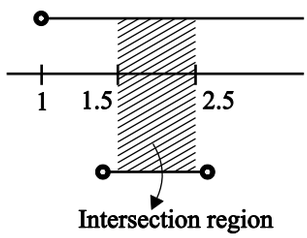
24. 0.5

Given : $P(A/B) = \frac{P(A \cap B)}{P(B)}$

$$P(1.5 < x \le 2.5 \mid x > 1)$$

$$= \frac{P\left((1.5 < x \le 2.5) \cap (x > 1)\right)}{P(x > 1)}$$

or $$\frac{P(1.5 < x \le 2.5)}{P(x > 1)}$$



$$= \frac{P(1.5 < x \le 2.5)}{1 - P(x \le 1)}$$

$$= \frac{\int_{1.5}^{2} \frac{1}{2}\,dx + \int_{2}^{2.5} \left(\frac{3-x}{3}\right) dx}{1 - \int_{0}^{1} \frac{x}{2}\,dx}$$

$$= \frac{\frac{1}{4} + \frac{1}{8}}{1 - \frac{1}{4}} = \frac{1}{2}$$

Hence, the correct answer is 0.5.

25. 92928

Given : $A = \begin{bmatrix} 1 & 2 & -3 \\ 0 & 4 & 5 \\ 0 & 0 & 6 \end{bmatrix}$

Eigen value of a upper triangular matrix is equal to the principal diagonal element.

So, $\lambda(A) = 1, 4, 6$

$\lambda(A^3) = 1, 64, 216;\ \lambda(A^2) = 1, 16, 36$

$\lambda(A^3 + A^2 + 2A) = 1+1+2,\ 64+16+4\times 2,\ 216+36+12$

$= 4, 88, 264$

$\therefore \quad \text{Det}\,(A^3 + A^2 + 2A) = 4 \times 88 \times 264 = 92928$

Hence, the correct answer is 92928.

26. (A)

Given : $I = \int_{1}^{3} e^{3x} \left(\log x + \frac{1}{x}\right) dx$

Let $3x = t$

$$dx = \frac{dt}{3}$$

On substituting,

$$I = \int_{3}^{9} e^{t} \left(\log\left(\frac{t}{3}\right) + \frac{3}{t}\right) \frac{dt}{3} \qquad \ldots(i)$$

$$f(t) = \log\left(\frac{t}{3}\right)$$

If $\quad f'(t) = \frac{3}{t} \times \frac{1}{3}$

$$I = \int_{3}^{9} e^{t} [f(t) + 3f'(t)]\,dt \qquad \ldots(ii)$$

We know,

$$\int e^{x} f(x) + f'(x)\,dx = e^{x} f(x) + C \qquad \ldots(iii)$$

$$= [e^{t} f(t)]_{3}^{9} = \left[e^{t} \log\left(\frac{t}{3}\right)\right]_{3}^{9}$$

$$= e^{9} \log 3 - e^{3} \log 1 = e^{9} \log 3$$

Hence, the correct option is (A).

27. 1

Given : $A = \begin{bmatrix} 1 & 2 & 3 & 2 \\ 2 & 3 & 5 & 1 \\ 1 & 3 & 4 & 5 \end{bmatrix}_{3\times 4}$

On performing transformations,

$R_2 \to R_2 - 2R_1$ and $R_3 \to R_3 - R_1$,

$$A = \begin{bmatrix} 1 & 2 & 3 & 2 \\ 0 & -1 & -1 & -3 \\ 0 & 1 & 1 & 3 \end{bmatrix}$$

$R_3 \to R_3 + R_2$,

$$\begin{bmatrix} 1 & 2 & 3 & 2 \\ 0 & -1 & -1 & -3 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

Above matrix is row echelon form we can say that $\rho(A)_{3\times4} = 2$

Hence, number of independent solution

$= \text{Number of row} - \rho(A)_{3\times4}$

$= 3 - 2 = 1$

Hence, the correct answer is 1.

28. 0.197

Given : $P = \begin{bmatrix} \frac{x}{\sqrt{2}} & \frac{y}{\sqrt{2}} \\ \frac{-1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \end{bmatrix}$

'x' and 'y' follow binomial distribution with probability of success, $p = \frac{1}{3}$ and number of trials, $n = 3$

For P to be orthogonal,

$$AA^T = I$$

$$= \begin{bmatrix} \frac{x}{\sqrt{2}} & \frac{y}{\sqrt{2}} \\ \frac{-1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \end{bmatrix} \begin{bmatrix} \frac{x}{\sqrt{2}} & \frac{-1}{\sqrt{2}} \\ \frac{y}{\sqrt{2}} & \frac{1}{\sqrt{2}} \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

$$\frac{x^2}{2} + \frac{y^2}{2} = 1 \text{ and } \frac{-x}{\sqrt{2}} + \frac{y}{\sqrt{2}} = 0$$

$$x^2 + y^2 = 2 \qquad \ldots(\text{i})$$

and $x = y \qquad \ldots(\text{ii})$

$\therefore \quad P(x = 1, y = 1) = P(x = 1)P(y = 1)$

($\because$ Independent variables)

$$= \left[{}^3C_1 \left(\frac{1}{3}\right)\left(\frac{2}{3}\right)^2 \right]\left[{}^3C_1 \left(\frac{1}{3}\right)\left(\frac{2}{3}\right)^2 \right] = \frac{16}{81}$$

Hence, the correct answer is 0.197.

29. 0

Given : $(P(X^TY)^{-1}P^T)^T = (P \times 3 \times 3 \times P^T)^T$

$p - q = 2 - 2 = 0$

Hence, the correct answer is 0.

30. 5

Given : $|A|_{3\times3} = 5$

$B = \text{adj } (5A)$

On taking determinant both sides,

$$|B| = |\text{adj}(5A)| = |5^{3-1} \text{ adj}(A)|$$

$$|B| = |25 \text{ adj}(A)| = 25^3 |\text{adj}(A)|$$

$$|B| = 25^3 \times |A|^2 = 5^6 \times 5^2 = 5^8$$

$\therefore \quad \sqrt[8]{|B|_{3\times3}} = \sqrt[8]{5^8} = 5$

Hence, the correct answer is 5.

31. – 1

Given : On writing expansion,

$$\lim_{x\to0} \frac{a\left(x - \frac{x^3}{3!} + \ldots\ldots\right) + b\left(1 - \frac{x^2}{2!} + \ldots\ldots\right) + cx}{x^3} = \frac{-1}{6}$$

For finite limit, $a = -c$, $b = 0$

$$\frac{a+b}{c} = \frac{-c+0}{c} = -1$$

Hence, the correct answer is – 1.

32. (A), (C)

Given : $f(x, y) = x^2 + y^2 + 4x + 8$

$$p = \frac{\partial f}{\partial x} = 2x + 4 = 0,\ x = -2$$

$$q = \frac{\partial f}{\partial y} = 2y = 0,\ y = 0$$

Point $p(-2, 0)$,

$$r = \frac{\partial^2 f}{\partial x^2} = 2;\ t = \frac{\partial^2 f}{\partial y^2} = 2;\ s = \frac{\partial^2 f}{\partial x \partial y} = 0$$

$rt - s^2 = 2 \times 2 - 0 = 4$, i.e. $r > 0$

Hence, $(-2, 0)$ is point of minimum

$f_{(\min)} = (-2)^2 + 0 + 4(-2) + 8 = 4$

Hence, the correct options are (A) and (C).

33. (B), (D)

Given : Matrix is an upper triangular matrix so, eigen value of P are $1, -4$ and 5.

(A) Then eigen value of P^{-1} are $1, \frac{-1}{4}$ and $\frac{1}{5}$.

(B) $|5P^T| = 5^3 |P^T| = 125 \times |P|$

$= 125 \times$ Product of eigen values of $'P'$

$= 125 \times 1 \times -4 \times 5 = -2500$

(C) $\because |P| \neq \pm 1$ hence can't be an orthogonal matrix

(D) Eigen values of P are

$1^{2022}, (-4)^{2022}, 5^{2022} = 1, 2^{4044}, 5^{2022}$

Hence, the correct options are (B) and (D).

34. (B), (C), (D)

Given : $'P'$ is non-singular.

$|P| \neq 0$

$|P - OI| \neq 0$

But for eigen values, $|P - \lambda I| = 0$

No Eigen value can be zero

Hence, only option (A) is correct.

Hence, the correct options are (B), (C) and (D).

35. (B), (C), (D)

Given : $f(x) = \int_{x^2}^{x^3} t\,dt$

$f(x) = \int_{\phi(x)}^{g(x)} \psi(t)\,dt$

$f'(x) = g'(x)\psi g(x) - \phi'(x)\psi\phi(x)$

$f'(x) = 3x^2 \cdot x^3 - 2x \cdot x^2 = 3x^5 - 2x^3 = 0$

$x^3(3x^2 - 2) = 0$

$x = 0, 0, 0, \pm\sqrt{\frac{2}{3}}$

Total 5 extremum points.

On finding $f''(x) = 15x^4 - 6x^2 = 3x^2(5x^2 - 2)$

$f''(0) = 0$

$x = 0$ is point of inflection

$f''\left(\pm\sqrt{\frac{2}{3}}\right) = 3 \times \frac{2}{3}\left(5 \times \frac{2}{3} - 2\right) = 2\left(\frac{4}{3}\right) = \frac{8}{3}$

Both at $x = \pm\sqrt{\frac{2}{3}}, f(x)$ has minimum value.

Hence, the correct options are (B), (C) and (D).

36. 2.5

Given : Total probability $= 1$

Area of $f(x) = 1$

$\frac{1}{2}(1+5) \times K = 1$

$K = \frac{1}{3}$

$f(x)$ can be written as,

$$f(x) = \begin{cases} \frac{x}{6}, & 0 \le x < 2 \\ \frac{1}{3}, & 2 \le x \le 3 \\ \frac{(5-x)}{6}, & 3 \le x < 5 \end{cases}$$

Then, $E(x) = \int_{-\infty}^{\infty} x f(x)\,dx$

$= \int_0^2 \frac{x^2}{6}\,dx + \int_2^3 \frac{x}{3}\,dx + \int_3^5 \frac{x(5-x)}{6}\,dx$

$= \left(\frac{x^3}{18}\right)_0^2 + \left(\frac{x^2}{6}\right)_2^3 + \left(\frac{5x^2}{2} - \frac{x^3}{3}\right)_3^5 \times \frac{1}{6}$

$= \frac{8}{18} + \frac{5}{6} + (25-9)\frac{5}{12} - \left(\frac{125-27}{18}\right)$

$= 2.5$

Hence, the correct answer is 2.5.

37. 0.167

Given : $L = \lim_{x \to \infty} \frac{\ln(x^2 - 4x + 8)}{\ln(x^{12} + x^6 + 6)}$

$$= \lim_{x\to\infty} \frac{\ln\left(x^2\left(1-\frac{4}{x}+\frac{8}{x^2}\right)\right)}{\ln\left(x^{12}\cdot\left(1+\frac{1}{x^6}+\frac{6}{x^{12}}\right)\right)}$$

$$= \lim_{x\to\infty} \frac{\ln x^2 + \ln\left(1-\frac{4}{x}+\frac{8}{x^2}\right)}{\ln x^{12} + \ln\left(1+\frac{1}{x^6}+\frac{6}{x^{12}}\right)}$$

$$= \lim_{x\to\infty} \frac{2\ln x}{12\ln x}\left[\frac{1+\frac{\ln\left(1-\frac{4}{x}+\frac{8}{x^2}\right)}{\ln x^2}}{1+\frac{\ln\left(1+\frac{1}{x^6}+\frac{6}{x^{12}}\right)}{\ln x^{12}}}\right]$$

$$= \frac{2}{12}\times 1\times 1 = \frac{1}{6} = 0.167$$

Hence, the correct answer is 0.167.

38. (A), (D)

Given : $A = \begin{bmatrix} \frac{1}{2} & \frac{1}{2} & 4 \\ \frac{-7}{2} & 2 & -2 \\ \frac{\beta}{2} & 4 & \frac{\alpha}{2} \end{bmatrix}$

Since, $[A]$ is orthogonal rows R_1, R_2, R_3 and columns C_1, C_2 and C_3 are orthonormal.

$$C_1^T \cdot C_2 = 0$$

$$\begin{bmatrix} \frac{1}{2} & \frac{-7}{2} & \frac{\beta}{2} \end{bmatrix}\begin{bmatrix} \frac{1}{2} \\ 2 \\ 4 \end{bmatrix} = 0$$

$$\frac{1}{4} - 7 + 2\beta = 0$$

$$\beta = \frac{27}{8}$$

Similarly, $C_2^T \cdot C_3 = 0$

$$\begin{bmatrix} \frac{1}{2} & 2 & 4 \end{bmatrix}\begin{bmatrix} 4 \\ -2 \\ \frac{\alpha}{2} \end{bmatrix} = 0$$

$$2 - 4 + 2\alpha = 0$$

$$\alpha = 1$$

Hence, the correct options are (A) and (D).

39. (A)

Given : Probability of choosing a private car = 0.45

Probability of choosing a public transport

$$= 1 - 0.45 = 0.55$$

Among public transport,

Probability of choosing a bus (public transport)

$$= 0.55 \times 0.55$$

$$= 0.3$$

Probability of choosing metro (public transport)

$$= 0.55 - 0.3$$

$$= 0.25$$

Hence, the correct option is (A).

40. 0.314

Given : $P(H) = \frac{1}{5}$ and $P(W) = \frac{1}{7}$

Required probability $P(H \cup W)$

$$= P(H) + P(W) - P(H \cap W)$$

$$= \frac{1}{5} + \frac{1}{7} - \left(\frac{1}{5}\times\frac{1}{7}\right) = \frac{11}{35} = 0.314$$

Hence, the correct answer is 0.314.

41. (B)

Given : $I = \int_0^\infty e^{-y^3} y^{\frac{1}{2}}\, dy$

Putting $y^3 = t$

Differentiating both the sides with respect to t,

$$3y^2 dy = dt$$

$$y^{\frac{1}{2}} dy = \frac{1}{3} y^{\frac{-3}{2}} dt = \frac{1}{3} t^{\frac{-1}{2}} dt$$

$$I=\int_0^{\infty} e^{-t}\frac{1}{3}t^{\frac{-1}{2}}dt$$

Using the property of gamma function,

$$\int_0^{\infty} e^{-t}t^{n-1}dt=\Gamma n$$

Here, $n-1=\frac{-1}{2} \quad \Rightarrow \quad n=\frac{1}{2}$

$$I=\frac{1}{3}\Gamma n$$

$$I=\frac{1}{3}\Gamma\frac{1}{2}=\frac{1}{3}\sqrt{\pi}$$

Hence, the correct option is (B).

42. (C)

Given : $I=\int_{-\frac{\pi}{2}}^{\frac{\pi}{2}}\frac{\sin 2x}{1+\cos x}dx$

$$f(x)=\frac{\sin 2x}{1+\cos x}$$

$$f(-x)=\frac{\sin(2\times(-x))}{1+\cos(-x)}$$

$$f(-x)=\frac{\sin(-2x)}{1+\cos(-x)}=\frac{-\sin 2x}{1+\cos x}$$

$$\left[\text{Since,}\quad \begin{matrix}\sin(-\theta)=-\sin\theta\\ \cos(-\theta)=\cos\theta\end{matrix}\right]$$

Since, $f(x)=-f(-x)$

Hence, it is a odd function.

$\therefore \quad \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}}\frac{\sin 2x}{1+\cos x}dx=0$

Hence, the correct option is (C).

43. (D)

Given : $I=\int_0^{\frac{\pi}{4}}\left(\frac{1-\tan x}{1+\tan x}\right)dx$

. Method 1:

$$I=\int_0^{\frac{\pi}{4}}\left(\frac{1-\frac{\sin x}{\cos x}}{1+\frac{\sin x}{\cos x}}\right)dx$$

$$I=\int_0^{\frac{\pi}{4}}\left(\frac{\cos x-\sin x}{\cos x+\sin x}\right)dx$$

Let $\cos x+\sin x=t, \ (-\sin x+\cos x)dx=dt$

Changing the limits,

$$x=0\Rightarrow t=1$$

$$x=\frac{\pi}{4}\Rightarrow t=\sqrt{2}$$

Then, $I=\int_1^{\sqrt{2}}\frac{1}{t}dt$

$$I=[\ln t]_1^{\sqrt{2}}=\ln(\sqrt{2})-\ln(1)$$

$$I=\ln\sqrt{2}=\ln(2)^{\frac{1}{2}}=\frac{1}{2}\ln 2$$

Hence, the correct option is (D).

. Method 2:

$$I=\int_0^{\pi/4}\frac{\tan\frac{\pi}{4}-\tan x}{1+\tan\frac{\pi}{4}\times\tan x}dx$$

$$I=\int_0^{\pi/4}\tan\left(\frac{\pi}{4}-x\right)dx$$

$$I=\int_0^{\pi/4}\tan x\,dx$$

$$I=[\log\sec x]_0^{\pi/4}$$

$$I=\log\sec\frac{\pi}{4}-\log\sec 0$$

$$I=\log\sqrt{2}-\log 1=\frac{1}{2}\ln 2$$

Hence, the correct option is (D).

44. (D)

For X and Y be two independent random variables.

(i) $E(XY)=E(X)E(Y)$ …(i)

(ii) $\text{Cov}(X,Y)=E(XY)-E(X)E(Y)$

$=E(X)E(Y)-E(X)E(Y)$

[From equation (i)]

$=0$

(iii) $\text{Var}(X+Y)=\text{Var}(X)+\text{Var}(Y)$

(iv) $E(X^2Y^2)=E(X^2)E(Y^2)$

Therefore, relation in option (D) is False.
Hence, the correct option is (D).

45. (B)

Given : A is an $n\times n$ real matrix and $A^2=I$.
Determinant of A^2 is given by,

$$|A^2|=|I|=1$$
$$|A|=\pm 1$$
$$|A|\neq 0 \quad \text{[Condition for unique solution]}$$

Therefore, $Ax=y$ is consistent and has unique solution given by $x=A^{-1}y$.
Hence, the correct option is (B).

46. (A)

Given : A probability density function is,

$$P_x(x)=Me^{-2|x|}+Ne^{-3|x|}$$

By the property of probability density function (P.D.F.),

$$\int_{-\infty}^{\infty} P_x(x)\,dx=1$$

$$\int_{-\infty}^{\infty} (Me^{-2|x|}+Ne^{-3|x|})\,dx=1$$

$P_x(x)$ is even function as $|x|$ is even function.
So, by the property of even function,

$$2\int_{0}^{\infty} (Me^{-2x}+Ne^{-3x})\,dx=1$$

$$2M\left(\frac{e^{-2x}}{-2}\right)_0^{\infty}+2N\left(\frac{e^{-3x}}{-3}\right)_0^{\infty}=1$$

$$-M(e^{-\infty}-e^{0})-\frac{2}{3}N(e^{-\infty}-e^{0})=1$$

$$-M(0-1)-\frac{2}{3}N(0-1)=1$$

$$M+\frac{2}{3}N=1$$

Hence, the correct option is (A).

47. (A)

Given :

(i) Real matrices are :
$[A]_{3\times1},[B]_{3\times3},[C]_{3\times5},[D]_{5\times3},[E]_{5\times5}$ and $[F]_{5\times1}$.

(ii) Matrices [B] and [E] are symmetric.

Statement I :

Matrix product $[F]^T[C]^T[B][C][F]$ is a scalar.

Product of $[F]^T$ and $[C]^T$ is given by,

$$[F]^T_{1\times5}[C]^T_{5\times3}=[P]_{1\times3}$$

Product of $[P]$ and $[B]$ is given by,

$$[P]_{1\times3}[B]_{3\times3}=[Q]_{1\times3}$$

Product of $[Q]$ and $[C]$ is given by,

$$[Q]_{1\times3}[C]_{3\times5}=[R]_{1\times5}$$

Product of $[R]$ and $[F]$ is given by,

$$[R]_{1\times5}[F]_{5\times1}=[S]_{1\times1}$$

Since, order of product of $[F]^T[C]^T[B][C][F]$ is 1×1 i.e. scalar quantity.
Hence, statement I is true.

Statement II :

Matrix product $[D]^T[F][D]$ is always symmetric.

Product of $[D]^T$ and $[F]$ is given by,

$$[D]^T_{3\times5}[F]_{5\times1}=[M]_{3\times1}$$

Product of $[M]_{3\times1}$ and $[D]_{5\times3}$ is not possible since number of columns of matrix M is not equal to number of rows of matrix D.

Therefore, Matrix product $[D]^T[F][D]$ is not possible.

Hence, statement II is false.
Hence, the correct option is (A).

48. 2

Given : Matrix A is upper triangular matrix
Eigen value of $A=1,i$

Eigen value of $A^{2024}=1,\ A^{2024}=1,1$

Hence, trace $A^{2024} = a + d = 1 + 1 = 2$

Hence, the correct answer is 2.

49. 0.021

Given : $I = \int \frac{dx}{6|x|\sqrt{x^2-1} \times 6} = \frac{1}{36}\int \frac{dx}{|x|\sqrt{x^2-1}}$

$$\frac{d}{dx}(\sec^{-1} x) = \frac{1}{|x|\sqrt{x^2-1}}$$

So, $I = \frac{1}{36} \times \sec^{-1}(x) + C = f(x)$

At $x = 1$,

$$f(1) = \frac{\sec^{-1} x}{36} + C = 0$$

$$C = 0$$

So, $f(x) = \frac{\sec^{-1}(x)}{36} = f(\sqrt{2}) = \frac{\sec^{-1}(\sqrt{2})}{36}$

$$= \frac{\pi/4}{36} = \frac{\pi}{144}$$

Hence, the correct answer is 0.021.

50. 0.33

Given :

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

$$\frac{1}{2} = P(A) + [1 - P(B)] - P(A).P(B^c)$$

$$\frac{1}{2} = P(A) + \left(1 - \frac{3}{4}\right) - P(A)\left(1 - \frac{3}{4}\right)$$

$$\frac{1}{2} = P(A) + \frac{1}{4} - \frac{1}{4}P(A)$$

$$\frac{1}{4} = \frac{3}{4}P(A)$$

$$P(A) = \frac{1}{3} = 0.33$$

Hence, the correct answer is 0.33.

51. 8

Given : The given Limit can be solved by Leibnitz Rule

$$I = \lim_{x \to \frac{\pi}{4}} \frac{\int_2^{\sec^2 x} f(t)\,dt}{\left(x^2 - \frac{\pi^2}{16}\right)} = \frac{0}{0} \text{ form}$$

$$I = \lim_{x \to \frac{\pi}{4}} \frac{\frac{d}{dx}\left(\int_2^{\sec^2 x} f(t)\,dt\right)}{\frac{d}{dx}\left(x^2 - \frac{\pi^2}{16}\right)} = \frac{0}{0}$$

$$= \lim_{x \to \frac{\pi}{4}} \frac{2\sec^2 x \tan x \times f(\sec^2 x)}{2x}$$

$$= \lim_{x \to \frac{\pi}{4}} \frac{\sec^2 \frac{\pi}{4} \tan \frac{\pi}{4} \times f\left(\sec^2 \frac{\pi}{4}\right)}{\frac{\pi}{4}}$$

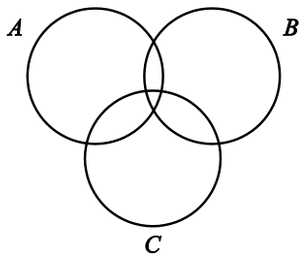
$$= \lim_{x \to \frac{\pi}{4}} \frac{\sec^2 \frac{\pi}{4} \tan \frac{\pi}{4} \times f\left(\sec^2 \frac{\pi}{4}\right)}{\frac{\pi}{4}}$$

$$= \frac{2f(2)}{\frac{\pi}{4}} = \frac{8f(2)}{\pi} = 8$$

Hence, the correct answer is 8.

52. 0.44

Given : Sets



P (exactly one A or B)

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

$$= P(A) + P(B) - 2P(A \cap B)$$

According to question,

$$P(A) + P(B) - 2P(A \cap B) = \frac{1}{4} \quad \ldots(i)$$

$$P(B)+P(C)-2P(B\cap C)=\frac{1}{4} \quad \ldots(ii)$$

$$P(C)+P(A)-2P(A\cap C)=\frac{1}{4} \quad \ldots(iii)$$

On adding (i), (ii) and (iii)

$$2\begin{bmatrix} P(A)+P(B)+P(C)-P(A\cap B) \\ -P(B\cap C)-P(C\cap A)\end{bmatrix}=\frac{3}{4}$$

Also, $P(A\cap B\cap C)=\frac{1}{16}$

So, P (at least one)

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

$$=\frac{3}{8}+\frac{1}{16}=\frac{7}{16}$$

Hence, the correct answer is 0.44.

53. (A)

Given : $PX=Q$

It is a non-homogenous equation.

So, for existence of at least one solution, the augmented matrix $[P:Q]$ must have the same rank as matrix P.

Hence, the correct option is (A).

54. (D)

Given : A 3×3 real symmetric matrix S.

Two Eigen values and respective Eigen vector are :

$$\lambda_1=a\neq0,\ X_1=\begin{bmatrix}x_1\\x_2\\x_3\end{bmatrix}$$

$$\lambda_2=b\neq0,\ X_2=\begin{bmatrix}y_1\\y_2\\y_3\end{bmatrix}$$

By the properties of real symmetric matrices,

$$[X_1]^T[X_2]=0$$

$$\begin{bmatrix}x_1 & x_2 & x_3\end{bmatrix}\begin{bmatrix}y_1\\y_2\\y_3\end{bmatrix}=0$$

$$x_1y_1+x_2y_2+x_3y_3=0$$

Hence, the correct option is (D).

55. – 6

Given : $A=\begin{bmatrix}2 & 1 & 1\\ 2 & 3 & 4\\ -1 & -1 & -2\end{bmatrix}$

Eigen values are $\lambda_1=1,\ \lambda_2=-1$ and $\lambda_3=3$.

By Cayley Hamilton theorem, every square matrix satisfies its own characteristics equation.

The characteristic equation is given by,

$$|A-\lambda I|=0$$

$$AI=\lambda I\Rightarrow A=\lambda$$

The above expression shows that the values of λ can be put in any expression of the matrix A.

For $\lambda_1=1$,

Eigen value of A^3-3A^2 is given by,

$$A^3-3A^2=1^3-3\times1^2=-2$$

For $\lambda_2=-1$,

$$A^3-3A^2=(-1)^3-3\times(-1)^2=-4$$

For $\lambda_3=3$,

$$A^3-3A^2=3^3-3\times3^2=0$$

So, trace of matrix (A^3-3A^2)

$$=\text{ Sum of Eigen values}$$
$$=(-2)+(-4)+0=-6$$

Hence, the trace of (A^3-3A^2) is – 6.

56. (A)

Given : Box contains 8 Red balls and 8 Green balls.

Two balls are drawn randomly in succession without replacement.

$\therefore$ Probability of first ball red and second ball green is

$$\frac{8}{16}\times\frac{8}{15}=\frac{4}{15}$$

Hence, the correct option is (A).

57. (A), (B), (C), (D)

Given : Matrix $A_{2\times 2}=\begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}$

Since A is symmetric i.e. $a_{ij}=a_{ji}$

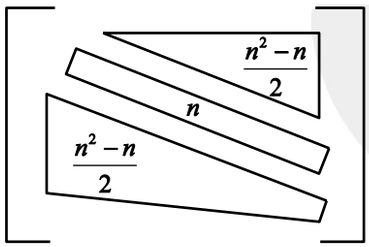
So, $a_{12}=a_{21}$, we have three possible places positions containing either 0 or 1 and it can be filled as,

$[a_{11}]$ $[a_{21}$ & $a_{12}]$ $[a_{22}]$

(0 or 1) (0 or 1) (0 or 1)

2 ways $\times 2$ ways $\times 2$ ways $=2^3$ ways

So, the total number of distinct symmetric matrix of order 2×2 with each element being 0 or $=2^3=8$ ways for $n\times n$ matrix



Total number of elements $=n^2$

Total number of elements $=n$

For symmetry, total possible positives $=\dfrac{n^2-n}{2}$

Total number of possible positions to be filled by either 0 or 1 $=\dfrac{n^2-n}{2}+n=\dfrac{n^2+n}{2}$

So, total number of ways to fill these positions with 0 or 1

$$=2\times 2\times 2\times .....\times 2\left\{\frac{n^2-n}{2}\text{ times}\right\}$$

$$=(2)^{\frac{n^2+n}{2}}$$

For $n=4: 2^{\frac{16+4}{2}}=2^{10}$

For $n=8: 2^{\frac{64+8}{2}}=2^{36}$

For $n=3: 2^{\frac{9+3}{2}}=2^{6}$

For $n=6: 2^{\frac{36+6}{2}}=2^{21}$

Hence, the correct options are (A), (B), (C) and (D).

58. (A)

Given : A matrix is defined as, $A=[a_{ij}]_{n\times n}$

where, $a_{ij}=\begin{cases} i, & i=j \\ 0, & \text{Otherwise} \end{cases}$

Thus, all the elements except diagonal are zero and diagonal elements are given by,

$$a_{11}=1,\ a_{22}=2,\ a_{33}=3,.....,a_{nn}=n$$

$$A=\begin{bmatrix} 1 & 0 & 0 & \cdots & 0 \\ 0 & 2 & 0 & \cdots & 0 \\ 0 & 0 & 3 & \cdots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & \cdots & n \end{bmatrix}_{n\times n}$$

The sum of all elements is given by the sum of its main diagonal elements.

$$=(1+2+3+.....+n)=\frac{n(n+1)}{2}$$

Hence, the correct option is (A).

59. 3

Given : A probability density function is as given below,

$$f(x)=\frac{e^{-\frac{x}{3}}}{G}\text{ and }x\in[0,\infty)$$

By the property of probability density function,

$$\int_{-\infty}^{\infty} f(x)\,dx=1 \quad\Rightarrow\quad \int_{0}^{\infty}\frac{e^{-\frac{x}{3}}}{G}dx=1$$

$$\frac{1}{G}\int_0^{\infty} e^{\frac{-x}{3}}dx=1$$

$$-3\left[e^{\frac{-x}{3}}\right]_0^{\infty}=G$$

$$-3(e^{-\infty}-e^{0})=G$$

$$K=3$$

Hence, the value of constant G is **3**.

60. (D)

Given : $f(y)=\lim_{y\to 0}\frac{1}{y}\int_0^y f(x)\,dx$

Let, $g(y)=\int_0^y f(x)dx$

Differentiating $g(y)$ with respect to y,

$$\frac{d}{dy}g(y)=f(y) \qquad \ldots(i)$$

Then, $f(y)=\lim_{y\to 0}\frac{g(y)}{y}$ $\qquad \ldots(ii)$

$$f(y)=\frac{g(0)}{0}$$

where, $g(0)=g(y)\big|_{y=0}$

$$g(0)=\int_0^{y=0} f(x)dx=0$$

So, $f(y)=\frac{0}{0}$

It is in the form of $\left(\frac{0}{0}\right)$, so applying L-Hospital's rule,

$$f(y)=\lim_{y\to 0}\frac{\frac{d}{dy}g(y)}{\frac{d}{dy}(y)}$$

From equation (i),

$$f(\mathrm{y})=\lim_{y\to 0}\frac{f(y)}{1}$$

$$f(y)=f(0)$$

Hence, the correct option is (D).

❖❖❖❖

12 General Aptitude

Practice Questions

Q.1 Select the option which is CLOSEST in meaning to the capitalized word.

PROTAGONIST

(A) Prophet (B) Opponent

(C) Explorer (D) Champion

Q.2 Select the option which is CLOSEST in meaning to the capitalized word.

RAVENOUS

(A) Treachery (B) Hungry

(C) Collection (D) Sadness

Q.3 Find out the choice that corrects the underlined part of the following sentence. The assistant was asked that why he was generally late

(A) Why was he

(B) Why that he was

(C) Why he was

(D) No correction required

Q.4 The following question is given with blank space. You are required to fill in the blank space with the most appropriate word out of the alternatives

Ravens appear to behave _____, actively helping one another to find food.

(A) Mysteriously (B) Aggressively

(C) Cooperatively (D) Defensively

Q.5 Choose the best word to complete the sentence

The student was extremely foolhardy; he had the _____ to question the senior professor's judgment

(A) Wisdom (B) Temerity

(C) Interest (D) Trepidation

Q.6 The question below consists of a pair of related words followed by four pairs of words. Select the pair that best expresses the relation in the original pair.

CURRENT : ELECTRICITY

(A) Scale : dimension

(B) Fabrication : metal

(C) Beam : light

(D) Ripple : Pond

Q.7 Given below is a statement followed by two conclusions. Assuming the statement to be true, decide which one logically follows

Statements : Cactus has thick leaves and requires little or no water.

Conclusions :

I. Any plant that has thick leaves can sustain with little or no water.

II. Cactus can survive in arid deserts.

(A) Conclusion I is implied

(B) Conclusion II is implied

(C) Both conclusion I and II are implied

(D) Neither conclusion I nor II are implied

Q.8 The question has a set of four statements. Each statement has three segments. Choose the alternative where the third segment in the statement can be logically deduced using both the preceding two, but not just from one of them.

(i) All religions teach values ; Sufism is a religion ; Sufism teaches values.

(ii) Buddhism is an oriental religion ; only oriental religion teach spirituality ; Buddhism teaches spirituality.

(iii) Theists believe in God ; atheists do not believe in God ; theists are not atheists.

(iv) Money is valuable ; character is valuable ; money is character.

(A) (iv) only

(B) (ii) only

(C) (i) only

(D) (i), (ii) and (iii)

Q.9 Find the missing letter

$\boxed{C} \times \boxed{F} \rightarrow \boxed{8}$

$\boxed{D} \times \boxed{G} \rightarrow \boxed{15}$

$\boxed{B} \times \boxed{?} \rightarrow \boxed{19}$

Note : For the above question vowels are not considered as part of alphabet

(A) Y (B) X

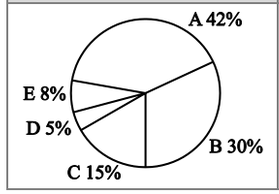
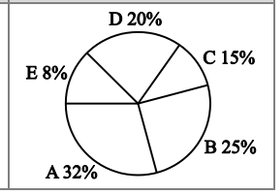
(C) W (D) Z

Q.10 A trader buys a certain amount of goods worth ₹ 22520. He decides to make a profit of 5.36% on the sale of goods worth ₹ 5000 and increase the profit percent by 3.14% for sales upto ₹ 15000 and then increase the profit percent for the sale of remaining lot such that he is able to make a profit of 25% on the sale of the full lot. Find the profit that he makes on the third lot of goods.

(A) ₹ 5620 (B) ₹ 3212

(C) ₹ 4512 (D) None of these

Q.11 The pie chart below shows the percentage of student's attempted different entrance examinations A, B, C, D and E respectively in 2005 and 2009

Distribution of student in 2005 (Total = 1,42,000)	**Distribution of student in 2009 (Total = 2,00,000)**
	

Between 2005 and 2009, by what percent the number of students increased in the exams A, B and D combined?

(A) 40.84 (B) 46.48

(C) 30.48 (D) 48.04

Q.12 Company Alpha buys free-travel coupons from people who are awarded the coupons by Bravo Airlines for flying frequently on Bravo Airplanes. The coupons are sold to people who pay less for the coupons than they would pay by purchasing tickets from Bravo. This marketing of coupons results in lost revenue for Bravo.

To discourage the buying and selling of free-travel coupons, it would be best for bravo Airlines to restrict the

(A) Number of coupons that a person can be a awarded in a particular year.

(B) Limiting use of the coupons to those who were awarded the coupons and members of their immediate families.

(C) Days that the coupons can be used from Monday through Friday.

(D) Amount of time that the coupons can be used after they are issued.

Q.13 Wine Company Representative : The corks of red wine bottles pose a threat to the environment because they are treated with chemicals that are especially toxic in landfills. However, the new cork that our company developed, which will be adopted by the entire red wine industry, represents a solution. Since the new cork is natural and not treated with chemicals, when the industry completes its transition to the new cork, there will no longer be any threat to landfills from red wine corks.

Which of the following, if true, most weakens the argument above?

(A) The industry's transition to the new red wine corks will take years, allowing thousands of old corks to pollute landfills.

(B) Even after the industry's transition to new corks, a large number of wine bottles with old corks will continue to be consumed.

(C) The new corks take considerably longer to produce.

(D) Production of the new cork emits more toxic fumes than were emitted in the production of the old cork.

Q.14 In a population of N families, 60% of families have three children, 20% of the families have two children and the remaining families have one child. What is the probability that a randomly picked child belongs to a family with two children?

(A) $\frac{3}{23}$ (B) $\frac{6}{23}$

(C) $\frac{3}{10}$ (D) $\frac{1}{6}$

Q.15 The sum of five consecutive even numbers A, B, C, D, and E is 130. The product of A and E is _____.

Q.16 If $\log_4 \frac{2}{x} + \log_{16} 0.5 = 2$, then

(A) $4\log_4 x = -7$ (B) $2\log_4 x = -7$

(C) $2\log_{16} x = -7$ (D) $\log_{16} x = -7$

Q.17 In a family, a couple has a son and a daughter. The age of the father is three times that of his daughter and the age of the son is half of his mother. The wife is 9 years younger to her husband and the brother is seven years older than his sister. What is the age of the mother?

(A) 40 years (B) 50 years

(C) 45 years (D) 60 years

Q.18 If x varies directly as y and inversely as z and if $x = a$ when $y = b$ and $z = c$, find x when $y = b^2$ and $z = c^2$

(A) $\frac{a^2}{b}$ (B) $\frac{a^2}{c}$

(C) $\frac{ab}{c}$ (D) $\frac{ac}{b}$

Q.19 Two trains travel in the same direction at speeds of 54 km/hr and 81 km/hr. A police man, who is siting in the faster train, passes the slower train in 50 sec. The length of the slower train in meter is _____.

Q.20 Ram reaches his office 20 min late if he walks at 6 km/hr from his house and he reaches 20 min early to the office if he walks at 8 km/hr from his house. Find the distance (in km) between his house to office.

Q.21 A, B and C can complete a piece of work in 8, 12 and 24 days respectively. If A and B work on the first days, B and C work on the second day and A and C work on the third day and the same pattern continues 4^{th} day onward, then in

how many days will the work be completed?

(A) 3 (B) 6

(C) 8 (C) 12

Q.22 A trapezium with parallel sides 2 cm and 12 cm is inscribed in a circle. If the height of the trapezium is 12 cm, then what is the perimeter of the trapezium?

(A) 26 cm (B) 38 cm

(C) 28 cm (D) 40 cm

Q.23 A conical tent is to accommodate 10 persons. Each person must have 6 meter square space to sit and 30 meter cube of air to breathe. What will be the height (m) of the cone?

Q.24 There are five hotels in a line. If 4 men go into hotel at 11 a m what is the probability that each go into a different hotel?

(A) $\frac{124}{125}$ (B) $\frac{24}{125}$

(C) $\frac{48}{125}$ (D) $\frac{48}{625}$

Q.25 Pick out the one alternative which can be used to substitute the underlined group of words correctly, without changing the meaning of the sentence.

It was <u>them who had left before I arrived</u>.

(A) They who has left before I had arrived

(B) Them who had went before I had arrived

(C) Them who had left before I had arrived

(D) They who had left before I arrived

Q.26 In each of the following question, identify the pair that best expresses a relationship similar to that expressed in the original pair.

PAIN : ANODYNE

(A) Speed : Cop

(B) Slag : Smelting

(C) Gear : Clutch

(D) Stain : Detergent

Q.27 The following question consists of some statements followed by options consisting of three statements put together in a specific order. Choose the option which indicated a valid argument logically related statements that is where the third statement is a conclusion drawn from the preceding statements.

P : All mothers love their sons.

Q : Indira loves her son.

R : Indira is a mother

S : Some mothers love their sons.

T : Indira loves only her son.

(A) PQR (B) PRQ

(C) PRT (D) RSQ

Q.28 Out of 83 students, 47 students like Hindi movies, 38 like English movies and 9 students like both Hindi and English movies. How many students like neither Hindi nor English movies?

(A) 9 (B) 6

(C) 7 (D) 16

Q.29 Read the following information carefully and answer the question given below :

(i) A, B, C, D, E, F and G are sitting around a circle and are facing the center.

(ii) G is second to the left of C, who is to the immediate left of F.

(iii) A is third to the left of E

(iv) B is between D and E

Which of the following is false?

(A) A is fourth to the right of E

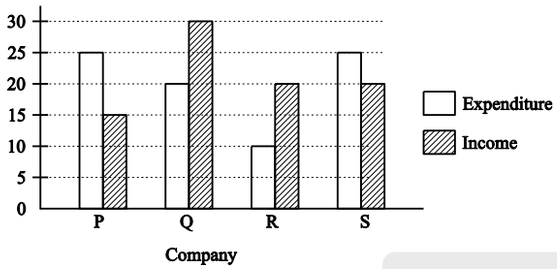
(B) G is to the immediate right of D

(C) F is third to the right of D

(D) B is to the immediate left of D

Q.30 Study the graph and answer the question that follows.

Income and expenditure (in crore Rs.) of four companies in the year 2014 is shown.



If the income of company Q in 2014 was 20% more than its income in 2013 and the company had earned a profit of 10% in 2013, then its expenditure in 2013 (in Crore Rs.) was _____(2 decimal places)

Q.31 The average life expectancy for the United States population as a whole is 73.9 years, but children born in Hawaii will live an average of 77 years, and those born in Louisiana, 71.7 years. If a newly wed couple from Louisiana were to begin their family in Hawaii, their children would live longer than if the couple began family in Louisiana.

Which of the following, if true, would most significantly strengthen the conclusion drawn in the passage?

(A) As population density increases in Hawaii, life expectancy figures for the state are likely to be revised downward

(B) Environmental factors tending to favor longevity are abundant in Hawaii and less numerous in Louisiana

(C) Over the last decade, average life expectancy has risen at a higher rate for Louisianans than for Hawaiians.

(D) Twenty-five percent of all Louisianans who move to Hawaii live longer than 22 years,

Q.32 "This text book is designed for use by Intermediate Students. This book is designed to develop interest in the English language."

Find out the strongest assumption/ interference :

1. The primary aim of any text book is to ignite curiosity and interest in students the subject taught.
2. English language is spoken all over the world.
3. It is necessary for all intermediate students to learn English language.
4. If we have proficiency in English language, it is easy to get a job.

(A) Only 1 (B) Only 3

(C) 1 and 4 (D) 1 and 3

Q.33 How many digits are there in 2^{27} ?

Note : $(\log 2 = 0.3010)$

(A) 8 (B) 9

(C) 10 (D) 27

Q.34 There are a certain number of chocolates in a box. Ajit takes 1 chocolates less than half the number of chocolates in the box, Burman takes 2 chocolates less than one-third of the remaining and then, Chanti takes 3 chocolates less than one-fourth of the remaining. If there are still 36 chocolates left in the box. What was the initial number of chocolates in the box?

(A) 63 (B) 124

(C) 186 (D) None of these

Q.35 A truck covers 448 km in 8 hours. The average speed of bicycle is $\frac{1}{4}$th of average speed of truck. The distance covered by bicycle in 7 hours is _____ km.

Q.36 The distance between two station A and B is 600 km. One train leaves station A towards station B at the average speed of 54 kmph. After an hour another train left station B towards station A at the average speed of 66 km per hour. The distance from station A where the two trains meet is _____ Kms.

Q.37 In a certain factory, each one of the a number of workers produces b pairs of shoes every c hours. If the workers work around the clock without any breaks, how many days are required to produce 1,000 pairs of shoes?

(A) $\frac{125c}{3ab}$ (B) $\frac{1000c}{ab}$

(C) $\frac{3a}{125bc}$ (D) $\frac{3c}{125ab}$

Q.38 A is 60% as efficient as B. C does half of the work done by A and B together. If C alone does the work in 80 days, then A, B and C together can do the work in

(A) $\frac{80}{3}$ (B) $\frac{50}{4}$

(C) $\frac{85}{3}$ (D) None of these

Q.39 How much water should be added to 150 litres of solution which contains 40% milk solution, to make the content of milk 30%?

(A) 40 litres (B) 20 litres

(C) 50 litres (D) 60 litres

Q.40 An isosceles ΔABC is inscribed in a circle such that one of its sides lies on the diameter of the circle. If the radius of the circle is 6 cm, find the area of the ΔABC.

(A) 108 cm^2 (B) 72 cm^2

(C) 54 cm^2 (D) 36 cm^2

Q.41 In a hall, there are 13 lamps among which 2 are of red, 2 are of green, 2 are of yellow and 2 are of blue colours and other 5 lamps of different colors. Each one of these except the two red lamps has a separate control switch. However, both the red lamps have one switch in common. Find the number of ways in which the hall can be illuminated by switching on any 4 lamps.

(A) 167 (B) 39

(C) 188 (D) 385

Q.42 The missing term in the following series is 128, 200, 288, …, 512

(A) 324 (B) 361

(C) 392 (D) 441

Q.43 If 50 dogs caught 50 chicks in 50 seconds then how many dogs are required to catch 1000 chicks in 1000 seconds.

(A) 100 (B) 1000

(C) 50 (D) 500

Q.44 In an examination, a student's average marks were 90 per paper. If she had obtained 5 more marks in her physics paper and 5 more marks in her mathematics paper, her average per paper would have been 92. How many papers were their in the examination?

(A) 5 (B) 10

(C) 8 (D) 11

Q.45 Munna gave milk to his three sons Dilharan, Nitesh and Saurabh, in three pots of the shapes of a hemisphere, a cube and a cuboid respectively. If radius

of hemispherical pot is 5 cm, side of cubic pot is 5 cm and sides of cuboid pot are $5\text{ cm}\times5\text{ cm}\times6\text{ cm}$, then who will get more milk?

(A) Dilharan (B) Nitesh
(C) Saurabh (D) Equal to all

Q.46 The question is followed by two statements I and II. Mark the answer as

(A) If the question can be answered with the help of statement I, alone.
(B) If the question can be answered with the help of statement II, alone.
(C) If both statement I and statement II are needed to answer the question.
(D) If the question cannot be answered even with the help of both the statement.

If x, y and z are real numbers, is $z - x$ even or odd?

(i) xyz is odd
(ii) $xy + yz + zx$ is even

Q.47 Two stations P and Q are 110 km apart on a straight line. One train starts from P at 7 am and travels towards Q at 20 kmph speed. Another train start from Q at 8 am and travels towards P at a speed of 25 kmph. At what time will they meet?

(A) 9 am (B) 10 am
(C) 10.30 am (D) 11 am

Q.48 In a chess competition involving some boys and girls of a school, every student had to play exactly one game with every other student. It was found that in 45 games both the players were girls and in 190 games both were boys. The number of games in which one player was a boy and the other was a girl is

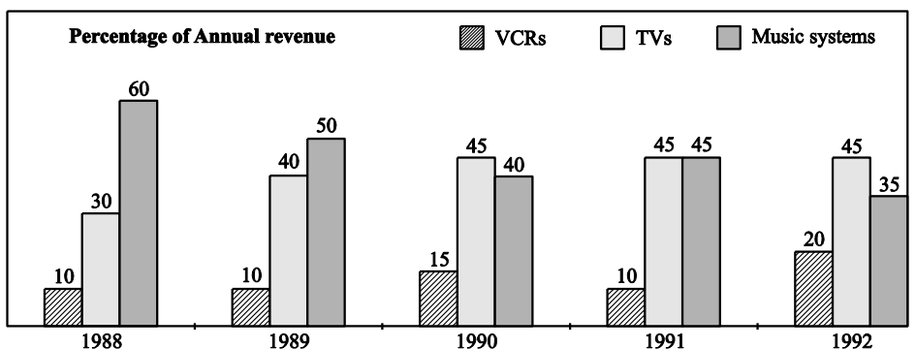
(A) 200 (B) 216
(C) 235 (D) 256

Q.49 In a certain code language 'SHASHI' is written as 'WLWWLE'. Then how is 'BRAJKISHOR' written in that code>

(A) FVWNOEWLKV
(B) FUEMNOWLVS
(C) FUENMOWMSV
(D) FVENNMWLSW

Q.50 Answer the following question based on the following graph

Annual revenue of XYZ corporation	
Year	**Revenue (Rs. lakhs)**
1988	20,000
1989	24,000
1990	29,600
1991	39,500
1992	52,500

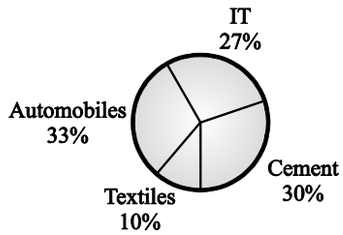


The greatest increase in the revenue over the previous year for VCRs was in :

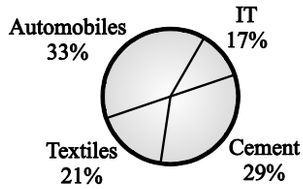
(A) 1989 (B) 1990 (C) 1991 (D) 1992

Q.51 Company *XYZ* has four major businesses – Automobiles, IT, Cement and Textiles. The two pie charts show the distribution of revenues and costs across these businesses for the year 2008. The total revenue for the year 2008 is 3000 crores and the company has made a profit of 600 crores in the same period.

Distribution of revenues



Distribution of costs



What is the approximate profit percentage for company *XYZ* in its textile business?

(A) 68% (B) – 40% (C) – 11% (D) – 68%

Q.52 Three numbers which are co-prime to each other are such that the product of the first two is 551 and that of the last two is 1073. The sum of three number is

(A) 85 (B) 80

(C) 75 (D) 65

Q.53 What is the remainder when

$(2!)^3 + (3!)^3 + (4!)^3 + (5!)^3 + ... + (n!)^3$

is divided by 5, where n is the largest 3-digit number?

(A) 1 (B) 2

(C) 3 (D) 4

Q.54 Choose the word which is most nearly the SAME in meaning as the word given in bold

TEDIOUS

(A) Husky (B) Boring

(C) Alarming (D) Deciduous

Q.55 Police encourages to report any crime witnessed by citizens as otherwise it could be taken as being _____ in that crime.

Complete the sentence using appropriate option.

(A) Disinterested (B) adept

(C) Absorbed (D) Complicit

Q.56 Select the word out of the options which correctly analyzes the underlined words

With her _____ hearing ability, Koushalya could here across the walls.

(A) inferior (B) poor

(C) keen (D) myopic

Q.57 In the following sentence, part of the sentence is left blank. Choose the best alternative among the four.

Reena made some _____ comments on her friend Richa and she was soundly chastised by her co-workers.

(A) Flattering

(B) Reverent

(C) Irreverent

(D) Complimentary

Q.58 Check for error in underlined part of the sentence.

It is common practice for a bank official to ask that a client presents an identification document of some kind before performing a transaction.

(A) No error

(B) Client present some sort of identification document.

(C) Client will present an identification document of some kind.

(D) Clients present an identification document of some kind.

Q.59 The below question contains statements and conclusions. Take the statements to be true and find out what conclusions can be drawn.

S1 : All eye drops are liquids.

S2 : Some eye drops are ear drops.

C1 : Liquids are drinkable.

C2 : Some eye drops are drinkable.

C3 : All liquids are eye drops.

C4 : Some ear drops are drinkable.

(A) I and II follow

(B) II, III and IV follow

(C) Only III follow

(D) None follow

Q.60 Read the statement or passage and then choose the best answer to the question. Answer the question on the basis of what is stated or implied in the statement or passage.

Myths are stories, the products of fertile imagination, sometimes simple, often containing profound truths. They are not meant to be taken too literally. Details may sometimes appear childish, but most myths express a culture's most serious beliefs about human beings, eternity, and God. The main idea of this passage is that myths

(A) Are created primarily to entertain young children

(B) Are purposely written for the reader who lacks imagination

(C) Provide the reader with a means of escape from reality

(D) Illustrate the values that are considered important to a society

Q.61 In order to offset the traffic snarls and the parking woes, the city police commissioner has devised a plan according to which, automobiles should be parked in the premises of temples and educational institutions.

Which of the following assumptions the police commissioner must be NOT making?

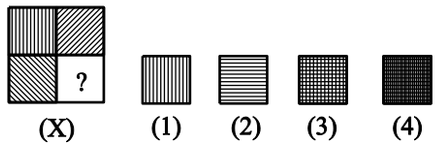
(A) Students rarely use the parking lot in their schools since they are accompanied by their elders.

(B) It is customary that places of worship should be visited on foot rather than otherwise.

(C) Typically the town planning department stipulates that every construction for the purpose of education or worship should invariably allocate one-third of the open place for parking.

(D) The congregations at places like education and worship symbolize tranquility and so are free from violence and noise.

Q.62 Identify the figure that completes the pattern.



(A) 1 (B) 2

(C) 3 (D) 4

Q.63 Given below are two premises, with four conclusions drawn from then (taking singly or together) which conclusions

are validly drawn? Select the correct answer from the codes given below :

(i) All bats are mammals.

(ii) Birds are not bats.

Conclusions :

(A) Birds are not mammals.

(B) Bats are not birds.

(C) All mammals are bats.

(D) Some mammals are not bats.

(A) A (B) B

(C) C (D) D

Q.64 Given below two premise and four conclusions are drawn from them (taking singly or together). Select the code that states the conclusion validly drawn.

Premises :

(i) All religious persons are emotional.

(ii) Ram is a religious person.

Conclusion :

(i) Ram is emotional.

(ii) All emotional persons are religious.

(iii) Ram is not a non- religious person.

(iv) Some religious persons are not emotional.

(A) Only conclusion (i) follows.

(B) Both conclusion (iii) and (iv) follows.

(C) Both conclusion (i) and (iii) follows.

(D) Only conclusion (iii) follows.

Q.65 The area of a square is d. What is the area of the circle which has the diagonal of the square as its diameter?

(A) πd (B) πd^2

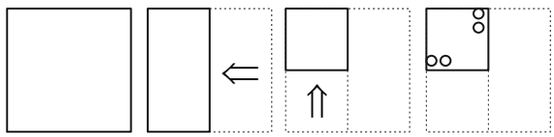
(C) $\left(\frac{1}{2}\right)\pi d^2$ (D) $\left(\frac{1}{2}\right)\pi d$

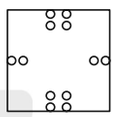
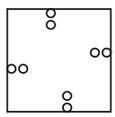
Q.66 28 persons are in a room. 15 of them play hockey, 17 of them play football and 10 of them play both hockey and football. Then the number of persons playing neither hockey nor football is :

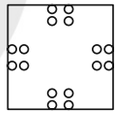
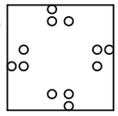
(A) 6 (B) 17

(C) 13 (D) 3

Q.67 A piece of paper is folded and punched as shown below in the question figures. From the given answer figures, indicated how it will appear when opened.

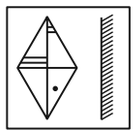


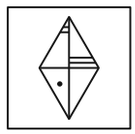
(A)  (B) 

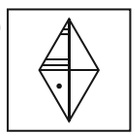
(C)  (D) 

Q.68 Choose the correct mirror image of given figure from given options:

Questions figure:



(A)  (B) 

(C)  (D) 

Q.69 Ten persons are sitting in two parallel rows. In row-1 A, B, C, D and E are sitting facing north. In row-2 P, Q, R, S and T are sitting facing south. The person in row-1 exactly faces the person in row-2.

R does not sit opposite to C. A sits second from extreme end. Only one person sits between one who faces A and Q. B is not an immediate neighbor of A and does not sits apposite to Q. E sits second to the left of B. T does not faces E and never sits at extreme end. S is not an immediate neighbor of T. C does not sit opposite to Q. Choose the pairs of person who sits on corners.

(A) PRCB (B) CBST

(C) ATBS (D) PSCB

Q.70 Select the option that is different from the other three options

(A) Resentful (B) Untroubled

(C) Desolate (D) Sad

Q.71 Find the unit digit in the expression $78^{5562} \times 56^{256} \times 97^{1250}$ _____.

Q.72 In a queue of fifteen people facing North, Rahul's position is ninth from the end of the queue only four people are standing between Rahul and Tom. Karan is standing immediately after Tom. Bharti is standing exactly between Karan and Rahul. Sonali is standing before Bharti, but after Tom. What is the position of Sonali from beginning of the queue?

[**Note :** All people are standing one behind the other].

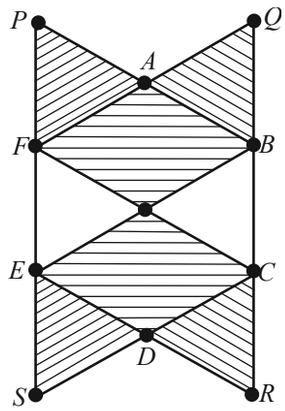
(A) Seventh

(B) Eleventh

(C) Fourth

(D) Cannot be determined

Q.73 In the given figure *ABCDEF* is a regular hexagon whose. Side is 6 cm. *APF*, *QAB*, *DCE* and *DES* are equilateral triangles. What is the area (in cm^2) of the shaded region?



(A) $24\sqrt{3}$ (B) $13\sqrt{3}$

(C) $72\sqrt{3}$ (D) $36\sqrt{3}$

Q.74 In the question given below are given three statements followed by three conclusion I, II and III. You have to take the given statements to be true if they seen to be variance from commonly known facts. Read all the conclusions and decide which of the given conclusion logically follows from the given statements disregarding commonly known facts.

Statements :

Some nurses are doctors

All doctors are medicine

Some medices are tablet

Conclusion :

I. At least some tablets are doctors.

II. Some medicines are doctor is a possibility.

III. Some medicines are definitely nurses.

(A) I and II follows

(B) II and III follows

(C) Either III or IV follows

(D) None of these

Q.75 Let A, B, C be three events such that $P(A)=0.3, P(B)=0.4, P(C)=0.8$, $P(A\cap B)=0.08, P(A\cap C)=0.28$, $P(A\cap B\cap C)=0.09$.

If $P(A \cup B \cup C) \geq 0.75$, then

(A) $0.23 \leq P(B \cap C) \leq 0.48$

(B) $0.23 \leq P(B \cap C) \leq 0.75$

(C) $0.48 \leq P(B \cap C) \leq 0.75$

(D) $0.23 \leq P(A \cap C) \leq 0.75$

Answers General Aptitude

1.	D	2.	B	3.	C	4.	C	5.	B
6.	C	7.	B	8.	D	9.	B	10.	B
11.	A	12.	B	13.	B	14.	D	15.	660
16.	B	17.	D	18.	C	19.	375	20.	16
21.	B	22.	D	23.	15	24.	B	25.	D
26.	D	27.	B	28.	C	29.	C	30	22.77
31.	B	32.	A	33.	B	34.	B	35.	98
36.	299.7	37.	A	38.	A	39.	C	40	D
41.	D	42.	C	43.	C	44.	A	45.	A
46.	A	47.	B	48.	A	49.	A	50.	D
51.	B	52.	A	53.	C	54.	B	55.	D
56.	C	57.	C	58.	B	59.	D	60.	D
61.	B	62.	B	63.	B	64.	C	65.	D
66.	A	67.	C	68.	B	69.	D	70.	B
71.	6	72.	C	73.	C	74.	D	75.	A

Explanations General Aptitude

1. (D)

Prophet : A person who proclaims the will of God.

Explorer : Someone who explores new area.

Protagonist : Champion of some cause or idea, leading character.

Hence, the correct option is (D).

2. (B)

Ravenous : Extremely hungry, famished or intense eager for gratification or satisfaction.

Treachery : Violation of faith, betrayal of trust, treason.

Hence, the correct option is (B).

3. (C)

Rule :

(i) The conjunction 'that' will not be used in indirect speech (interrogative sentence).

(ii) In interrogative sentence of indirect speech, the question is changed into assertive form.

So, options (B) and (D) can be easily eliminated. Only option (C) logically follows the flow of sentence (rule 2).
Hence, the correct option is (C).

4. (C)

This sentence asks you to look for a word that describes how the ravens behave.
Rule : The information after the comma restates and defines the meaning of the missing word.
Actively helping one another to find food, clearly tells how cooperative they are.
Hence, the correct option is (C).

5. (B)

The semicolon indicates that the second part is closely related to the first.
So, since the student was foolhardy (reckless) he was doing something unwise.
Wisdom : State of being wise. (Opposite in meaning)
Temerity : Reckless boldness or rashness. (Most suitable)
Trepidation : Fear and hesitation. (Opposite in meaning)
Hence, the correct option is (B).

6. (C)

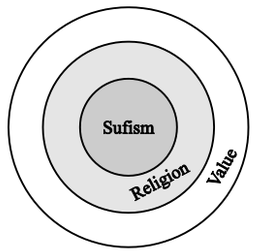
(DEFINING CHARACTERISTIC)
Electricity is transmitted as a current.
Light is transmitted as a beam.
Hence, the correct option is (C).

7. (B)

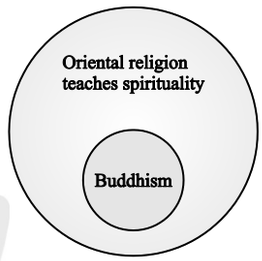
Conclusion I is extreme since we have no information about other plants.
Conclusion II is correct because the statement explicitly mentions that cactus requires little water and it can be concluded that cactus can sustain in arid or dry deserts.
So, it can be inferred that only conclusion II is implied.
Hence, the correct option is (B).

8. (D)

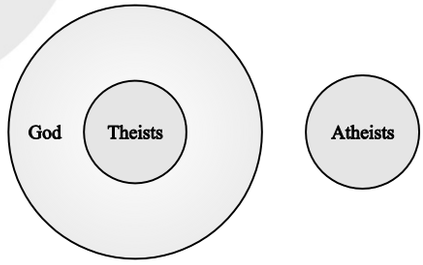
Observe the following Venn diagram :
(i)



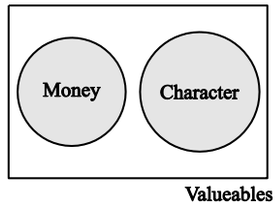
(ii)

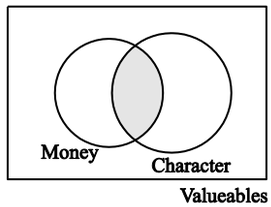


(iii)



(iv)





In statements (i), (ii) and (iii), the third segment logically follows its preceding segments.
But in statement (iv) it can be clearly observed that, the third segment is ambiguous since, there

are two possible ways from the preceding two statements.

Hence, the correct option is (D).

9. (B)

The alphabets (excluding vowels) can be number-coded as below :

	1	2	3		4	5	6		7	8	9	10	11
X	B	C	D	**X**	F	G	H	**X**	J	K	L	M	N
	12	13	14	15	16		17	18	19	20	21		
X	P	Q	R	S	T	**X**	V	W	X	Y	Z		

Checking the given two equations :

$C \rightarrow 2$ $\quad F \rightarrow 4$ $\quad 2 \times 4 = 8$

$D \rightarrow 3$ $\quad G \rightarrow 5$ $\quad 3 \times 5 = 15$

So, the third equation can be solved as :

$$\boxed{B} \times \boxed{?} \rightarrow \boxed{19}$$

Putting, $B \rightarrow 1$

$$1 \times ? = 19 \implies ? = 19$$

Therefore,

$$? = 19$$

Hence, the correct option is (B).

10. (B)

C.P. of goods for the trader = ₹ 22520

$$\text{S.P.} = \frac{125}{100} \times 22520 = ₹\, 28150$$

$\therefore$ Profit = ₹ 5630

Now, $5630 = 0.0536 \times 5000 + 0.085 \times 10000 + \frac{x}{100} \times 7520$

$$5630 = 268 + 850 + 75.2x$$

$75.2x =$ ₹ 4512 (where, $x = 60$)

Which is nothing but profit from sale of third lot.

Hence, the correct option is (B).

11. (A)

The number of students appeared in exams A, B and D combined in 2005

$$= (42 + 30 + 5)\% = 77\% \text{ of } 142000$$

$$= \frac{77}{100} \times 142000$$

The number of students appears for exams A, B and D combined in 2009

$$= (32 + 25 + 20)\% = 77\% \text{ of } 200000$$

$$= \frac{77}{100} \times 200000$$

Percentage increase is given by,

$$= \frac{\frac{77}{100} \times 200000 - \frac{77}{100} \times 142000}{\frac{77}{100} \times 142000} \times 100$$

$$= \frac{200000 - 142000}{142000} \times 100$$

$$= \frac{58000}{142000} = 40.84\%$$

Hence, the correct option is (A).

12. (B)

Company alpha is causing a loss to Bravo by marketing the coupons. So, Bravo has to devise a plan which can restrict Alpha company from buying and selling coupons.

The best plan is stated in option (B) i.e. by limiting the use of the coupons to those who were awarded the coupons and members of their immediate family.

Hence, the correct option is (B).

13. (B)

Options (A) and (C) are considering the time it takes for transition as a problem. But it does not weaken the argument stated.

Option (D) considers the problem of toxic fumes emitted in the production which is not the part of above argument.

Option (B) : If true, then also the threat of landfills will be prevalent and therefore weakens above argument.

Hence, the correct option is (B).

14. (D)

Let us consider total number of families $= 100$

In that 60% of families having 3 children

i.e., $60 \times 3 = 180$ (Number of children)

Likes that 20% have 2 children $= 20 \times 2 = 40$

20% have 1 children $= 20 \times 1 = 20$

Probability of choosing a children the family have two children

$$= \frac{40}{(180+40+20)} = \frac{40}{240} = \frac{1}{6}$$

Hence, the correct option is (D).

15. 660

Given : Let $A = x - 4$

$B = x - 2$

$C = x$

$D = x + 2$ and $E = x + 4$

According to the question,

$$(x-4)+(x-2)+(x) + (x+2)+(x+4) = 130$$

$$5x = 130 \implies x = 26$$

Thus, $A = 22$ and $E = 30$

$$A \times E = 22 \times 30 = 660$$

Hence, the correct answer is 660.

16. (B)

$$\log_4 \frac{2}{x} + \log_{16} 0.5 = 2$$

Property : $\log_{a^m} x = \frac{1}{m} \log_a x$

$$\log_4 \frac{2}{x} + \log_{4^2} \frac{1}{2} = 2$$

$$\log_4 \frac{2}{x} + \frac{1}{2} \log_4 \frac{1}{2} = 2$$

$$\left(\log_4 2 - \log_4 x\right) + \frac{1}{2} \log_4 \frac{1}{2} = 2$$

$$\log_4 x = \log_4 2 - \frac{1}{2} \log_4 2 - 2$$

$$\log_4 x = \frac{1}{2} \log_4 2 - 2$$

$$\log_4 x = \frac{1}{2} \times \frac{1}{2} - 2 = -\frac{7}{4}$$

$$4 \log_4 x = -7$$

Hence, the correct option is (A).

17. (D)

Let the age of mother be x years

Age of the son $= \frac{x}{2}$ years

and the age of the daughter $= \left(\frac{x}{2} - 7\right)$ years

and the age of the father $= 3\left(\frac{x}{2} - 7\right)$ years

$$3\left(\frac{x}{2} - 7\right) - x = 9$$

$$\frac{3x}{2} - x - 21 = 9$$

$$\frac{x}{2} = 30$$

$$x = 30 \times 2 = 60 \text{ years}$$

Hence, the correct option is (D).

18. (C)

Given : $x \propto \frac{y}{z}$

$$x = \frac{ky}{z} \quad (k \text{ is constant})$$

When $y = b,\ z = c\ ;\ x = a$

$$a = \frac{kb}{c} \implies k = \frac{ac}{b}$$

When $y = b^2$ and $z = c^2$,

$$x = \frac{ky}{z} = \frac{ac}{b} \times \frac{b^2}{c^2} = \frac{ab}{c}$$

Hence, the correct option is (C).

19. 375

Let x be the length of slower train.

Time taken by faster train to pass slower train

$$= \frac{x}{(81-54) \times \frac{5}{18}} = 50$$

$$\frac{x}{22.5 - 15} = 50$$

$$x = 375$$

Hence, the correct answer is 375.

20. 16

Let the usual time taken be 't' hrs and speed be 'x' km/hr.

$$\text{Distance} = xt = 6\left(t + \frac{20}{60}\right) = 8\left(t - \frac{20}{60}\right)$$

$$2(3t+1) = \frac{8}{3}(3t-1)$$

$$6(3t+1) = 8(3t-1)$$

$$6t = 14 \Rightarrow t = \frac{7}{3}$$

$$\text{Distance} = 6\left(\frac{7}{3} + \frac{1}{3}\right) = 6 \times \frac{8}{3} = 16 \text{ km}$$

Hence, the correct answer is 16.

21. (B)

$$\text{Work done on the first day} = \frac{1}{8} + \frac{1}{12} = \frac{5}{24}$$

$$\text{Work done on the second day} = \frac{1}{12} + \frac{1}{24} = \frac{3}{24}$$

$$\text{Work done on the third day} = \frac{1}{8} + \frac{1}{24} = \frac{4}{24}$$

Work done in the first three days

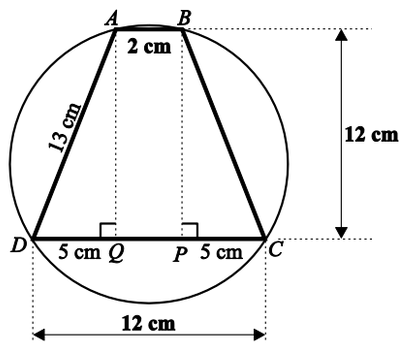
$$= \frac{5}{24} + \frac{3}{24} + \frac{4}{24} = \frac{12}{24} = \frac{1}{2}$$

$\because$ $\frac{1}{2}$ work is done in 3 days.

Thus, the work will be completed in 6 days.

Hence, the correct option is (B).

22. (D)



Any trapezium inscribed in a circle is always an isosceles trapezium.

$$AD = BC \text{ and } DQ = PC = 5 \text{ cm}$$

Now, in ΔAQD, right angle is at Q,

$$AQ^2 + QD^2 = AD^2$$

$$AD = 13 \text{ cm}$$

Perimeter of trapezium

$$= (2+12+13+13) = 40 \text{ cm}$$

Hence, the correct option is (D).

23. 15

Given : Each person occupies area of 6 m^2.

10 person occupies area of $6 \times 10\ m^2 = 60\ m^2$

(which is πr^2 where r is the radius of base)

Each person need volume of 30 m^3 to breathe.

10 person occupies volume of 300 m^3.

The volume of cone $\frac{1}{3}\pi r^2 h = 300\ m^3$

Now $\pi r^2 = 60$, thus the above expression becomes $\left(\frac{1}{3}\right) \times 60 \times h = 300$

$$h = 15 \text{ m}$$

Hence, the correct answer is 15.

24. (B)

Four men can go in five hotels in $5 \times 5 \times 5 \times 5 = 5^4$ ways

Number of ways in which 4 men can go into different hotel $= {}^5P_4 = \frac{5!}{(5-4)!} = 5!$

$$\text{Required probability} = \frac{5!}{5^4} = \frac{120}{625} = \frac{24}{125}$$

Hence, the correct option is (B).

25. (D)

The most suitable flow of sentence is

It was they who had left before I arrived.

Hence, the correct option is (D).

26. (D)

Defining characteristics

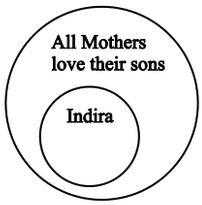
The function of anodyne is to reduce pain.

The function of detergent is to remove stain.

Hence, the correct option is (D).

27. (B)

Observe the following Venn diagram :

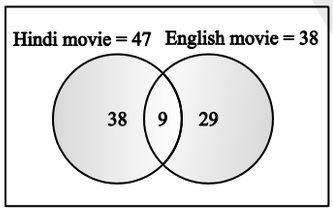


Hence, the correct option is (B).

28. (C)

47 like Hindi movie, 9 like both Hindi and English.

Hence, only Hindi movie $=47-9=38$



38 Like English movie, 9 like both English and Hindi movie.

Hence, only English movie $=38-9=29$

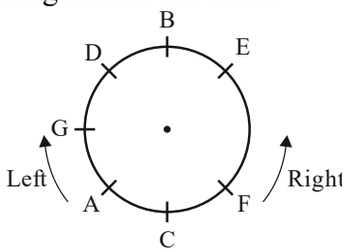
Required number of student

$$=83-(38+29+9)=7$$

Hence, the correct option is (C).

29. (C)

Given figure shows the correct position of persons sitting around the circle.



Clearly, F is fourth to the right of D.

Hence, the correct option is (C).

30. 22.77

Profit is computed on expenditure.

Let income of company Q in 2013 = Rs. x Crore

According to question the income of Q in 2014 is 20% more than that in 2013.

So, $30=\frac{120}{100}x$

$x=25$ Crore

Let expenditure of Q in 2013 be Rs. E Crore

Then,

$$\text{Profit \%} = \frac{\text{Income}-\text{Expenditure}}{\text{Expenditure}}\times 100$$

$$10=\left(\frac{25-E}{E}\right)\times 100$$

$$10=\left(\frac{25}{E}-1\right)\times 100$$

$$E=25\times\frac{10}{11}=22.77$$

Expenditure of Q in 2013 = Rs.22.77 Crore

Hence, the correct answer is 22.77.

31. (B)

Option (A) and (C) will weaken the asked conclusion. Between option (B) and (D), if true, option (B) will strengthen the conclusion.

Hence, the correct option is (B).

32. (A)

Option (B), (C) and (D) has irrelevant information's.

Only option (A) is the strongest interference from the given statement.

Hence, the correct option is (A).

33. (B)

Given : $(\log 2=0.3010)$

Let, $x=2^{27}$

Taking $\log_{10}$ on both sides,

$$\log_{10}2^{27}=27\log_{10}2$$

$$\log_{10} 2^{27} = 27 \times 0.3010$$

$$\log_{10} 2^{27} = 8.127$$

Taking antilog on both sides,

$$2^{27} = 10^{8.127} \Rightarrow [9 \text{ digits}]$$

Hence, the correct option is (B).

34. (B)

Let N be the number of chocolates in the box

Number of chocolates left after Ajit has taken

$$= \frac{N}{2} + 1$$

Number of chocolates left after Burman has taken $= \frac{2}{3}\left[\frac{N}{2} + 1\right] + 2 = \frac{N}{3} + \frac{8}{3}$

Number of chocolates left after Chanti has taken

$$= \frac{3}{4}\left[\frac{N}{3} + \frac{8}{3}\right] + 3 = \frac{N}{4} + 5$$

According to question,

$$\frac{N}{4} + 5 = 36 \Rightarrow \frac{N}{4} = 31$$

$$N = 124$$

Hence, the correct option is (B).

35. 98

Given : A truck covers 448 km in 8 hours.

Average speed of truck

$$= \frac{\text{Distance covered}}{\text{time taken}} = \frac{448}{8} = 56 \text{ kmph}$$

According to question,

Average speed of bicycle

$$= \frac{1}{4} \times \text{Average speed of truck}$$

$$= \frac{1}{4} \times 56 = 14 \text{ kmph}$$

Distance covered by bicycle in 7 hours

$$= 14 \times 7 = 98 \text{ km}$$

Hence, the correct answer is 98.

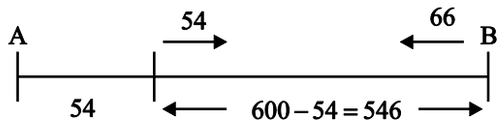
36. 299.7

Given : Distance between A and B is 600 km

Speed of first train = 54 km/hr

Speed of second train $= 66 \text{km/hr}$

But 2nd train leaves 1 hr after the first. So first train has covered 54 km



Relative speed $= 54 + 66 = 120$ km/hr

Time taken $= \frac{546}{120} = 4.55$ hr

First train travels $((54 \times 4.55) + 54)$ km i.e. 299.7 km by the time they meet.

Hence, the correct answer is 299.7.

37. (A)

One worker takes 'c' hours to produce 'b' pairs of shoes.

Thus, each worker produces $\frac{b}{c}$ pairs of shoes per hour.

'a' number of worker produce $\frac{ab}{c}$ pairs of shoes per hour.

Therefore, in one day $24 \times \frac{ab}{c}$ pairs of shoes are produced.

So, to produce one pair of shoes, days required

$$= \frac{c}{24ab} \text{ days}$$

Days required to produce 1000 pairs of shoes is given by,

$$1000 \times \frac{c}{24ab} = \frac{125c}{3ab}$$

Hence, the correct option is (A).

38. (A)

Given : C can do a work in 80 days.

So, C's one day work $= \frac{1}{80}$

According to question, C does half of the work done by $(A+B)$

$$\frac{1}{80}=\frac{A+B}{2}$$

So, $(A+B)'s$ one day work $=\frac{1}{40}$

$(A+B+C)'s$ one day work

$$=\frac{1}{80}+\frac{1}{40}=\frac{3}{80}$$

$(A+B+C)$ can do $\frac{3}{80}$ work in 1 day.

$(A+B+C)$ can do the work in $\frac{80}{3}$ days.

Hence, the correct option is (A).

39. (C)

Quantity of milk present in the solution = 40% of 150 = 60

Quantity of water present in the solution = 60% of 150 = 90

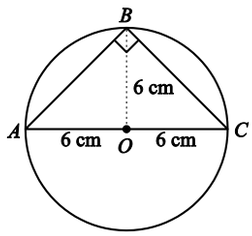
Let us add x litres of water to make 30% milk solution (i.e. 70% water)

So, $90+x=70\%$ of $(150+x)$

$$\frac{90+x}{150+x}=\frac{7}{10}\Rightarrow x=50$$

Hence, the correct option is (C).

40. (D)



As one of its sides lies on the diameter therefore it is a right angled isosceles triangle

Area of $\Delta ABC=\frac{1}{2}\times AC\times BO$

$$=\frac{1}{2}\times 12\times 6=36\text{ cm}^2$$

Hence, the correct option is (D).

41. (D)

Given : In a hall, there are 13 lamps (2 Red, 11 others).

Both the 2 Red lamps have a common switch.

All the 11 other lamps have separate control switches.

So, total switches = 12

To switch on 4 lamps, the possible ways are

Case I : Both Red lamps are ON.

1 Switch for 2 Red lamps.

2 More switches can be selected for 2 more lamps out of 11 remaining switches.

So, the number of possible ways to switch ON 4 lamps is,

$$1\times {}^{11}C_2={}^{11}C_2$$

Case II : None of the Red lamps are ON.

4 switches can be selected for 4 lamps out of 11 switches (Red not considered).

So, the number of possible ways to switch ON 4 lamps is, ${}^{11}C_4$

Thus, total possible ways $={}^{11}C_2+{}^{11}C_4$

$$=\frac{11!}{2!\times 9!}+\frac{11!}{4!\times 7!}=385$$

Hence, the correct option is (D).

42. (C)

$4^2\times 8=128$ $\quad$ $6^2\times 8=288$

$8^2\times 8=512$

$5^2\times 8=200$ $\quad$ $7^2\times 8=392$

Hence, the correct option is (C).

43. (C)

50 dogs catch 50 chicks in 50 seconds, so in 1000 seconds, 50 dogs will catch

$$\frac{M_1H_1}{W_1}=\frac{M_2H_2}{W_2}$$

where, $M_1 = 50$ dogs, $H_1 = 50$ sec,

$W_1 = 50$ chicks, $H_2 = 1000$ sec,

$W_2 = 1000$ chicks.

So, $M_2 = 50$

Hence, the correct option is (C).

44. (A)

Given : Average marks per paper $= 90$

Let us assume total number of paper $= x$

and sum of marks in all the papers $= y$

$$\text{Average} = \frac{\text{Sum of marks}}{\text{number of papers}} = \frac{y}{x}$$

$$90 = \frac{y}{x} \quad \Rightarrow \quad y = 90x$$

According to question,

$$92 = \frac{y+5+5}{x}$$

$$92 = \frac{90x+10}{x}$$

$$92x - 90x = 10$$

$$2x = 10$$

$$x = 5$$

Hence, the correct option is (A).

45. (A)

Amount of milk for Dilharan:

Volume of the hemispherical pot

$$= \frac{2}{3} \times \pi r^3$$

$$= \frac{2}{3} \times \frac{22}{7} \times (5)^3$$

$$= 261.90 \text{ cm}^3$$

Amount of milk for Nitesh:

Volume of the cubic pot $= (5)^3 = 125$ cm^3

Amount of milk for Saurabh:

Volume of the cuboid pot $= 5 \times 5 \times 6 = 150$ cm^3

Since, volume of hemispherical pot is maximum, therefore Dilharan will get the maximum milk.

Hence, the correct option is (A).

46. (A)

From statement I, we can say that all three of them are odd. Hence, (z – x) is even. So, only statement I is sufficient to answer the question.

Hence, the correct option is (A).

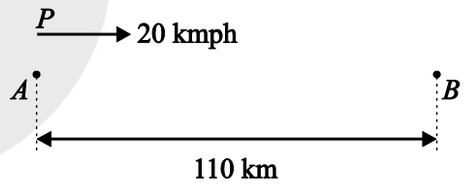
47. (B)

Given : Two stations are 110 km apart.

Let, the two stations are A and B.

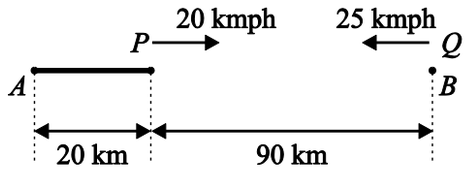
At 7 am :

The train *P* starts from *A* towards *B* at a speed of 20 kmph.



At 8 am : Train *P* has covered a distance of $20\left(\frac{\text{km}}{\text{hr}}\right) \times 1(\text{hr}) = 20\,\text{km}$ and continues towards *B*.

The train *Q* starts from *B* towards *A* at a speed of 25 kmph.



Remaining distance of 90 km is covered by both the trains.

So, relative speed $= 25 + 20 = 45$ kmph

They meet after $= \frac{90}{45} = 2\,\text{hrs}$ i.e. 2 hrs after 8 am

i.e. $8 + 2 = 10$ am

Hence, the correct option is (B).

48. (A)

Let there be g girls and b boys.

Number of games between two girls,

$${}^{g}C_2 = 45$$

$$\frac{g(g-1)}{2} = 45$$

$$g^2 - g - 90 = 0 \Rightarrow (g-10)(g+9) = 0$$

$$g = 10 \text{ and } g = -9 \Rightarrow g = 10$$

(number of girls cannot be negative)

Number of games between two boys,

$${}^{b}C_2 = 190$$

$$\frac{b(b-1)}{2} = 190$$

$$b^2 - b - 380 = 0 \Rightarrow (b-20)(b+19) = 0$$

$$b = 20 \text{ and } b = -19 \Rightarrow b = 20$$

(number of boys cannot be negative)

The total number of games

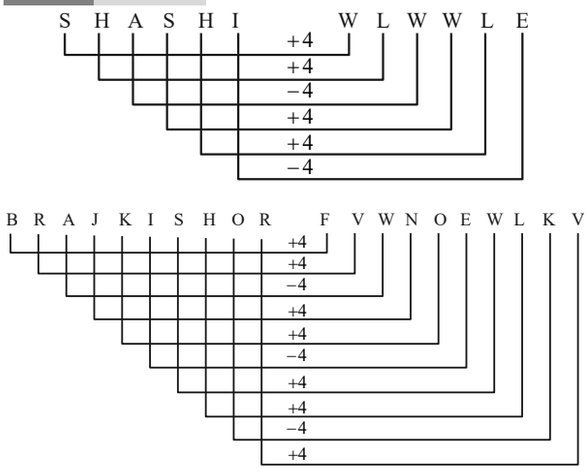
$$= {}^{(g+b)}C_2 = {}^{30}C_2 = \frac{30 \times 29}{2 \times 1} = 435$$

Number of games in which one player is a boy and the other is a girl

$$= 435 - 45 - 190 = 200$$

Hence, the correct option is (A).

49. (A)



For consonant : + 4

For vowel : – 4

Hence, the correct option is (A).

50. (D)

Annual revenue for VCRs in Rs. lakhs	
1988	$0.1 \times 20000 = 2000$
1989	$0.1 \times 24000 = 2400$
1990	$0.15 \times 29600 = 4440$
1991	$0.1 \times 39500 = 3950$
1992	$0.2 \times 52500 = 10500$

From the above table, it is clear that the greatest increase in revenue is observed in 1992.

Hence, the correct option is (D).

51. (B)

Total revenues = 3000 crore

Total profit = 600 crore

Key Point

Cost + [Profit (+ve) or Loss (– ve)] = Revenue

Total cost = 3000 – 600 = 2400 crore

Now, share of textiles in the total revenues

$= 10\%$ i.e. $0.1 \times 3000 = 300$ crore

Similarly, share of textiles in the total cost

$= 21\%$ i.e. $0.21 \times 2400 = 504$ crore

Now, profit for the textiles division

= revenues – cost = 300 – 504

= – 204 crores (Loss of 204 crore)

Therefore, profit percentage $= \frac{\text{Profit}}{\text{Cost}} \times 100$

$$= -\frac{204}{504} \times 100 = -40.47\%$$

Hence, the correct option is (B).

52. (A)

Co-prime numbers have 1 as the common factor.

So middle number = H.C.F of 551 and 1073 = 29

$$\text{First number} = \frac{551}{29} = 19$$

$$\text{Third number} = \frac{1073}{29} = 37$$

Sum of three numbers = 19 + 29 + 37 = 85
Hence, the correct option is (A).

53. (C)

Terms beyond 4! will have 5 as a factor and hence are divided by 5.
So, Remainder will be zero for numbers beyond 4!.
Hence, the remainder will be the same when, $(2!)^3+(3!)^3+(4!)^3$ is divided by 5.
The remainder when these numbers are divided by 5 are as follows :

$$\text{Rem}\frac{(2!)^3}{5}=3$$

$$\text{Rem}\frac{(3!)^3}{5}=1$$

$$\text{Rem}\frac{(4!)^3}{5}=\text{Rem}\frac{(24)^3}{5}=4$$

So, the final remainder of $\frac{(3+1+4)}{5}$ is 3.
Hence, the correct option is (C).

54. (B)

Husky : Muscular and heavily built.
Boring : Lacking in interest, tedious.
Alarming : Frightening, causing fear.
Deciduous : Being shed at the end of a period of growth.
Hence, the correct option is (B).

55. (D)

'Complicit' means involved in a questionable act or a crime. The words in the other options do not support the reference to the context of the sentence.
Hence, the correct option is (D).

56. (C)

"Keen" means being extremely sensitive or responsive. Since, Koushalya could hear across the walls, she must be having extremely sensitive hearing ability.
Hence, the correct option is (C).

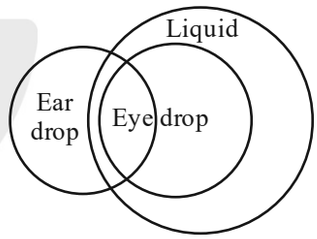
57. (C)

"Irreverent" means lacking respect or seriousness. Since, Reena was chastised by her co-workers, she must have made some disrespecting comments on her friend Richa.
Hence, the correct option is (C).

58. (B)

'Ask' is one of the 9 verbs to which the subjunctive rule applies (if it is followed by 'that'). This means that the next verb after 'ask that' should be in base form. Therefore, 'present' will be used.
Hence, the correct option is (B).

59. (D)



C1 : Liquid are drinkable. Does not follow as the variable drinkable is not present in statement.
C2 : Some eye drop are drinkable. Does not follow, as the variable drinkable is not present in statement.
C3 : All liquid are eye drops. Does not follow, as seen in the diagram.
C4 : Some ear drop are drinkable. Does not follow, as the variable drinkable is not present in the statement.
Hence, the correct option is (D).

60. (D)

The passage states that myths are stories that often contain profound truths and they express a culture's belief. Therefore, the main idea of this passage is that myths illustrate the values that are considered important to a society.
Hence, the correct option is (D).

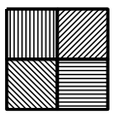
61. (B)

Assuming that places of worship and education are visited bare-foot does not mean that people do not use vehicles to reach them.

Thus, this is the assumption which cannot be logically made by the city police commissioner.

Hence, the correct option is (B).

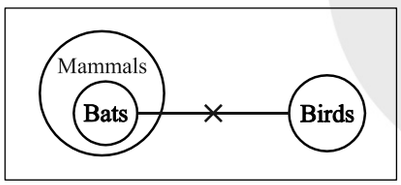
62. (B)



Hence, the correct option is (B).

63. (B)

The Venn diagram according to the given premises is as follows :



Given conclusions :

(A) Birds are not mammals.

False, from Venn diagram we can't say that birds are not mammals.

(B) Bats are not birds.

True, from Venn diagram we can say that bats are not birds.

(C) All mammals are bats.

False, all bats are mammals, but we can't say all mammals are bats.

(D) Some mammals are not bats.

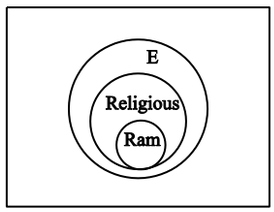
False, from Venn diagram we can't say that some mammals are not bats.

So, conclusion statements 'B' is true.

Hence, the correct option is (B).

64. (C)

The Venn diagram according to the given premises is as follows :



Conclusion :

(a) Ram is emotional.

True, from Venn diagram we can say that ram is emotional.

(b) All emotional persons are religious.

False, from Venn diagram we can say that all religious persons are emotional but not all emotional persons are religious.

(c) Ram is not a non-religious person.

True, from Venn diagram we can say that ram is a religious person.

(d) Some religious persons are not emotional.

False, from Venn diagram we can say that all religious person are emotional but we can't say that all emotional person are religious.

So, conclusion statements (a) and (c) are correct.

Hence, the correct option is (C).

65. (D)

Given : Area of a square $= d$

As we know

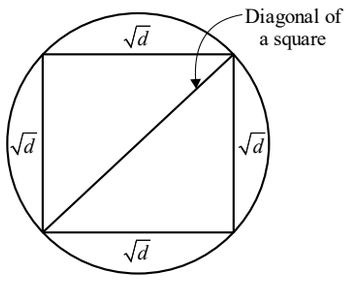
Area of a square $A = a^2$ (where a is side)

So, from the question,

$\because$ Area of a square $= d$

$\therefore$ The side of a square $= \sqrt{d}$

& Diagonal of a square = Diameter of circle



From Pythagoras theorem,

Diagonal of a square $= \sqrt{(\sqrt{d})^2 + (\sqrt{d})^2} = \sqrt{2d}$

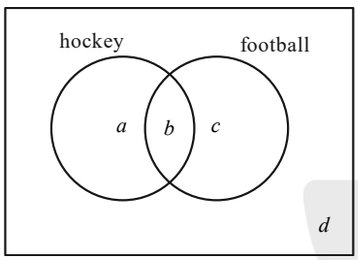
Radius of a circle $= \frac{\sqrt{2d}}{2} = \sqrt{\frac{d}{2}}$

Area of a circle $= \pi r^2 = \pi \times \sqrt{\frac{d}{2}} \times \sqrt{\frac{d}{2}} = \frac{\pi d}{2}$

Hence, the correct option is (D).

66. (A)

From given conditions we can draw a diagram as follows :



and let total number of persons

$= a + b + c = 28 \rightarrow (1)$

So, number of persons who play hockey

$= a + b = 15 \rightarrow (2)$

& Number of persons who play football

$= b + c = 17 \rightarrow (3)$

& Number of persons who play hockey and football $= b = 10 \rightarrow (4)$

From (2) $\Rightarrow a = 5$

From (3) $\Rightarrow c = 7$

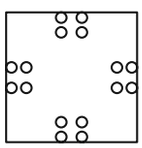
From (1) $\Rightarrow d = 6$

Number of persons who play neither hockey nor football $= d = 6$

Hence, the correct option is (A).

67. (C)

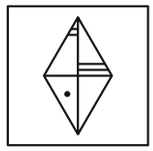
The unfolded form of paper will be represented as,



Hence, the correct option is (C).

68. (B)

The correct mirror image of the figure given will be,



Hence, the correct option is (B).

69. (D)

Given : There are two rows.

In row-1 A, B, C, D and E are sitting facing north. In row-2 P, Q, R, S and T are sitting facing south. The person in row-1 exactly faces the person in row-2.

R does not sit opposite to C.

A sits second from extreme end.

Only one person sits between one who faces A and Q.

B is not an immediate neighbor of A and does not sits apposite to Q.

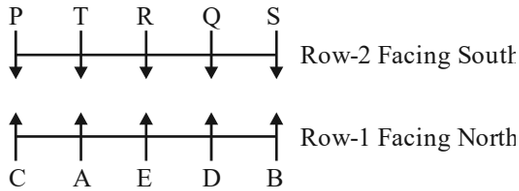
E sits second to the left of B.

T does not faces E and never sits at extreme end.

S is not an immediate neighbor of T.

C does not sit opposite to Q.

From given condition we can draw a sitting arrangement as shown below figure,



The persons sitting corners are PSCB.

Hence, the correct option is (D).

70. (B)

Untroubled synonyms are calm, peaceful and serene.

Resentful, Desolate and Sad are same category.

Hence, the correct option is (B).

71. 6

We can get the unit digit in the expression by looking at the pattern followed by 78, 56 and 97 when they are raised to high powers.

In fact, for the last digit we just need to consider the unit digit of each part of the product. A number (Like 78) having 8 as the digit will yield unit digits as :

$78^1 \to 8$

$78^2 \to 4$

$78^3 \to 2$

$78^4 \to 6$

$78^5 \to 8$

$78^6 \to 4$

$78^7 \to 2$

$78^8 \to 6$

Hence, from the above pattern we can say that

$8^{4n+1} \to 8$

$8^{4n+2} \to 4$

Hence, 78^{5562} will yield 4 as unit digit.

Similarly,

$56^1 \to 6$

$56^2 \to 6$

$56^3 \to 6$

$56^4 \to 6$

$\therefore$ 56^{256} will yield 6 as the unit digit.

Similarly,

$97^1 \to 7$

$97^2 \to 9$

$97^3 \to 3$

$97^4 \to 1$

$7^{4n+1} \to 7$

$\therefore$ $7^{4n+2} \to 9$

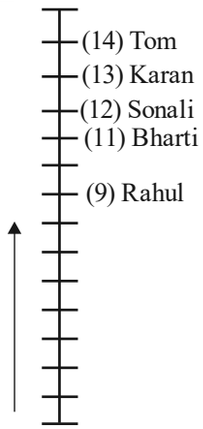
Hence, 97^{1250} will yield unit digit of 9.

Hence, the required unit digit is given by

$4 \times 6 \times 9 \to$ '6' Answers.

Hence, the correct answers are 6.

72. (C)



Total people $= M + N - 1$

$15 = 12 + N - 1$

$N = 4$

Hence, the correct option is (C).

73. (C)

From the question, each side = 6 cm

We know that,

Area of equilateral $\Delta = \frac{\sqrt{3}}{4}(\text{side})^2$

So, area of the equilateral triangle

$= \frac{\sqrt{3}}{4} \times 6^2 = 9\sqrt{3}$ cm^2

The area of shaded region

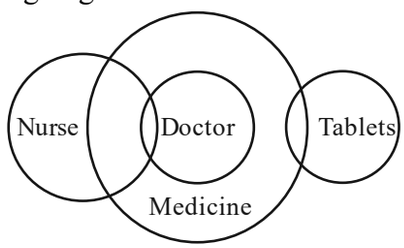
$= 8 \times$ [Area of equilateral triangles]

$= 8 \times 9\sqrt{3} = 72\sqrt{3}$ cm^2

Hence, the correct option is (C).

74. (D)

According to given information



From the above Venn-diagram, only conclusion (III) follows :

1. Atleast some tablets are doctor. Does not follow, as we can see in the diagram.
2. Some medicine are doctor is a possibility. Does not follows, as we can see in the diagram some medicine are doctor is a real case and we cannot make possibility of real case.
3. Some medicine are definitely nurse. Follows, as we can see in the diagram some part of medicine is intersected with nurse.

Hence, the correct option is (D).

75. (A)

Since $P(A \cup B \cup C) \geq 0.75$ therefore

$$0.75 \leq P(A \cup B \cup C) \leq 1$$

$$0.75 \leq P(A) + P(B) + P(C) - P(A \cap B) - P(B \cap C) - P(A \cap C) + P(A \cap B \cap C) \leq 1$$

$$0.75 \leq 0.3 + 0.4 + 0.8 - 0.08 - P(B \cap C)$$

$$-0.28 + 0.09 \leq 1$$

$$0.75 \leq 1.23 - P(B \cap C) \leq 1$$

$$-0.48 \leq -P(B \cap C) \leq -0.23$$

$$-0.23 \leq P(B \cap C) \leq 0.48$$

Hence, the correct option is (A).