

TEST DETAILS

1. Engineering MathematicsTest No. 1, 2 & 3
2. Digital LogicTest No. 1, 2 & 3
3. Computer OrganizationTest No. 1 & 2
4. Theory of ComputationTest No. 1, 2 & 3
5. Data Structure and AlgorithmsTest No. 1, 2 & 3
6. Operating SystemsTest No. 1 & 2
7. Database Management SystemsTest No. 1 & 2
8. Compiler DesignTest No. 1 & 2
9. Computer NetworksTest No. 1 & 2
10. Software Engineering and Web TechnologyTest No. 1
11. Verbal AbilityTest No. 1
12. Numerical AbilityTest No. 1

Engineering Mathematics-I

Computer Science Engineering

Test ID:

2	1	2	1
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Duration: 90 minutes

Maximum Marks: 50

Read the following instructions carefully:

1. Write your roll number, your name and name of the examination center at the specified locations of the ORS.
2. Using HB pencil, darken the appropriate bubble under each digit of your registration number and the letters corresponding to your paper code.
3. All the questions in this question paper are of objective type.
4. Questions must be answered on Objective Response Sheet (ORS) by darkening the appropriate bubble (marked A, B, C, D) using HB pencil against the question number on the left hand side of the ORS. **Each question has only one correct answer.** In case you wish to change an answer, erase the old answer completely. More than one answer bubbled against a question will be treated as a wrong answer.
5. This question paper contains 30 objective type questions. Q.1 to Q.10 carry **one** mark each and Q.11 to Q.30 carry **two** marks each.
6. Un-attempted questions will carry zero marks.
7. The question pair (27, 28) is common data questions.
8. The questions pair (29, 30) is questions with linked answers. The answer to the second question of the above pair will depend on the answer to the first question of the pair. If the first question in the linked pair is wrongly answered or is un-attempted, then the answer to the second question in the pair will not be evaluated.
9. **NEGATIVE MARKING:** For Q.1 to Q.10, $\frac{1}{3}$ rd mark will be deducted for each wrong answer. For Q. 11 to Q.30, $\frac{2}{3}$ rd mark will be deducted for each wrong answer. For the pair of questions with linked answers, there will be negative marks only for wrong answer to the first question, i.e. for Q.29, $\frac{2}{3}$ rd mark will be deducted for wrong answer. There is no negative marking for Q.30.
10. Calculator without data connectivity is allowed in the examination hall. Charts, graph sheets or tables are NOT allowed in the examination hall.
11. Rough work can be done on the question paper itself.

Q. No.1-10 Carry One Mark Each.

- Let A be a 3x3 matrix and B its adjoint matrix. If $|B| = 64$, then $|A| =$
(A) ± 2 (B) ± 4 (C) ± 8 (D) ± 12
- Matrix A is such that $A^2 = 2A - I$, where I is the unit matrix, then for $n > 2$, $A^n =$
(A) $nA - (n-1)I$ (B) $nA - I$ (C) $2^{n-1}A - (n-1)I$ (D) $2^{n-1}A - I$
- If $A \neq A^2 = I$, then $\det(I+A) =$
(A) 0 (B) -1 (C) 1 (D) 2
- For a matrix A of rank r,
(A) $\text{rank}(A^T) < r$ (B) $\text{rank}(A^T) = r$ (C) $\text{rank}(A^T) > r$ (D) None of these
- Let $f(0) = 1$, $f(1) = 2.72$, then from trapezoidal rule, the approximate value of $\int_0^1 f(x) dx$ is
(A) 3.72 (B) 1.86 (C) 1.72 (D) 0.86
- By the application of Simpson's $1/3^{\text{rd}}$ rule for numerical integration, with three sub intervals, the value of $\int_0^1 \frac{dx}{1+x}$ is
(A) $\frac{17}{24}$ (B) $\frac{17}{36}$ (C) $\frac{25}{36}$ (D) $\frac{17}{25}$
- Consider the matrix $A = (a_{ij}) = \begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix}$. What is the element a_{12} of A^{-1} ?
(A) 1 (B) 0 (C) -1 (D) $3/2$
- If the correlation coefficient between x and y is 0.28, covariance between x and y is 7.6 and the variance of x is 9, then the SD of y is
(A) 9.8 (B) 10.1 (C) 9.05 (D) 10.05
- The probability that a contractor will get a plumbing contract is $2/3$, probability that he will not get an electrical contract is $5/9$. If the probability of getting atleast one contract is $4/5$, what is the probability that he will get both?
(A) $1/4$ (B) $3/4$ (C) $14/45$ (D) $11/12$

10. If A and B are two events with $P(A) = 0.4$, $P(B)=0.3$ and $P(A \cap B) = 0.2$, Find $P[\bar{A} \cup \bar{B}]$ and $P[\bar{A} \cap \bar{B}]$
 (A) 0.1 and 0.9 (B) 0.8 and 0.1 (C) 0.2 and 0.8 (D) 0.9 and 0.1

Q. No.11-30 Carry Two Marks Each

11. The characteristic equation of a 3×3 matrix A is defined as $\alpha(\lambda) = |\lambda I - A| = \lambda^3 + \lambda^2 + 2\lambda + 1 = 0$, then $A^{-1} =$
 (A) $-A^2 + A + 2I$ (B) $A^2 + A + I$ (C) $-(A^2 + A + I)$ (D) $-(A^2 + A + 2I)$

12. What is rank of $\begin{vmatrix} 6 & 1 & 3 & 8 \\ 4 & 2 & 6 & -1 \\ 10 & 3 & 9 & 7 \\ 16 & 4 & 12 & 15 \end{vmatrix}$?
 (A) 1 (B) 2 (C) 3 (D) 4

13. Let A and B be 3×3 matrices such that $A^T = -A$, $B^T = B$, then matrix $\lambda AB + 3BA$ is a skew symmetric matrix for
 (A) $\lambda = 3$ (B) $\lambda = -3$ (C) $\lambda = 3$ or $\lambda = -3$ (D) None of these

14. The system of equations
 $x + ay + az = 0$
 $bx + y + bz = 0$
 $cx + cy + z = 0$
 where a, b and c are non zero and non unity, has a non trivial solution, then the value of $\frac{a}{1-a} + \frac{b}{1-b} + \frac{c}{1-c} =$
 (A) 0 (B) 1 (C) -1 (D) $\frac{abc}{a^2 + b^2 + c^2}$

15. Consider the polynomial function $f(x) = x^3 + 5x - 7$ for $x = -1, 0, 1, 2, 3, 4, 5$. Match List I with List II

List I		List II	
P	$\Delta f(2)$	1	6
Q	Δy_0	2	24
R	$\nabla^2 f(1)$	3	$\Delta^2 y_1$
S	$\Delta^2 f(0)$	4	0

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

16. Calculate $\Delta f(39)$ and $\Delta^2 f(38)$ for the data given below.

X	35	36	37	38	39	40	41
y	14.298	14.144	13.986	13.825	13.661	13.495	13.328

- (A) 0.166, 0.002 (B) -0.166, -0.002
 (C) 0.002, 0.166 (D) -0.002, -0.166

17. If $y_0 = 3$, $y_1 = 12$, $y_2 = 81$, $y_3 = 200$, $y_4 = 100$, then find $\Delta^4 y_0$.

- (A) 256 (B) 144 (C) 259 (D) -259

18. Given

X	1	1.2	1.4	1.6	1.8	2
Y	2.72	3.32	4.06	4.96	6.05	7.39

Find $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$ at $x=1.2$

- (A) 3.3125 and 3.9375 (B) 3.9375 and 3.3125
 (C) 3.21 and 3.19 (D) 3 and 4

19. 2% of the fuses manufactured by a firm are expected to be defective. Find the probability that a bus containing 200 fuses contains 3 or more defective fuses.

- (A) 0.4321 (B) 0.5871 (C) 0.9817 (D) 0.7621

20. One hundred identical coins, each with probability P of showing up heads are tossed once. If $0 < P < 1$ and the probability of heads showing on 50 coins is equal to that of heads showing on 51 coins. Then the value of P is

- (A) $\frac{1}{2}$ (B) $\frac{49}{101}$ (C) $\frac{50}{101}$ (D) $\frac{51}{101}$

21. A bag contains 3 green and 2 red balls. A man draws 2 balls at random from the bag. If he is to receive 20paise for every green ball he draws and 10paise for every red one, what is his expectation?

- (A) 30paise (B) 16paise (C) 8paise (D) 32paise

22. Find the constant C so that $f(x) = C \left(\frac{2}{3}\right)^x$; $x=1,2,3,\dots$ satisfies the p.d.f. of a discrete random variable x .

- (A) 1 (B) $\frac{1}{2}$ (C) $\frac{3}{4}$ (D) 2

23. Two dice numbered 1,2,3,4,5,6 on the faces are thrown. Let A be the event that the sum of the points on the faces are odd and B is the event that atleast one number is 1.

Match List I with List II

List I		List II	
1	$A \cap \bar{B}$	P	13/36
2	$\bar{A} \cap \bar{B}$	Q	1/6
3	B/A	R	1/3
		S	6/11

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

24. In a series of $2n$ observations, half of them equal to a and remaining equal to $-a$. If the SD of observations is 2, then $|a| =$

- (A) $\frac{1}{n}$ (B) $\sqrt{2}$ (C) 2 (D) $\frac{\sqrt{2}}{n}$

25. A set of numbers consist of three 4's, five 5's, six 6's and eight 8's and seven 10's. The mode of this set of numbers is:

- (A) 6 (B) 7 (C) 8 (D) 10

26. A can hit a target 3 times in 6 shots, B 2 times in 6 shots and C 4 times in 4 shots. What is the probability that atleast 2 shots hit the target?

- (A) $\frac{1}{3}$ (B) $\frac{1}{6}$ (C) $\frac{2}{3}$ (D) $\frac{1}{2}$

Common Data Questions: 27 & 28

If X and Y are two random variables having joint density function

$$f(x, y) = \frac{1}{8}(6 - x - y); 0 < x < 2, 2 < y < 4$$

$$= 0 \text{ otherwise}$$

27. $P(X < 1 \cap Y < 3) =$

- (A) $\frac{1}{8}$ (B) $\frac{7}{8}$ (C) $\frac{3}{8}$ (D) $\frac{4}{8}$

28. $P[X + Y < 3] =$

- (A) 5/24 (B) 19/25 (C) 21/24 (D) 1

Statement for Linked Answer Questions: 29 & 30

29. Find the Eigen values for $A = \begin{bmatrix} 5 & 4 \\ 1 & 2 \end{bmatrix}$
- (A) 9, -2 (B) 6, 1 (C) 2, 5 (D) 4, 3
30. Find the corresponding eigen vectors.
- (A) (4,1) and (1,-1) (B) (3,2) and (2,5)
- (C) (1,0) and (0,1) (D) Does not exist

Answer Keys

1	C	2	A	3	A	4	B	5	B	6	C	7	A
8	C	9	C	10	B	11	D	12	B	13	A	14	C
15	A	16	B	17	D	18	A	19	D	20	D	21	D
22	B	23	A	24	B	25	C	26	C	27	C	28	A
29	B	30	A										

Explanations:-

1. We know that, $A(\text{adj}A) = |A|I \Rightarrow AB = |A|I$ (Since $B = (\text{adj}A)$)
 $\Rightarrow |AB| = |A|^3$; $|A||B| = |A|^3$; $|A|64 = |A|^3$, $|A|^3 = 64 \Rightarrow |A| = \pm 8$

2. For $n=3$, $A^3 = A.A^2 = A(2A - I) = 2A^2 - AI$
 Now Substituting, $n = 3$ in option (A), we have
 $= 2(2A - I) - A = 3A - 2I = 3A - (3 - 1)I = 2A^2 - AI$
 Hence, A Option is correct

3. $A \neq A^2 = I \Rightarrow (A + I)(A - I) = 0 \dots \dots \dots (1)$
 let $|A + I| \neq 0$, then $(A + I)^{-1}$ exists
 Multiplying, $(A + I)^{-1}$ to (1), we have
 $(A + I)^{-1}(A + I)(A - I) = (A + I)^{-1}0 = 0$
 $I(A - I) = 0$; $(A - I) = 0 \Rightarrow A = I$, which is a contradiction
 Hence, $|A + I| = 0$, i.e. $|A + I| = 0$

6. $h = \frac{1}{2}$, $y = \frac{1}{1+x}$

i	x	y	
1	0	$\frac{1}{1+0} = 1$	$= y_0$
2	0.5	$\frac{1}{1+0.5} = \frac{2}{3}$	$= y_1$
3	1	$\frac{1}{1+1} = \frac{1}{2}$	$= y_2$

$y_0 = 1$; $y_1 = \frac{2}{3}$; $y_2 = \frac{1}{2}$

By Simpson's Rule, $\int_0^1 \frac{dx}{1+x} = \frac{h}{3} [(y_0 + y_2) + 4y_1] = \frac{25}{36}$

7. $A^{-1} = \begin{pmatrix} -2 & 1 \\ 3/2 & -1/2 \end{pmatrix}$

8. $\rho = \frac{\text{cov}(x, y)}{\sigma_x \sigma_y} \Rightarrow 0.28 = \frac{7.6}{\sigma_y \times 3} \Rightarrow \sigma_y = 9.05$

9. $P(A) = \frac{2}{3}; P(B) = \frac{5}{9}$ and $P(A \cup B) = \frac{4}{5}$
 $P(B) = \frac{4}{9}; P(A \cap B) = P(A) + P(B) - P(A \cup B) = \frac{2}{3} + \frac{4}{9} - \frac{4}{5} = \frac{14}{45}$

10. $P[\overline{A \cup B}] = P[\overline{A \cap B}] = 1 - P(A \cap B) = 1 - 0.2 = 0.8$

The event B can be written as $B(\overline{A \cap B}) \cup (A \cap B)$ and $\overline{A \cap B}$ and $A \cap B$ are disjoint events

$\therefore P(B) = P(\overline{A \cap B}) + P(A \cap B) \therefore P(\overline{A \cap B}) = P(B) - P(A \cap B) = 0.3 - 0.2 = 0.1$

11. We know that, every matrix satisfies its characteristics equation

$\therefore A^3 + A^2 + 2A + I = 0$

$A^{-1} [A^3 + A^2 + 2A + I] = 0$

$A^2 + A + 2I + A^{-1} = 0; A^{-1} = -[A^2 + A + 2I]$

12. Given is a 4x4 matrix and we can have minors of order 1,2,3,4.

Minor of order 4 is $\begin{vmatrix} 6 & 1 & 3 & 8 \\ 4 & 2 & 6 & -1 \\ 14 & 3 & 9 & 7 \\ 16 & 3 & 12 & 15 \end{vmatrix} = 0$

Minor of order 3 = $\begin{vmatrix} 6 & 1 & 3 \\ 4 & 2 & 6 \\ 10 & 3 & 9 \end{vmatrix}$ Apply $R_3 - R_2$
 $= \begin{vmatrix} 6 & 1 & 3 \\ 4 & 2 & 6 \\ 6 & 1 & 3 \end{vmatrix} = 0 (\because R_1 = R_3)$

Similarly by applying $R_3 - R_2$ we can show that two rows of each of the minors of order 3 are identical and hence they are zeroes.

Minor of order 2 = $\begin{vmatrix} 6 & 1 \\ 4 & 2 \end{vmatrix} = 8k \neq 0; \therefore p(A) = 2$

$$13. \quad [\lambda AB + 3BA]^T = \lambda (AB)^T + 3(BA)^T = \lambda B^T A^T + 3A^T B^T$$

$$= \lambda (B)(-A) + 3(-A)(B) \quad [\because A^T = -A, B^T = B] = -\lambda BA - 3AB = -(3AB + \lambda BA) \Rightarrow \lambda = 3$$

$$14. \quad \text{For non trivial solution, } \begin{vmatrix} 1 & a & a \\ b & 1 & b \\ c & c & 1 \end{vmatrix} = 0; \text{ operate } C_1 - C_2, C_2 - C_3$$

$$\text{We get } \begin{vmatrix} 1-a & 0 & a \\ b-1 & 1-b & b \\ 0 & c-1 & 1 \end{vmatrix} = 0 \Rightarrow (1-a)[(1-b) - b(c-1)] + a(b-1)(c-1) = 0$$

Divide by $(a-1)(b-1)(c-1)$, we have

$$\frac{1}{c-1} + \frac{b}{b-1} + \frac{a}{a-1} = 0 \Rightarrow \frac{(1-c)+c}{c-1} + \frac{b}{b-1} + \frac{a}{a-1} = 0$$

$$1 + \frac{c}{c-1} + \frac{b}{b-1} + \frac{a}{a-1} = 0 \Rightarrow \frac{a}{a-1} + \frac{b}{b-1} + \frac{c}{c-1} = -1$$

$$15. \quad f(-1) = -13; f(0) = -7; f(1) = -1; f(2) = 11; f(3) = 35; f(4) = 77; f(5) = 143$$

The difference table for this $f(x)$ is shown below

x	y=f(x)	First Differences	Second Differences	Third Differences
$x_0 = -1$	$y_0 = -13$			
$x_1 = 0$	$y_1 = -7$	6		
$x_2 = 1$	$y_2 = -1$	6	0	
$x_3 = 2$	$y_3 = 11$	12	6	6
$x_4 = 3$	$y_4 = 35$	24	12	6
$x_5 = 4$	$y_5 = 77$	42	18	6
$x_6 = 5$	$y_6 = 143$	66	24	

$$\Delta f(-1) = \Delta y_0 = 6$$

$$\Delta f(2) = \nabla y_3 = 24$$

$$\Delta^2 f(0) = \Delta^2 y_1 = 6$$

$$\Delta^2 f(1) = \Delta^2 y_2 = 12$$

$$\nabla f(5) = \nabla y_6 = 66$$

$$\nabla f(2) = \nabla y_3 = 12$$

$$\nabla^2 f(4) = \nabla^2 y_5 = 18$$

$$\nabla^2 f(1) = \nabla^2 y_2 = 0$$

18.

x	y	1 st Difference	2 nd Difference	3 rd Difference	4 th Difference
1	2.72				
1.2	3.32	0.6			
1.4	4.06	0.74	0.14	0.02	0.01
1.6	4.96	0.9	0.16	0.03	0.03
1.8	6.09	1.09	0.19	0.06	
2	7.39	1.34	0.25		

$$\left. \frac{dy}{dx} \right|_{x=1.2} = \frac{1}{0.2} \left[0.74 - \frac{1}{2} \times 0.16 + \frac{1}{3} \times 0.03 - \frac{1}{4} \times 0.03 \right] = 3.3125$$

$$\left. \frac{d^2y}{dx^2} \right|_{x=1.2} = \frac{1}{(0.2)^2} \left[0.16 - 0.03 + \frac{11}{12} \times 0.03 \right] = 3.9375$$

19.
$$\left. \begin{aligned} P &= \frac{2}{100} = 0.02 \\ n &= 200, p=0.02 \end{aligned} \right\} \begin{array}{l} n \text{ is very large, } p \text{ is small} \end{array}$$

∴ x can be treated as a Poisson value with parameter $\lambda = np = 200 \times 0.02 = 4$

$$P(x) = \frac{e^{-\lambda} \lambda^x}{x!}, \quad x=0,1,2,\dots$$

$$\begin{aligned} P[3 \text{ or more defectives}] &= 1 - p[x < 3] = 1 - [P(0) + P(1) + P(2)] \\ &= 1 - e^{-4} [1 + 4 + 8] = 0.7621 \end{aligned}$$

20. Given ${}^{100}C_{50} q^{50} p^{50} = {}^{100}C_{51} q^{49} p^{51} \Rightarrow 51q = 50p \Rightarrow 51(1-p) = 50p, \quad p = \frac{51}{101}$

21. The two balls drawn may be both green, one green and one red or both red.
In these cases, the man receives 40paise, 30paise and 20paise respectively.
Let X be the amount the man receives. Then

$$P[x=40] = P[\text{both green}] = \frac{{}^3C_2}{{}^5C_2} = 0.3$$

$$P[x=30] = P[\text{one green one red}] = \frac{{}^3C_2 \times {}^2C_1}{{}^5C_2} = 0.6$$

$$P[x=20] = P[\text{both red}] = \frac{{}^2C_2}{{}^5C_2} = 0.1$$

∴ Probability distribution of x is

x	40	30	20		
P(x)	0.3	0.6	0.1		

$$E(x) = \sum xP(x) = 40 \times 0.3 + 30 \times 0.6 + 20 \times 0.1 = 32 \text{ paise}$$

22. If f is the p.d.f. of X , then

$$\sum_{x \in A} f(x) = 1 \Rightarrow C \left[\frac{2}{3} + \left(\frac{2}{3}\right)^2 + \left(\frac{2}{3}\right)^3 + \dots \right] = 1, \quad C \left(\frac{2/3}{1 - \frac{2}{3}} \right) = 1 \Rightarrow C = \frac{1}{2}$$

23. The sample space is given by

$$S = \{(x, y) : x, y \in N, 1 \leq x \leq 6 \text{ and } 1 \leq y \leq 6\} \text{ and } n(s) = 36$$

$$A = \left\{ (1, 2), (1, 4), (1, 6), (2, 1), (2, 3), (2, 5), (3, 2), (3, 4), (3, 6), (4, 1), (4, 3), (4, 5), (5, 2), (5, 4), (5, 6), (6, 1), (6, 3), (6, 5) \right\}$$

$$B = \{(1, 2), (1, 3), (1, 4), (1, 5), (1, 6), (2, 1), (3, 1), (4, 1), (5, 1), (6, 1), (1, 1)\}$$

$$A \cap B = \{(1, 2), (1, 4), (1, 6), (2, 1), (4, 1), (6, 1)\}$$

$$P(A) = \frac{n(A)}{n(S)} = \frac{18}{36} = \frac{1}{2}, \quad P(B) = \frac{n(B)}{n(S)} = \frac{11}{36}, \quad P(A \cap B) = \frac{n(A \cap B)}{n(S)} = \frac{6}{36} = \frac{1}{6}$$

$$P(A \cup B) = P(A) + P(B) - P(A \cap B) = \frac{1}{2} + \frac{11}{36} - \frac{1}{6} = \frac{23}{36}$$

$$P(\overline{A \cap B}) = P(\overline{A \cup B}) = 1 - P(A \cup B) = 1 - \frac{23}{36} = \frac{13}{36}$$

$$P(A/B) = \frac{P(A \cap B)}{P(B)} = \frac{1/6}{11/36} = \frac{6}{11}, \quad P(B/A) = \frac{P(A \cap B)}{P(A)} = \frac{1/6}{1/2} = \frac{1}{3}$$

24. $X : a \ a \ a \dots\dots\dots ; X = -a \dots\dots\dots -a$

$$X^2 : a^2 \ a^2 \ a^2 \dots\dots\dots a^2 = a^2 \dots\dots\dots a^2$$

$$\sigma^2 = \frac{\sum x^2}{N} - \left(\frac{\sum x}{N} \right)^2 = \frac{2na^2}{2n} - \left(\frac{0}{2n} \right)^2 = a^2$$

$$\text{Given S.D.} = \sigma = \sqrt{a^2} = a = \sqrt{2}$$

25. Mode = 8, since frequency is maximum for 8.

$$\begin{aligned} &P(A) = \frac{3}{6} \\ &P(B) = \frac{2}{4} \\ &P(C) = \frac{4}{4} \end{aligned} \left\{ \begin{array}{l} \text{For atleast 2 hits, we have} \\ 1. \text{ All the three can hit} \\ P(A, B, C) = P(A) \cdot P(B) \cdot P(C) = \frac{3}{6} \times \frac{2}{6} \times \frac{4}{4} \end{array} \right.$$

$$2. \text{ B and C hit, A misses it} = P(\bar{A}) \cdot P(B) \cdot P(C) = \left(1 - \frac{3}{6}\right) \cdot \frac{2}{6} \times \frac{4}{4} = \frac{1}{6}$$

$$3. \text{ A and C hit, B misses it} = P(A) \cdot P(\bar{B}) \cdot P(C) = \frac{1}{2} \times \left(1 - \frac{2}{6}\right) \times \frac{4}{4} = \frac{1}{3}$$

$$\therefore P(2 \text{ short hit}) = \frac{1}{6} + \frac{1}{6} + \frac{1}{3} = \frac{2}{3}$$

$$27. \quad P[X < 1 \cap Y < 3] = \int_{-\infty}^1 \int_{-\infty}^3 f(x, y) \, dx \, dy = \int_0^1 \int_2^3 \frac{1}{8} (6 - x - y) \, dx \, dy = \frac{3}{8}$$

$$28. \quad P[x + y < 3] = \int_0^1 \int_2^{3-x} \frac{1}{8} (6 - x - y) \, dx \, dy = \frac{5}{24}$$

Engineering Mathematics-II

Computer Science Engineering

Test ID:

2	1	2	2
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Duration: 90 minutes

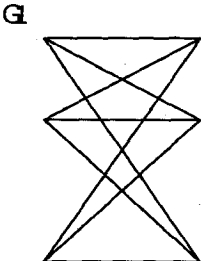
Maximum Marks: 50

Read the following instructions carefully:

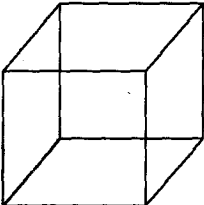
1. Write your roll number, your name and name of the examination center at the specified locations of the ORS.
2. Using HB pencil, darken the appropriate bubble under each digit of your registration number and the letters corresponding to your paper code.
3. All the questions in this question paper are of objective type.
4. Questions must be answered on Objective Response Sheet (ORS) by darkening the appropriate bubble (marked A, B, C, D) using HB pencil against the question number on the left hand side of the ORS. **Each question has only one correct answer.** In case you wish to change an answer, erase the old answer completely. More than one answer bubbled against a question will be treated as a wrong answer.
5. This question paper contains 30 objective type questions. Q.1 to Q.10 carry **one** mark each and Q.11 to Q.30 carry **two** marks each.
6. Un-attempted questions will carry zero marks.
7. The question pair (27, 28) is common data questions.
8. The questions pair (29, 30) is questions with linked answers. The answer to the second question of the above pair will depend on the answer to the first question of the pair. If the first question in the linked pair is wrongly answered or is un-attempted, then the answer to the second question in the pair will not be evaluated.
9. **NEGATIVE MARKING:** For Q.1 to Q.10, $1/3^{\text{rd}}$ mark will be deducted for each wrong answer. For Q. 11 to Q.30, $2/3^{\text{rd}}$ mark will be deducted for each wrong answer. For the pair of questions with linked answers, there will be negative marks only for wrong answer to the first question, i.e. for Q.29, $2/3^{\text{rd}}$ mark will be deducted for wrong answer. There is no negative marking for Q.30.
10. Calculator without data connectivity is allowed in the examination hall. Charts, graph sheets or tables are NOT allowed in the examination hall.
11. Rough work can be done on the question paper itself.

Q.No.1-10 Carry One Mark Each

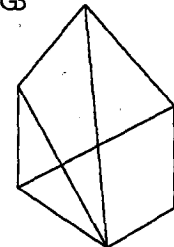
- What is chromatic number of $K_{5,8}$?
 (A) 5 (B) 8 (C) 13 (D) 2
- What is vertex cover of K_8 ?
 (A) 8 (B) 9 (C) 256 (D) 7
- For isomorphic graph, which of the following is true?
 A. The degree sequence of two graphs should be same
 B. Number of edges in two graph are same
 C. Number of vertices in two graph are same
 D. All of these
- Which of the following graph is planar?



G1



G2



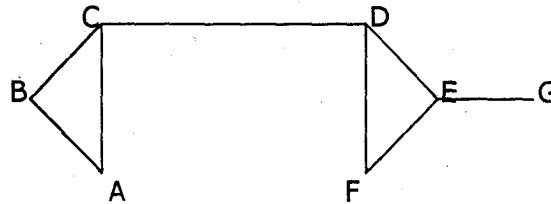
G3

(A) G1, G2 (B) G2, G3 (C) G1, G3 (D) G2 only
- How many minimum spanning trees are possible on complete graph with 7 vertices?
 (A) 7^5 (B) 7^6 (C) 7^7 (D) 7^8
- The expression $(\sim q \wedge (p \rightarrow q))$ is equivalent to
 (A) $\sim q$ (B) $\sim p$ (C) $\sim q \wedge \sim p$ (D) $p \rightarrow q$
- Let $X(p, q)$ represent $p+q=5$, where p, q are real numbers, then consider the following quantifications.
 $Q_1 : \forall p \exists q x(p, q)$
 $Q_2 : \exists q \forall p x(p, q)$
 (A) Q_1 is true and Q_2 is false (B) Q_2 is true and Q_1 is false
 (C) Both Q_1 and Q_2 are true (D) Both Q_1 and Q_2 are false
- Which of the following is not a tautology?
 (A) $P \rightarrow (P \cap Q)$ (B) $P \cup \sim P$ (C) $(P \rightarrow Q) \rightarrow P$ (D) $P \rightarrow (Q \rightarrow P)$

9. Which of the following is false?

- (A) $P \rightarrow P \cup Q$ (B) $Q \rightarrow P \cup Q$ (C) $P \cap Q \rightarrow P$ (D) $P \rightarrow P \cap Q$

10. For the graph shown below, which of the following are cut sets?



- (A) {CD} (B) {EG} (C) Both (D) None of these

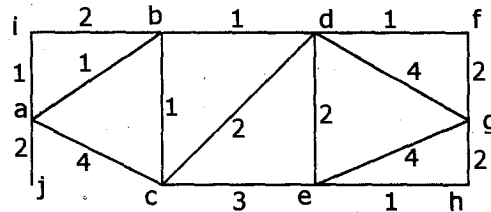
Q. No. 11 – 30 Carry Two Marks Each

11. For a simple bipartite graph with v vertices and e edges, which of the following equations is true?

- (A) $e = \frac{V^2}{4}$ (B) $e \geq \frac{V^2}{4}$ (C) $e \leq V^2$ (D) $e \leq \frac{V^2}{4}$

12. What is the cost of the minimum spanning tree for the following graph with Kruskal algorithm?

- (A) 12
(B) 14
(C) 16
(D) 18



13. Let G be simple graph with 30 vertexes, 40 edges and independent number of G is 8, then vertex cover of G is

- (A) 8 (B) 22 (C) 40 (D) 30

14. G is a connected planar simple graph with ' e ' edges and ' v ' vertices. Let r be the number of regions in a planar representation as G , then

- (A) $r=e+v+2$ (B) $r=e-v+1$ (C) $r=e+v+1$ (D) $r=e-v+2$

15. What is the first order predicate calculus statement equivalent to the following?
"Every child is liked by some person"

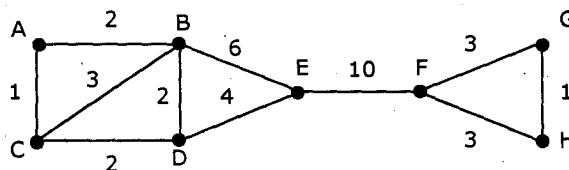
- (A) $\forall(x)[\text{child}(x) \rightarrow \exists(y)[\text{person}(y) \wedge \text{likes}(y,x)]]$
(B) $\forall(x)[\text{child}(x) \rightarrow \exists(y)[\text{person}(y) \rightarrow \text{likes}(y,x)]]$
(C) $\forall(x)[\text{child}(x) \wedge \exists(y)[\text{person}(y) \rightarrow \text{likes}(y,x)]]$
(D) $\exists(y) \forall(x)[\text{child}(x) \rightarrow [\text{person}(y) \wedge \text{likes}(y,x)]]$

16. Consider the following statements:
 $S_1 : \sim [\exists x, [\sim F(x)]] = \text{none false}$
 $S_2 : \sim [\forall x, [\sim F(x)]] = \text{none true}$
(A) S_1 is true and S_2 is false
(B) S_1 is false and S_2 is true
(C) S_1 & S_2 are true
(D) S_1 & S_2 are false
17. Consider the following statements:
 $P1 : ((A \rightarrow B) \wedge C) \equiv ((A \wedge C) \rightarrow (B \wedge C))$
 $P2 : ((A \rightarrow B) \vee C) \equiv ((A \vee C) \rightarrow (B \vee C))$
Which of the following is correct?
(A) P1 is valid but not P2
(B) P2 is valid but not P1
(C) P1 and P2 are both valid
(D) P1 and P2 are not valid
18. An undirected graph G has n nodes. Its adjacency matrix is given by an $n \times n$ square matrix, whose
1. Diagonal elements are 0's and
2. Non-diagonal lower triangular elements are all distinct
Which one of the following is true?
(A) Graph G has no minimum spanning tree (MST)
(B) Graph G has unique MST
(C) Graph G has multiple MST
(D) None of these
19. The chromatic number of wheel graph with 5 vertices is
(A) 3 (B) 4 (C) 5 (D) None of these
20. Which of the following statements is/are false?
1. Minimum spanning weight tree is unique for a graph.
2. Prim's and Kruskal's algorithm give the same minimum weight spanning tree.
3. Minimum weight spanning tree is unique if graph has unique weight.
(A) 1 only (B) 2 & 3 (C) 1, 2 & 3 (D) 1 & 2
21. Consider the following statements:
 $P1 : ((A \wedge B) \longleftrightarrow C) \equiv (A \leftrightarrow C) \wedge (B \leftrightarrow C)$
 $P2 : ((A \vee B) \longleftrightarrow C) \equiv (A \leftrightarrow C) \vee (B \leftrightarrow C)$
Which one of the following is true?
(A) P1 is valid, but not P2
(B) P2 is valid, but not P2
(C) P1 and P2 are both valid
(D) Both P1 and P2 are not valid

22. Which of the following is independent number of $K_{3,6}$?
 (A) 3 (B) 6 (C) 9 (D) 18
23. Which of the following represent degree sequence of a simple graph?
 1. 2,2,2,2,2,2 2. 3,3,3,3,6 3. 1,2,3,4,5,
 (A) 1 only (B) 2 only (C) 3 only (D) All of these
24. Which of following statements are true for planar graph?
 1. It always has Hamiltonian circuit.
 2. It is always connected
 3. It always satisfies $r = e - v + 2$
 4. It always satisfies $e \leq 3v - 6$
 5. It will have vertex cover of size at most $3n/4$
 6. It has independent set of size at least $n/3$
 (A) 1,2,4,5 (B) 1,2,5,6 (C) all (D) 3, 4, 5
25. Consider the following statements:
 $P_1 : ((A \leftrightarrow B) \wedge C) \equiv ((A \cap C) \leftrightarrow (B \cap C))$
 $P_2 : ((A \leftrightarrow B) \vee C) \equiv ((A \cup C) \leftrightarrow (B \cup C))$
 Which of the following is true?
 (A) P_1 is valid but not P_2 (B) P_2 is valid but not P_1
 (C) P_1 and P_2 are valid (D) P_1 and P_2 are both not valid
26. Number of match edges in K_6 is
 (A) 2 (B) 3 (C) 4 (D) 5

Common Data Questions: 27 & 28

Consider the graph given below:



27. Number of distinct minimal spanning trees that can be formed with Kruskal's algorithm is
 (A) 6 (B) 4 (C) 8 (D) none of these
28. What is the cost of minimal spanning tree using prim's algorithm starting with vertex 'E'?
 (A) 26 (B) 23 (C) 27 (D) none of these

Statement for Linked Answer Questions: 29 & 30

Let 'k' be the number of variables of a propositional function

29. Number of distinct propositional functions is

(A) k^2

(B) 2^{2^k}

(C) 2^k

(D) 2^{k^2}

30. For what value of k, the number of propositional functions will be 512?

(A) 23

(B) 3

(C) 9

(D) 5

Answer Keys

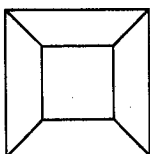
1	D	2	D	3	D	4	B	5	A	6	C	7	A
8	A	9	D	10	C	11	D	12	A	13	B	14	D
15	A	16	A	17	B	18	B	19	A	20	D	21	D
22	B	23	A	24	D	25	B	26	B	27	A	28	B
29	B	30	B										

Explanations:

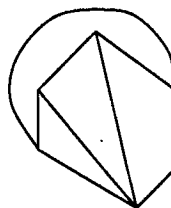
1. For any complete bipartite graph, chromatic number is 2.

2. Vertex cover of K_n is $n-1 = 7$

4. G_2, G_3 both are planar



G2



G3

5. Number of spanning trees for complete graph K_n is $n^{(n-2)}$

6.

p	q	$\sim q$	$p \rightarrow q$	$\sim p \wedge (p \rightarrow q)$	$\sim p$	$\sim q \wedge \sim p$
0	0	1	1	1	1	1
0	1	0	1	0	0	0
1	0	1	0	0	0	0
1	1	0	1	0	0	0

8. $P \rightarrow Q \equiv \sim P \cup Q$

$$(A) \quad P \rightarrow (P \cap Q) = \sim P \cup (P \cap Q) = (\sim P \cup P) \cap (\sim P \cup Q) = T \cap (\sim P \cup Q) = (\sim P \cup Q)$$

$$(B) \quad P \cup \sim P = \text{Tautology}$$

$$(C) \quad (P \rightarrow Q) \cup P \\ (\sim P \cup Q) \cup P \\ (\sim P \cup P) \cup Q \\ T \cup Q = T = \text{Tautology}$$

11. Let us assume x vertices on one side. So $v-x$ on other side no. of edges in this graph will be:

$$e = x \times (v - x) = vx - x^2$$

We want to maximize $e = vx - x^2$; $\frac{de}{dx} = v - 2x$; $v - 2x = 0$; $x = \frac{v}{2}$

$$\frac{d^2e}{dx^2} = -2; \text{ so } e_{\max} = \frac{v}{2} \left(v - \frac{v}{2} \right) = \frac{v^2}{4} \geq e$$

13. Vertex cover + line independent number = no. of vertices
Vertex cover = $30 - 8 = 22$

14. For any simple planar graph, the eq. $v + r = e + 2$ holds

17.

A	B	C	$A \rightarrow B$	$A \cap C$	$B \cap C$	$(A \rightarrow B) \cap C$	$(A \cap C) \rightarrow (B \cap C)$
0	0	0	1	0	0	0	1
0	0	1	1	0	0	1	1
0	1	0	1	0	0	0	1
0	1	1	1	0	1	1	1
1	0	0	0	0	0	0	1
1	0	1	0	1	0	0	1
1	1	0	1	0	0	0	0
1	1	1	1	1	1	1	1

For $A=0$ $B=0$ $C=0$

P1 $(0 \rightarrow 0) \wedge 0 \equiv (0 \wedge 0) \rightarrow (0 \wedge 0) \equiv 0 \equiv 1$

A	B	C	$A \rightarrow B$	$A \cup C$	$B \cup C$	$(A \rightarrow B) \cup C$	$(A \cup C) \rightarrow (B \cup C)$
0	0	0	1	0	0	1	1
0	0	1	1	1	1	1	1
0	1	0	1	0	1	1	1
0	1	1	1	1	1	1	1
1	0	0	0	1	0	0	0
1	0	1	0	1	1	1	1
1	1	0	1	1	1	1	1
1	1	1	1	1	1	1	1

18. The graph G has unique MST as it has all weights distinct and it is K_n .

19. The chromatic number of wheel graph = 4 (if no. of vertices is even)
= 3 (if no. vertices in odd)

20. There may be more than 1 minimum spanning tree possible.
 Prim's and Kruskal's algorithm can give different minimum spanning tree

21. Consider $A=0; B=1; C=0$

P1:

$$(0 \leftrightarrow 0) \equiv (0 \leftrightarrow 0) \wedge (1 \leftrightarrow 0)$$

$$1 \equiv 1 \wedge 0$$

$$1 \equiv 0$$

P2:

$$(A \cup B) \leftrightarrow C \equiv (A \leftrightarrow C) \vee (B \leftrightarrow C)$$

$$\Rightarrow 1 \leftrightarrow 0 \equiv 0 \leftrightarrow 0 \vee (1 \leftrightarrow 0) \Rightarrow 0 \equiv 1 \vee 0 \Rightarrow 0 \equiv 1$$

22. The independent number of $K_{m,n}$ is $\max(m,n)$

24. D

3. Planar graph always satisfies eq. $r=e-v+2$

4. Planar graph always satisfies eq. $e \leq 3v - 6$

5. Planar graph has vertex cover of size at most $3n$

25.

A	B	C	$A \leftrightarrow B$	$A \cap C$	$A \cup C$	$B \cap C$	$B \cup C$	$(A \leftrightarrow B) \cap C$	$A \cap C \leftrightarrow B \cap C$	$((A \leftrightarrow B) \vee C)$
0	0	0	1	0	0	0	0	0	1	1
0	0	1	1	0	1	0	1	1	1	1
0	1	0	0	0	0	0	1	1	1	0
0	1	1	0	0	1	1	1	0	0	1
1	0	0	0	0	1	0	0	1	1	0
1	0	1	0	1	1	0	1	0	0	1
1	1	0	1	0	1	1	1	0	0	1
1	1	1	1	1	1	1	1	1	1	1

We will get $(A \cup C) \leftrightarrow (B \cup C)$ same as $((A \leftrightarrow B) \vee C)$. Hence P2 is valid. P1 is not valid.

26. Number of match edges in K_6 is $\lfloor 6/2 \rfloor = 3$

27. If we run Kruskal's algorithm, we will get spanning trees as

$\{AC, AB, BD, DE, EF, FG, GH\}$

$\{AC, CD, BD, DE, EF, FG, GH\}$

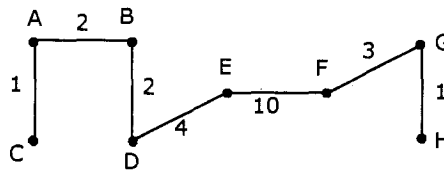
$\{AC, AB, CD, DE, EF, FG, GH\}$

$\{AC, AB, BD, DE, EF, FH, HG\}$

$\{AC, CD, BD, DE, EF, FH, HG\}$

$\{AC, AB, CD, DE, EF, FH, HG\}$

28. If we run prim's algorithm



29. The number of distinct propositional functions = 2^{2^k}

Engineering Mathematics-II

Computer Science Engineering

Test ID:

2	1	2	3
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Duration: 90 minutes

Maximum Marks: 50

Read the following instructions carefully:

1. Write your roll number, your name and name of the examination center at the specified locations of the ORS.
2. Using HB pencil, darken the appropriate bubble under each digit of your registration number and the letters corresponding to your paper code.
3. All the questions in this question paper are of objective type.
4. Questions must be answered on Objective Response Sheet (ORS) by darkening the appropriate bubble (marked A, B, C, D) using HB pencil against the question number on the left hand side of the ORS. **Each question has only one correct answer.** In case you wish to change an answer, erase the old answer completely. More than one answer bubbled against a question will be treated as a wrong answer.
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10. Calculator without data connectivity is allowed in the examination hall. Charts, graph sheets or tables are NOT allowed in the examination hall.
11. Rough work can be done on the question paper itself.

Q.No.1–10 Carry One Mark Each

1. Total number of bijective function from set of 6 elements to set of 6 elements is
(A) 2^6 (B) 6^2 (C) $6!$ (D) 6
2. Positive integers are _____ under division.
(A) Reflexive (B) Transitive
(C) Anti-symmetric (D) Partial ordered
3. Total number of symmetric and reflexive relations on set A with $|A| = 20$ is
(A) $2^{\frac{20^2}{2}}$ (B) $2^{\frac{(20^2+20)}{2}}$ (C) $2^{\frac{(20^2-20)}{2}}$ (D) 2^{20}
4. Let $(A, *)$ be group over set A $\forall x \in A$, then which of the following is true?
(A) $*$ is closed and associative operation (B) A has unique identity element
(C) Every element in A has inverse (D) All of these
5. Let P and Q are subsets of universal set U and complement of set P of U is denoted as P^c . Find
$$[\{p \cap (p \cap Q^c)\} \cap Q]^c$$

(A) P^c (B) Q^c (C) U (D) ϕ
6. The number of subsets of the set $\{1, 2, 3, \dots, k\}$ with even cardinality is
(A) $2^k - 1$ (B) 2^{k-1} (C) 2^{k+1} (D) 2
7. Total number of functions from a set of 8 elements to set of 10 elements is
(A) 10^8 (B) 8^{10} (C) 80 (D) $10!$
8. Let A, B and C be three non empty sets, then $(A - C) \cap (C - B)$ is
(A) A (B) B (C) C (D) ϕ
9. If $u = \frac{x^{-3/2} + y^{-3/2}}{x^{-11/7} + y^{-11/7}}$, then $x \frac{\partial u}{\partial x} + y \frac{\partial u}{\partial y} =$
(A) $(1/28)u$ (B) $(1/14)u$ (C) $(1/13)$ (D) None of these
10. Find the number of ways of arranging the letters of the word GATEFORUM such that all the vowels come together.
(A) 16380 (B) 720 (C) 2880 (D) 17280

Q.No.11-30 Carry Two Marks Each

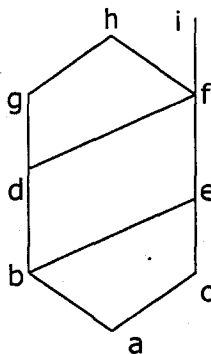
11. Consider a binary operation \odot over a set of $\{1, 2, 4, 7, 8, 11, 13, 17\}$
 $a \odot b = a \times b \text{ mod } 15$
 What are inverses of 8 and 7?
 (A) 2, 8 (B) 11, 13 (C) 2, 11 (D) None of these
12. Consider the binary relation R and S on non-empty set A. Both R and S is transitive. Which is true?
 1. $R \cap S$ is transitive 2. $R \cup S$ is transitive
 3. $R - S$ is transitive 4. $S - R$ is transitive
 (A) 1 (B) 2 (C) All (D) 1, 2
13. The set $\{0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$ under multiplication modulo 11 is
 1. It is closed
 2. It forms a group
 3. It does not form group because identity does not exist.
 4. It does not form group because 0 does not have inverse.
 (A) 1, 2 (B) 1, 3 (C) 1, 4 (D) 3, 4
14. Let A, B, C be arbitrary sets
 a. $(A - B) - C = A - (B \cup C)$
 b. $(A - B) - C = (A - C) - B$
 c. $(A - B) - C = (A - C) - (B - C)$
 Which of the following is true?
 (A) a, b (B) a, b, c (C) b, c (D) a, c
15. $\lim_{x \rightarrow \infty} \left[\frac{x^2 + 5x + 3}{x^2 + x + 2} \right]^x =$
 (A) e^4 (B) e^3 (C) e^2 (D) e
16. If $e^x = x^y$, then y has a
 (A) Maximum at $x = e$ (B) Minimum at $x = e$
 (C) Maximum at $x = e^{-1}$ (D) Minimum at $x = e^{-1}$

17. A subset relation over set $A = \{1, 2, 3, \dots, 10\}$ is
- | | | |
|---------------|--------------|-------------------|
| 1. Reflexive | 2. Symmetric | 3. Anti-symmetric |
| 4. Transitive | 5. Poset | 6. Asymmetric |
- (A) 1,2,4 (B) 1,3,4,6 (C) 1,3,4,5 (D) 1,2,6
18. How many ways can 4 boys and 4 girls be seated around a round table such that no two boys are adjacent?
- (A) 144 (B) 576 (C) 256 (D) None of these
19. Inverse of function exists if and only if
- | | |
|-------------------------------|------------------------------|
| (A) it is surjective function | (B) it is injective function |
| (C) it is bijective function | (D) it is constant function |
20. Given, F is function from C to A and G is function from B to C . Given $F \circ G$ is injective. Which of the following is true?
- (A) F must be injective but G may not be so
(B) G must be injective but F may not be so
(C) Both F and G must be injective
(D) Both F and G not necessarily be injective
21. Consider the binary operation \oplus over set of $Z_n = \{0, 1, \dots, n-1\}$
- $$a \oplus b = \begin{cases} a + b & \text{if } a + b < n \\ a + b - n & \text{if } a + b \geq n \end{cases}$$
- Then,
- | | |
|--|------------------------------|
| (A) It is not closed | (B) It does not form a group |
| (C) It form a group but not an Abelian group | (D) It is an Abelian group |
22. Homeomorphism of simple graph is
- | | |
|-------------------------|-----------------------------|
| (A) Reflexive relation | (B) Anti-symmetric relation |
| (C) Transitive relation | (D) Poset |
23. (R, \div) with binary operator ' \div ' over the set of real no's R is a
- | | | | |
|----------------|------------|-----------|-------------------|
| (A) Semi group | (B) Moniod | (C) Group | (D) Abelian group |
|----------------|------------|-----------|-------------------|
24. How many triangles can be formed from 10 points in a plane of which 5 points are collinear?
- (A) 720 (B) 660 (C) 420 (D) 480
25. There are 5 flags of different colours, which are used for signaling. How many different signals can be formed by using these flags?
- (A) 120 (B) 325 (C) 625 (D) None of these

26. Consider the set $A = \{1, 2, 3, 4, \dots, m-1\}$ of $(m-1)$ integers and consider the operation $x_m =$ multiplication modulo m . (A, X_m) forms a group when
- (A) $m-1$ is prime (B) $m \neq 0$ is composite
(B) m is prime (D) m is odd integer

Common Data Questions: 27 & 28

Consider the following Lattice



27. What is upper bound of (a, b, e) ?
- (A) e, f, d (B) a, b, e, d, g (C) e, f, i, h (D) e, f, i, g
28. What is lower bound of (d, b, e) ?
- (A) a (B) c (C) b, a (D) b

Statement for Linked Answer Questions: 29 & 30

Suppose that A and B are two non-empty sets and $n(A)$ and $n(B)$ are their cardinalities. It is given that from A to B , there are exactly 120 injections.

29. The cardinalities of B and A are respectively
- (A) 4, 5 (B) 6, 3 (C) 8, 5 (D) 7, 3
30. If $C = \{1, 2, 3, 4, 5, 6, 7\}$ and $C \supset B$, then $n(B-C)$ is _____
- (A) 1 (B) 2 (C) 0 (D) Can't say

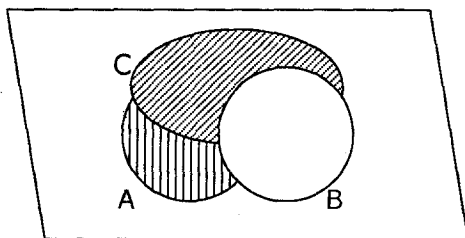
Answer Keys

1	C	2	D	3	C	4	D	5	C	6	B	7	A
8	D	9	B	10	D	11	D	12	A	13	C	14	B
15	A	16	A	17	C	18	A	19	C	20	B	21	D
22	D	23	B	24	B	25	B	26	B	27	C	28	C
29	B	30	C										

Explanations:

- Number of bijective function on set, with 6 element is $6!$.
- Divide relation over set of +ve integer is reflexive, antisymmetric and transitive. Hence it is partially ordered relation
- Reflexive means all diagonal should be present and symmetric means one half has choice = $2^{\left(\frac{20^2-20}{2}\right)}$
- $\left[\{p \cap (p \cap Q^c)\} \cap Q\right]^c = [(P \cap P) \cap (Q^c \cap Q)]^c = [P \cap \phi]^c = \phi^c = U$

8.



$$9. \quad \text{Given, } u = \frac{x^{-3/2} + y^{-3/2}}{x^{-11/7} + y^{-11/7}} = \frac{x^{-3/2} \left(1 + \frac{y^{-3/2}}{x^{-3/2}}\right)}{x^{-11/7} \left(1 + \frac{y^{-11/7}}{x^{-3/2}}\right)} = x^{1/14} \left(\frac{1 + y^{-3/2}/x^{-3/2}}{1 + \frac{y^{-11/7}}{x^{3/2}}} \right)$$

Clearly u is a homogeneous function of degree $\frac{1}{14}$

$$\therefore x \frac{\partial u}{\partial x} + y \frac{\partial u}{\partial y} = \frac{1}{14} u$$

10. The given work is GATEFORUM

Vowels are A, E, O, U (that is 4) Now consider all the vowels as one unit and the remaining 5 as 5 units that is a total of 6

These 6 units can arrange themselves in $6!$ ways

Also the 4 vowels can arrange themselves in $4!$ ways

Hence total number of arrangements = $(6!)(4!) = 17280$

11. Doesn't form group since the operation is not closed. For example,
 $4 \odot 11 = 44 \bmod 15 = 14$ is not in the set.

12. $R \cap S$ is transitive

$$R \cup S = R \{(1,2)\} \cup S \{(2,17)\}$$

$$R \cup S = \{(1,2)(2,17)\} \text{ not transitive}$$

$$R = \{(1,2)(2,3)(1,3)\}; S = \{(1,3)\}$$

$$R - S = \{(1,2)(2,3)\} \text{ not transitive}$$

$$R = \{(1,3)\}; S \{(1,2)(2,3)(1,3)\}$$

$$S - R = \{(1,2)(2,3)\} \text{ not transitive}$$

13. It is closed but 0 does not has inverse. So it does not form the group.

14. All are true on Venn diagram.

$$\begin{aligned} 15. \quad \lim_{x \rightarrow \infty} \left[\frac{x^2 + 5x + 3}{x^2 + x + 2} \right]^x &= \lim_{x \rightarrow \infty} \left(1 + \frac{4x + 1}{x^2 + x + 2} \right)^x \\ &= \lim_{x \rightarrow \infty} \left[\left(1 + \frac{4x + 1}{x^2 + x + 2} \right)^{\frac{x^2 + x + 1}{4x + 1}} \right]^{\frac{x(4x + 1)}{x^2 + x + 1}} = e^{\lim_{x \rightarrow \infty} \frac{x(4x + 1)}{x^2 + 4x + 1}} = e^{\lim_{x \rightarrow \infty} \frac{4 + \frac{1}{x}}{1 + \frac{1}{x} + \frac{1}{x^2}}} = e^4 \end{aligned}$$

$$16. \quad x = y \ln x, \quad \frac{dy}{dx} = \frac{\ln x - 1}{(\ln x)^2} = 0 \Rightarrow x = e \text{ (max)}$$

17. $a \leq a$ so reflexive

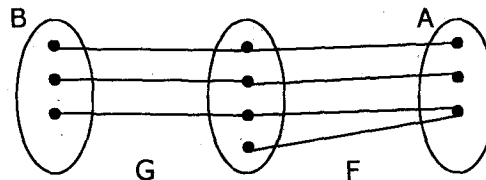
$$a \leq b, b \leq a \Rightarrow a = b \text{ antisymmetric}$$

$$a \leq b, b \leq c \Rightarrow a \leq c \text{ transitive}$$

$$1, 3, 4 \rightarrow \text{poset}$$

18. First 4 girls can be seated around a round table in $(4-1)! = 6$ ways
 Then there will be four places for 4 boys, and they can be seated in $4! = 24$ ways
 Hence required no. of ways = $24 \times 6 = 144$

20. G must be injective. F may not



22. A graph G is homeomorphic to itself
G1 is homeomorphic to G1. G2 is homeomorphic to G3, then G1 is homeomorphic to G3
All 1,2,3 implies poset
23. The set (R, \div) satisfies, closure, associative properties. There is also identity element (1), but there is no inverse for '0'.
Hence it is a monoid but not group.
24. Let, $n = 10, m = 5$
 \therefore The required number of triangles is $n_{p_3} - m_{p_3} = 10_{p_3} - 5_{p_3} = 720 - 6 = 660$
25. With 1 flag, we can form 5_{p_1} signals; with two flags we can form 5_{p_2} signals and so on.
Hence total number of signals = $5_{p_1} + 5_{p_2} + 5_{p_3} + 5_{p_4} + 5_{p_5} = 325$
29. Given, the number injections from A to B = 120
i.e., ${}^{n(B)}P_{n(A)} = 120$
If we proceed from options, we have $n(B) = 6$ and $n(A) = 3$
i.e., ${}^6P_3 = 6 \times 5 \times 4 = 120$
30. Here, $n(A) = 3, n(B) = 6$ and $n(C) = 7$, also given that $C \supset B \Rightarrow B \subset C$
 $\therefore B - C = \phi$
Hence, $n(B - C) = 0$

Digital Logic-I

Computer Science Engineering

Test ID:

2	1	2	4
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Duration: 90 minutes

Maximum Marks: 50

Read the following instructions carefully:

1. Write your roll number, your name and name of the examination center at the specified locations of the ORS.
2. Using HB pencil, darken the appropriate bubble under each digit of your registration number and the letters corresponding to your paper code.
3. All the questions in this question paper are of objective type.
4. Questions must be answered on Objective Response Sheet (ORS) by darkening the appropriate bubble (marked A, B, C, D) using HB pencil against the question number on the left hand side of the ORS. **Each question has only one correct answer.** In case you wish to change an answer, erase the old answer completely. More than one answer bubbled against a question will be treated as a wrong answer.
5. This question paper contains 30 objective type questions. Q.1 to Q.10 carry **one** mark each and Q.11 to Q.30 carry **two** marks each.
6. Un-attempted questions will carry zero marks.
7. The question pair (27, 28) is common data questions.
8. The questions pair (29, 30) is questions with linked answers. The answer to the second question of the above pair will depend on the answer to the first question of the pair. If the first question in the linked pair is wrongly answered or is un-attempted, then the answer to the second question in the pair will not be evaluated.
9. **NEGATIVE MARKING:** For Q.1 to Q.10, 1/3rd mark will be deducted for each wrong answer. For Q. 11 to Q.30, 2/3rd mark will be deducted for each wrong answer. For the pair of questions with linked answers, there will be negative marks only for wrong answer to the first question, i.e. for Q.29, 2/3rd mark will be deducted for wrong answer. There is no negative marking for Q.30.
10. Calculator without data connectivity is allowed in the examination hall. Charts, graph sheets or tables are NOT allowed in the examination hall.
11. Rough work can be done on the question paper itself.

Q. No. 1 – 10 Carry One Mark Each

1. Expression $A + \bar{A}B + \bar{A}\bar{B}C + \bar{A}\bar{B}\bar{C}D + \bar{A}\bar{B}\bar{C}\bar{D}E$ can be simplified to
 (A) $AB + BC + CD + DE$ (B) $A + B + C + D + E$
 (C) $A\bar{B} + B\bar{C} + C\bar{D} + D\bar{E}$ (D) $\bar{A}B + \bar{B}C + \bar{C}D + \bar{D}E$
2. The minimum number of NOR gates required to implement $A(A + \bar{B})(A + \bar{B} + C)$ is
 (A) 0 (B) 1 (C) 3 (D) 5
3. What does $A - B$ implement?
 (A) AB' (B) $A'B$ (C) $A + B'$ (D) $A' + B$
4. Minimum number of NAND and NOR gates required to implement the function EX – OR gate, respectively is
 (A) 5, 4 (B) 4, 4 (C) 5, 5 (D) 4, 5
5. Absorption theorem is given by
 (A) $x.1 = x$ (B) $x + 1 = 1$ (C) $x.x = x$ (D) $x(x + y) = x$
6. If M-represents the Maxterms $f = M_0M_1M_3M_5M_7$ then $f =$
 (A) $\bar{A}\bar{B} + C$ (B) $(A + B).\bar{C}$ (C) $C + \bar{A}.\bar{B}$ (D) C
7. Simplify the following Boolean functions to minimal SOP form:
 $F(X, Y, Z) = X'Y' + X'Z + XY + YZ'$
 (A) $x' + y$ (B) $x + y'$ (C) $xy + x'y'$ (D) None of these
8. Which one of the following statements is correct?
 (A) RAM is a non-volatile memory whereas ROM is a volatile memory
 (B) RAM is a volatile memory whereas ROM is a non-volatile memory
 (C) Both RAM and ROM are volatile memories but in ROM data is not lost when power is switched off
 (D) Both RAM and ROM are non volatile memory but in ROM data is lost when power is switched off
9. The logic expression $\bar{x} + x\bar{y}$ is equal to
 (A) $x + y$ (B) $\bar{x} + y$ (C) $x + \bar{y}$ (D) $\bar{\bar{x}}\bar{y}$

10. The logic expression $\overline{AB + ABC + ABD}$ is equal to

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

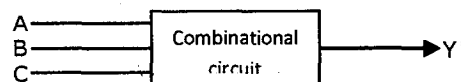
Q. No. 11 – 30 Carry Two Marks Each

11. The number of Minterms and Maxterms corresponding to the expression $f(A,B,C) = A + \overline{B} + \overline{C}$ is respectively

- (A) 3 and 5 (B) 5 and 3 (C) 4 and 4 (D) 7 and 1

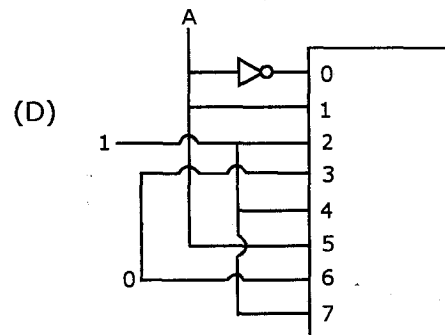
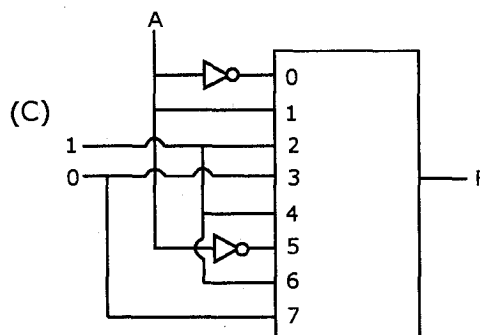
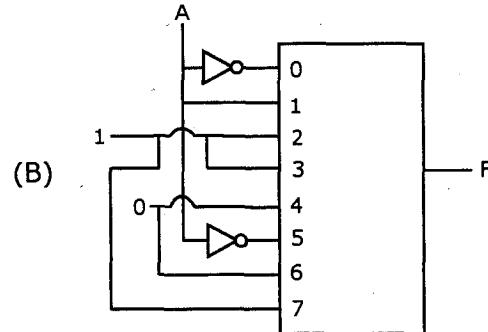
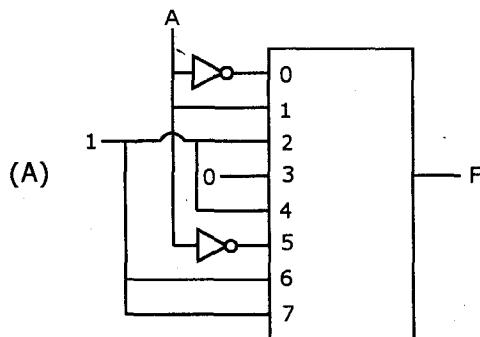
12. Truth table for the combinational circuit is shown below. The minimum number of two input NAND gates required to realize this logic circuit is

A	B	C	Y
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	0

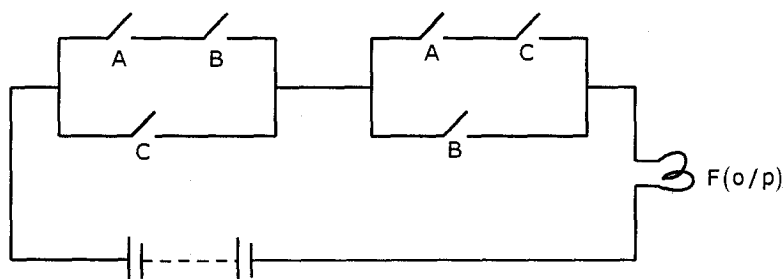


- (A) 3 (B) 4 (C) 5 (D) 6

13. The function $F = C\overline{D} + \overline{A}\overline{D} + B\overline{D} + \overline{A}B\overline{C} + A\overline{B}C\overline{D}$ can be realized with help of

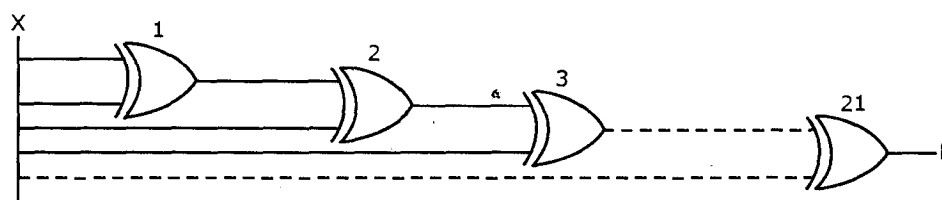


14. Find the expression for F for the circuit shown below.



- (A) $F = A \oplus B \oplus C$ (B) $F = (A + B.C) + (A + B.C)$
(C) $F = AB + AC + BC$ (D) $F = (\overline{A + B.C}) . (\overline{A.B + C})$

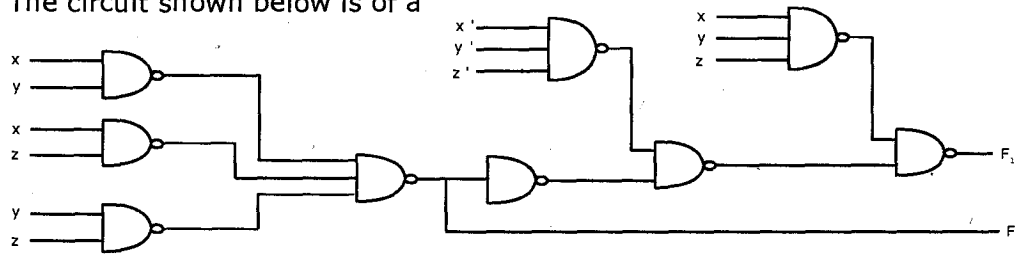
- 15.



Output (F) for above circuit will be

- (A) x (B) 1 (C) \bar{x} (D) Zero

16. The circuit shown below is of a



- (A) Adder (B) MUX (C) Subtractor (D) Buffer

17. $F = A \oplus B \oplus C \oplus D$ in SOP form is

- (A) $\sum(1, 3, 5, 7, 9, 10, 13, 15)$ (B) $\sum(0, 2, 5, 7, 13, 8, 9, 15)$
(C) $\sum(1, 2, 4, 7, 8, 11, 13, 14)$ (D) $\sum(0, 3, 5, 6, 9, 10, 12, 15)$

18. A four bit standalone binary full adder is constructed with three full adders and one half adder. It will give

- (A) Correct sum but incorrect carry out
(B) Incorrect sum but correct carry out
(C) Incorrect sum and in correct carry out
(D) Correct sum and correct carry out

19. The Karnaugh map for a minimized Boolean expression is given below.

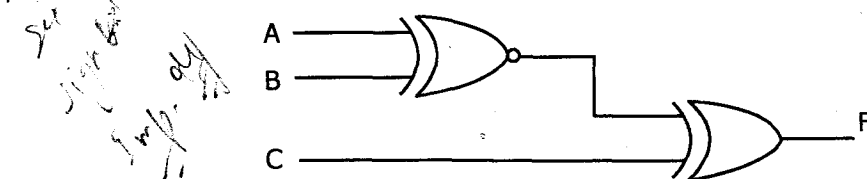
		BC			
A		00	01	11	10
		0	0	ϕ	
	1		0	ϕ	

The minimized SOP expression is $F(A,B,C) =$

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

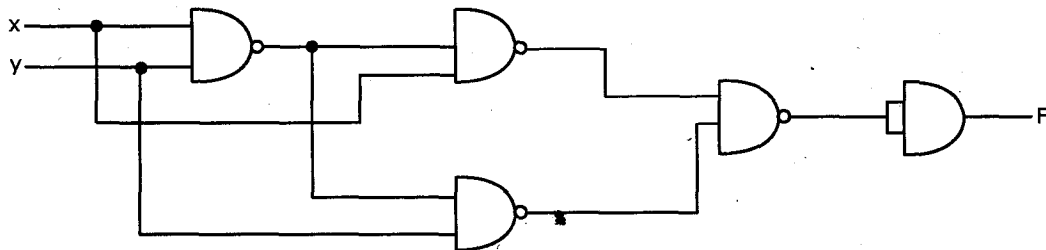
20. A combinational circuit is represented by the following figure:

F is equal to



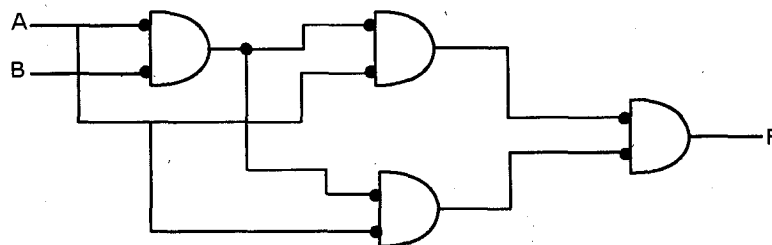
- (A) $\bar{A}\bar{B}C + \bar{A}B\bar{C} + A\bar{B}\bar{C} + \bar{A}\bar{B}\bar{C}$ (B) $ABC + \bar{A}\bar{B}\bar{C} + \bar{A}\bar{B}C + \bar{A}B\bar{C}$
(C) $ABC + \bar{A}\bar{B}\bar{C} + ABC + \bar{A}B\bar{C}$ (D) None of these

21. In the given circuit determine output F.



- (A) $x\bar{y} + \bar{x}y$ (B) $xy + \bar{x}\bar{y}$ (C) xy (D) None of these

22. In the given circuit, $F =$



- (A) $\bar{A}\bar{B} + \bar{A}B$ (B) $AB + \bar{A}\bar{B}$ (C) $A + B$ (D) None of these

23. The Karnaugh map of a four variable function $F(w, x, y, z)$ is given. In POS form, the function is

WX \ YZ				
	00	01	11	10
00		1	1	ϕ
01		1	1	ϕ
11	1	1	ϕ	ϕ
10			1	

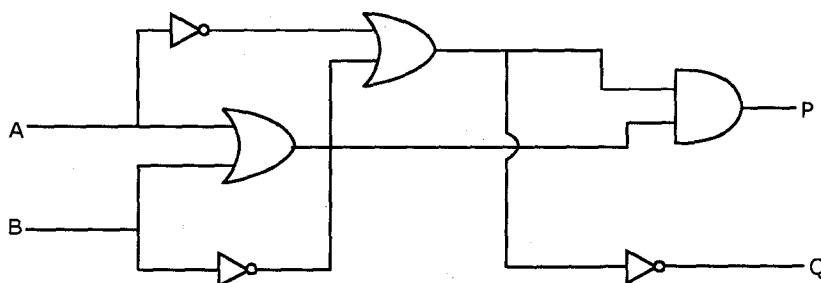
- (A) $F = (\bar{w} + \bar{z})(y + \bar{z})(w + \bar{x} + \bar{y})$ (B) $F = (w + \bar{z})(\bar{w} + \bar{x})(\bar{y} + \bar{z})$
 (C) $F = (w + z)(w + \bar{y})(\bar{w} + x + y)$ (D) $F = (w + z)(\bar{y} + z)(\bar{w} + x + y)$

24. Karnaugh Map of a function is given below. In SOP form, the function is

WX \ YZ				
	00	01	11	10
00	0	0		
01	0	0	ϕ	
11		0	0	
10		0	ϕ	

- (A) $w\bar{z} + y\bar{z} + \bar{w}x\bar{y}$ (B) $\bar{w}y + w\bar{z}$ (C) $wy + \bar{w}z$ (D) $\bar{w}z + \bar{y}z$

25. The given circuit is that of a



- (A) Multiplexer (B) Demultiplexer (C) Half adder (D) Half subtractor

26. A Boolean function is represented by $F = x + yz$. The canonical form in SOP configuration will be

- (A) $\bar{x}\bar{y}\bar{z} + xyz + x\bar{y}\bar{z} + x\bar{y}z + \bar{x}yz$ (B) $xyz + x\bar{y}\bar{z} + x\bar{y}z + x\bar{y}\bar{z} + \bar{x}yz$
 (C) $xyz + \bar{x}\bar{y}\bar{z} + \bar{x}yz + x\bar{y}z + x\bar{y}\bar{z}$ (D) None of these

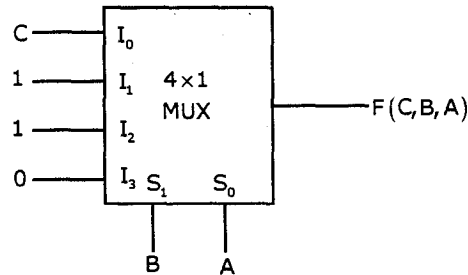
Common Data Questions: 27 & 28

Let $f = \sum(5, 6, 13)$ and
 $f_1 = \sum(0, 1, 2, 3, 5, 6, 8, 9, 10, 11, 13)$
 and $f = f_1 \cdot \bar{f}_2$, where f, f_1, f_2 are function of A, B, C, D

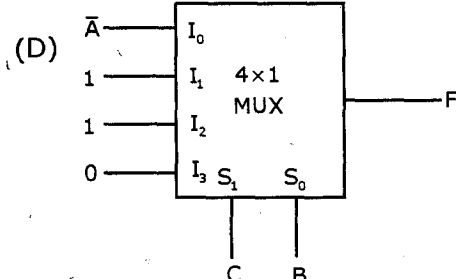
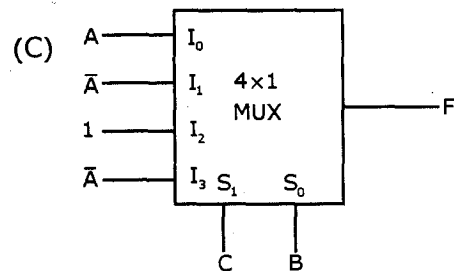
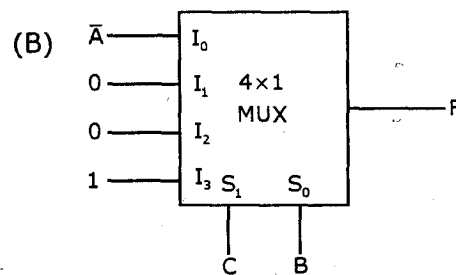
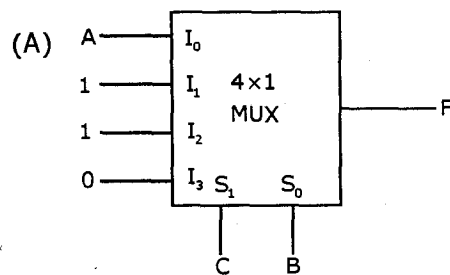
27. Total number of possible expressions for f_2 is
 (A) 1 (B) 2^5 (C) 2^9 (D) 1^{13}
28. Minimal value of f_2 is
 (A) A (B) $\bar{A} + C$ (C) \bar{B} (D) None of these

Statement for Linked Answer Questions: 29 & 30

Consider the given multiplexer.



29. The logic function realized by the given multiplexer arrangement (with MSB C in input line) is
 (A) $F = \sum(1, 2, 4, 5, 6)$ (B) $F = \sum(1, 2)$
 (C) $F = \sum(0, 1, 2)$ (D) $F = \sum(0, 1, 2, 4, 6)$
30. The given multiplexer can be arranged with LSB A in input line by which of the following configuration?



Answer Keys

1	B	2	A	3	A	4	D	5	D	6	B	7	A
8	B	9	D	10	C	11	B	12	D	13	C	14	C
15	D	16	A	17	D	18	D	19	C	20	A	21	B
22	B	23	D	24	B	25	C	26	B	27	B	28	C
29	A	30	C										

Explanations:

1.
$$\begin{aligned}
 A + AB + \bar{A}\bar{B}C + \bar{A}\bar{B}\bar{C}D + \bar{A}\bar{B}\bar{C}\bar{D}E &= A + \bar{A}B + \bar{A}\bar{B}C + \bar{A}\bar{B}\bar{C}(D + \bar{D}E) \\
 &= A + \bar{A}B + \bar{A}\bar{B}(C + \bar{C}(D + \bar{D}E)) = A + \bar{A} + (B + \bar{B}(C + D + E)) \\
 &= A + \bar{A} + (B + C + D + E) = A + B + C + D + E
 \end{aligned}$$
2.
$$A(A + \bar{B})(A + \bar{B} + C) = (AA + A\bar{B})(A + \bar{B} + C) = (A + A\bar{B})(A + \bar{B} + C) = A(A + \bar{B} + C) = A$$

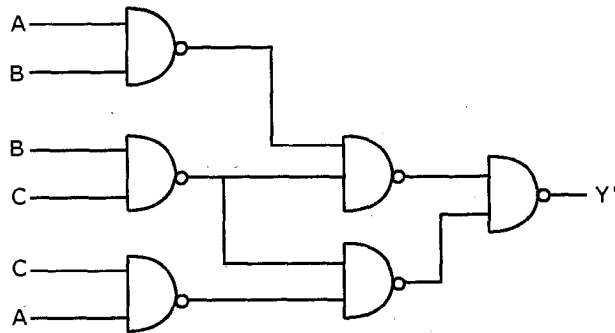
 Hence no NOR gate is required to implement this function
6. For maximum terms, put 0 instead of 1 in the boxes of Karnaugh Map
9.
$$\bar{x} + x\bar{y} = \bar{x}(1 + \bar{y}) + x\bar{y} = \bar{x} + \bar{x}\bar{y} + x\bar{y} = \bar{x} + \bar{y}(x + \bar{x}) = \bar{x} + \bar{y} = \overline{xy}$$
10.
$$AB + ABC + ABD = AB(1 + C + D) = AB$$

$$\overline{\overline{A} + \overline{B}} = \overline{\overline{A}\overline{B}} = AB \quad \therefore \overline{AB + ABC + ABD} = \overline{AB} = \overline{A} + \overline{B}$$
11.
$$\begin{aligned}
 f(A, B, C) &= A + \overline{B + \bar{C}} = A + \bar{B}.C \\
 &= A(B + \bar{B})(C + \bar{C}) + (A + \bar{A})\bar{B}C \\
 &= ABC + AB\bar{C} + A\bar{B}C + A\bar{B}\bar{C} + \bar{A}\bar{B}C \\
 &= \sum m(1, 4, 5, 6, 7) \rightarrow \text{minterms} \\
 f(A, B, C) &= A + \overline{B + \bar{C}} = A + \bar{B}.C = (A + \bar{B})(A + C) \\
 &= (A + \bar{B} + C\bar{C})(A + B\bar{B} + C) \\
 &= (A + \bar{B} + C)(A + \bar{B} + \bar{C})(A + B + C) \\
 &= \pi M(0, 2, 3) \rightarrow \text{max terms}
 \end{aligned}$$

12.

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

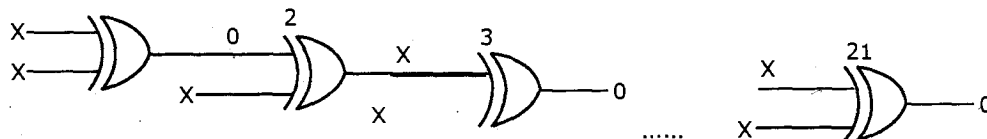
$$\therefore Y' = AB + AC + BC$$



14. Series switch \equiv AND

Parallel switch \equiv OR

15.



18. The adder at LSB does not have any carry in and so a half adder will do. This is valid for a stand alone unit.

19. The Karnaugh map may be redrawn as below:

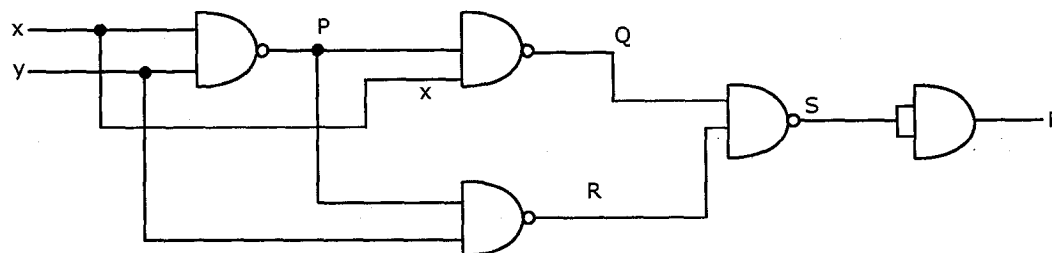
BC	00	01	11	10
A 0			0	1
A 1	1		0	1

$$F(A, B, C) = B + A\bar{C}$$

$$20. F = [A \odot B] \oplus C = \overline{[A \odot B]}C + [A \odot B]\bar{C}$$

$$= [A \oplus B]C + (\overline{AB + \bar{A}\bar{B}})\bar{C} = (\overline{AB} + \overline{\bar{A}\bar{B}})\bar{C} = (\overline{AB} + \overline{\bar{A}\bar{B}})\bar{C} = \overline{AB}C + \overline{\bar{A}\bar{B}}\bar{C} = \overline{AB}C + \overline{\bar{A}\bar{B}}\bar{C}$$

21.



P, Q, R & S are introduced as intermediate terms for solution purpose only

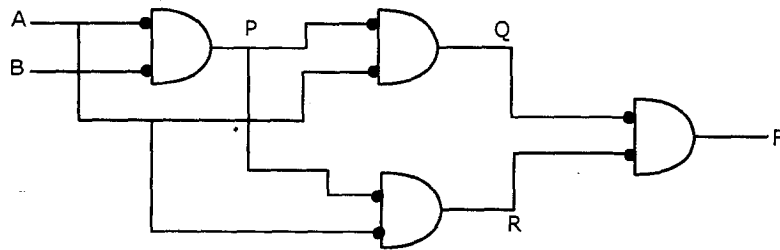
$$P = \overline{xy} = \bar{x} + \bar{y}, \quad Q = \overline{x(\bar{x} + \bar{y})} = \overline{x\bar{y}} = \bar{x} + y$$

$$R = \overline{y(\bar{x} + \bar{y})} = \overline{y\bar{x}} = x + \bar{y}$$

$$S = \overline{QR} = \overline{(x + \bar{y})(\bar{x} + y)} = \overline{xy + \bar{x}\bar{y}} = \overline{xy} + \overline{\bar{x}\bar{y}} = \overline{x \odot y} = x \oplus y$$

$$F = \overline{x \oplus y} = x \odot y$$

22.



$$P = \overline{A}\overline{B}; Q = \overline{A}\overline{B}.A = (A+B)\overline{A} = \overline{A}B$$

$$R = \overline{A}\overline{B}\overline{B} = (A+B)\overline{B} = \overline{A}\overline{B}; F = (\overline{A}\overline{B})(\overline{A}\overline{B}) = (A+\overline{B})(\overline{A}+B) = AB + \overline{A}\overline{B}$$

23. The Karnaugh map is modified as shown below:

YZ WX	00	01	11	10
00	0			φ
01	0			φ
11			φ	φ
10	0	0		0

24. The Karnaugh map is modified as shown below:

$$\therefore F = \overline{w}y + w\overline{z}$$

YZ WX	00	01	11	10
00			1	1
01			φ	1
11	1			1
10	1		φ	1

25. $P = (A+B)(\overline{A}+\overline{B}) = \overline{A}B + A\overline{B} = A \oplus B = S$ (sum of a half adder)

$$Q = \overline{(A+B)} = \overline{A}\overline{B} = C$$
 (carry of a half adder)

26. $x + yz; \quad x = x(y + \overline{y}) = xy + x\overline{y}$

$$\text{Further : } xy = xy(z + \overline{z}) + x\overline{y}(z + \overline{z}) = xyz + xy\overline{z} + x\overline{y}z + x\overline{y}\overline{z}$$

$$yz = yz(x + \overline{x}) = xyz + \overline{x}yz$$

$$\therefore F = xyz + xy\overline{z} + x\overline{y}z + x\overline{y}\overline{z} + xyz + \overline{x}yz = xyz + xy\overline{z} + x\overline{y}z + x\overline{y}\overline{z} + \overline{x}yz$$

27&28. $f = f_1 \cdot \bar{f}_2 \Rightarrow$

	AB	00	01	11	10
CD	00				
	01		1	1	
f	11				
	10		1		

	AB	00	01	11	10
CD	00	1			1
	01	1	1	1	1
f ₁	11	1			1
	10	1	1		1

There are 5 don't case

\therefore possible no. of expression for f_2 is 2^5

$f_2 = \bar{B}$

	AB	00	01	11	10
CD	00	1	X	X	1
	01	1			1
	11	1	X	X	1
	10	1		X	1

29. I - table

\bar{C}	I_0	I_1	I_2	I_3
	0	①	②	3
C	④	⑤	⑥	7

30.

I - table

	I_0	I_1	I_2	I_3
\bar{A}	0	②	④	⑥
A	①	3	⑤	7
	A	\bar{A}	1	\bar{A}

Digital Logic-II

Computer Science Engineering

Test ID:

2	1	2	5
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Duration: 90 minutes

Maximum Marks: 50

Read the following instructions carefully:

1. Write your roll number, your name and name of the examination center at the specified locations of the ORS.
2. Using HB pencil, darken the appropriate bubble under each digit of your registration number and the letters corresponding to your paper code.
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4. Questions must be answered on Objective Response Sheet (ORS) by darkening the appropriate bubble (marked A, B, C, D) using HB pencil against the question number on the left hand side of the ORS. **Each question has only one correct answer.** In case you wish to change an answer, erase the old answer completely. More than one answer bubbled against a question will be treated as a wrong answer.
5. This question paper contains 30 objective type questions. Q.1 to Q.10 carry **one** mark each and Q.11 to Q.30 carry **two** marks each.
6. Un-attempted questions will carry zero marks.
7. The question pair (27, 28) is common data questions.
8. The questions pair (29, 30) is questions with linked answers. The answer to the second question of the above pair will depend on the answer to the first question of the pair. If the first question in the linked pair is wrongly answered or is un-attempted, then the answer to the second question in the pair will not be evaluated.
9. **NEGATIVE MARKING:** For Q.1 to Q.10, $1/3^{\text{rd}}$ mark will be deducted for each wrong answer. For Q. 11 to Q.30, $2/3^{\text{rd}}$ mark will be deducted for each wrong answer. For the pair of questions with linked answers, there will be negative marks only for wrong answer to the first question, i.e. for Q.29, $2/3^{\text{rd}}$ mark will be deducted for wrong answer. There is no negative marking for Q.30.
10. Calculator without data connectivity is allowed in the examination hall. Charts, graph sheets or tables are NOT allowed in the examination hall.
11. Rough work can be done on the question paper itself.

Q. No.1-10 Carry One Mark Each

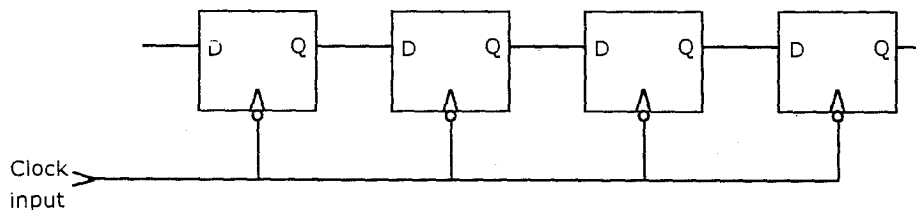
1. If $(212)_x = (153)_8$ then the base x is
(A) 5 (B) 6 (C) 7 (D) 8
2. For an edge-triggered D flip-flop,
(A) A change in the state of an flip-flop occurs only at a clock pulse edge
(B) The state that the flip-flop goes to depends on the D inputs
(C) The output follows the input at each clock pulse
(D) All of these
3. Asynchronous counter differs from a synchronous counter in
(A) the number of states in its sequence (B) the method of clocking
(C) the type of flip-flops used (D) the value of the modulus
4. For a 4-bit synchronous counter, propagation delay through 1 flip-flop is $10\mu\text{s}$.
Calculate the maximum output frequency of the counter.
(A) 100 KHz (B) 90 KHz (C) 71.5 KHz (D) 25 KHz
5. Consider the following conditions:
1. $t_p < \Delta t$
2. $\Delta t < T$
3. $t_p > \Delta t$
4. $\Delta t > T$
Where t_p = pulse width, Δt = propagation delay and T = clock period.
The race around condition in the JK flip-flop can be avoided if
(A) 1 and 2 are satisfied (B) 1 and 4 are satisfied
(C) 2 and 3 are satisfied (D) 3 and 4 are satisfied
6. If a counter needs to count up to 2048, then the minimum number of flip flops needed is
(A) 11 (B) 12 (C) 10 (D) 5
7. Statement (S): JK flip flop is better than SR flip flop as it can avoid race around condition.
Reason (R): JK flip flop rejects the input when both the outputs are 1 unlike SR flip-flop.
(A) S is false
(B) S is true but R is not the correct reason
(C) S is true and R is the reason
(D) S and R are true but not related

8. $(567)_{10}$ when converted to Hex will have the following value
(A) 732 H (B) 237 H (C) 352 H (D) 235 H
9. Excitation table of a flip flop gives
(A) Next state in terms of present state and control inputs
(B) Present state in terms of next state and control inputs
(C) Control inputs in terms of present state and next state
(D) Next state as a function of present state irrespective of control inputs
10. AF12H in decimal form will be
(A) 41325 (B) 44818 (C) 36266 (D) 32326

Q. No. 11 – 30 Carry Two Marks Each

11. $(3233)_4 + (1323)_4 + (3121)_4 + (3333)_4 + (2323)_4 =$
(A) $(13337)_4$ (B) $(13337)_{10}$ (C) $(33331)_4$ (D) $(3333)_{10}$

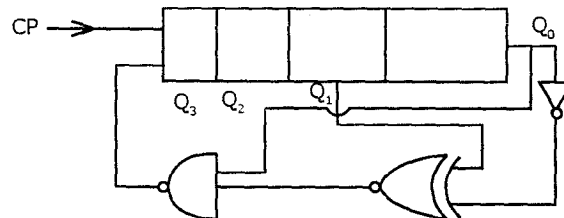
12.



The present state of the given shift register is 0111 (from left). Data input is 000000

After application of a clock pulse the state will be (from left)

- (A) 0111 (B) 0110 (C) 1110 (D) 0011
13. A 4 bit right shift register shown in the figure is configured in the circulating mode. Initial content is 0000. After three pulses, Q_3, Q_2, Q_1, Q_0 will be



- (A) 0000 (B) 1111 (C) 1110 (D) 1001

14. A slice of a signal is given below:

99
4



A slice of the enable signal for a D latch is given below:



Output waveform will be:

- (A)
 (B)
 (C)
 (D) None of these

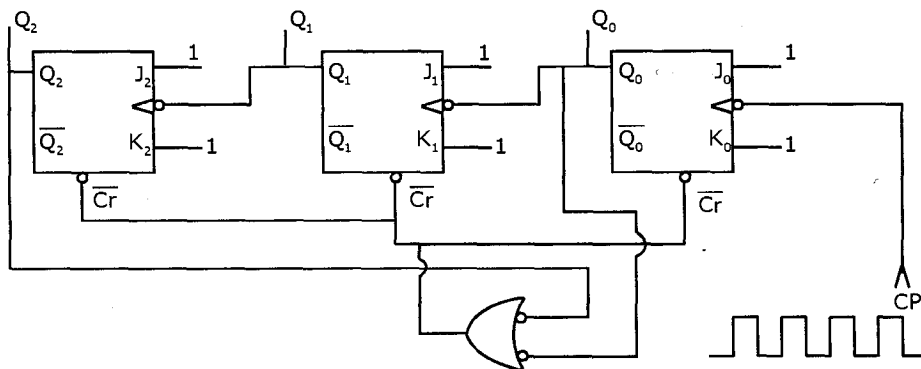
15. A n-stage Johnson counter divides the input clock by a factor equal to
 (A) n (B) 2n (C) n/2 (D) n^2
16. What is the corresponding decimal number corresponding to the 2's complement representation as 111101_2 ?
 (A) -3 (B) -7 (C) -5 (D) -29
17. A decade counter is realized by cascading a MOD 5 counter and a MOD 2 counter. In order to have a perfectly square waveform (50% duty ratio)
 (A) MOD 2 counter should be followed by MOD 5 counter
 (B) MOD 5 counter should be followed by MOD 2 counter
 (C) Neither of (A) and (B) can generate a perfectly square wave form
 (D) Either of (A) and (B) can generate a perfectly square wave form
18. A J-K flip-flop with an input tied to J and the inverse of the input tied to K is equivalent to
 (A) D flip-flop (B) T flip-flop (C) S-R flip-flop (D) None of these
19. The combinational element of a counter can be made with
 (i) flip-flops (ii) Logic gates (iii) PLA (iv) ROM
 (A) i only (B) ii, iii, iv only (C) ii only (D) all
20. An N-bit two's-complement numeral system can represent every integer in the range
 (A) -2^{N-1} to $+2^{N-1}-1$. (B) $-2^{N-1}-1$ to $+2^{N-1}-1$
 (C) -2^N to $+2^{N-1}-1$ (D) -2^N to $+2^N$

-
- ```

graph LR
 X((X)) --- OR((OR))
 OR --- Y((Y))
 Y --- S((S))
 Y --- INV[Inverter]
 INV --- R((R))
 S --- FF[SR Flip-Flop]
 R --- FF
 FF --- Q((Q))
 Q --- OR

```

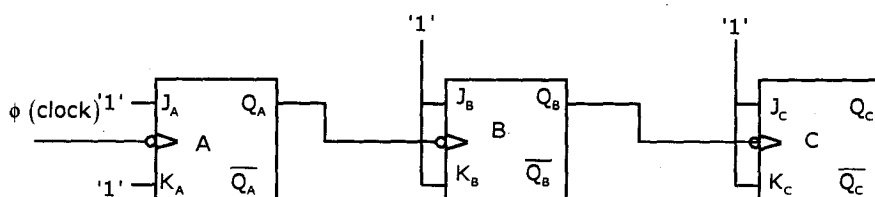
The given circuit is that of a short modulus ripple counter.



27. The MOD number is  
(A) 3 (B) 5 (C) 6 (D) 7
28. If in the given circuit, the two input negative OR gate is fed from  $Q_2$  &  $\overline{Q_0}$  then the MOD number will be  
(A) 5 (B) 0 (C) 2 (D) 4

**Statement for Linked Answer Questions: 29 & 30**

Consider the following counter:



29. The MOD of the counter will be  
(A) 5 (B) 6 (C) 7 (D) 8
30. If the input clock frequency is 1 kHz, the output frequency will be  
(A) 1kHz (B) 0.2kHz (C) 0.125kHz (D) 0.33kHz



[illegible]

[P and S are introduced as intermediate terms for solution only]

| cP | S | Q <sub>3</sub> | Q <sub>2</sub> | Q <sub>1</sub> | Q <sub>0</sub> | $\overline{Q_0}$ | $P = Q_1 \odot \overline{Q_0}$ | $S = \overline{PQ_0}$      |
|----|---|----------------|----------------|----------------|----------------|------------------|--------------------------------|----------------------------|
| 0  | 1 | 0              | 0              | 0              | 0              | 1                | $0 \odot 1 = 0$                | $\overline{0 \cdot 0} = 1$ |
| 1  | 1 | 1              | 0              | 0              | 0              | 1                | $0 \odot 1 = 0$                | $\overline{0 \cdot 0} = 1$ |
| 2  | 1 | 1              | 1              | 0              | 0              | 1                | $0 \odot 1 = 0$                | $\overline{0 \cdot 0} = 1$ |
| 3  | 1 | 1              | 1              | 1              | 0              | 1                | $1 \odot 1 = 1$                | $\overline{1 \cdot 0} = 1$ |
| 4  | 1 | 1              | 1              | 1              | 1              | 0                | $1 \odot 0 = 0$                | $\overline{0 \cdot 1} = 1$ |

25. Take all the digits to a particular base and then solve

$$2 \overline{)98}$$

$$2 \overline{)49} - 0$$

$$2 \overline{)24} - 1$$

$$2 \overline{)12} - 0$$

$$2 \overline{)6} - 0$$

$$2 \overline{)3} - 0$$

$$\overline{)1} - 1$$

$$(98)_{10} = (1100010)_2$$

$$(1D)_{16} = (00011101)_2$$

$$(72)_8 = (111010)_2$$

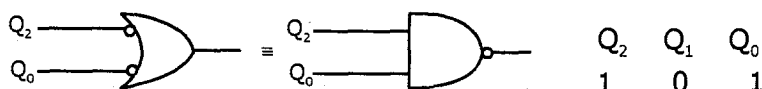
$$(1011)_2$$

Then add up

26.

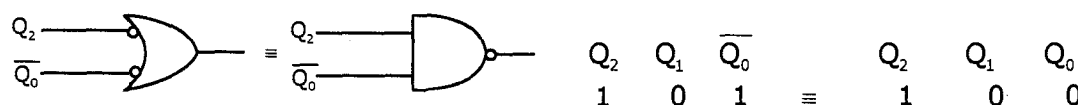
| X | $Q_{n+1}$        |
|---|------------------|
| 0 | $Q_n$            |
| 1 | $\overline{Q_n}$ |

27.



A  $\therefore$  MOD 5 counter

28.



The counter will be MOD 4 counter.

29.

| Clock           | J <sub>A</sub> | K <sub>A</sub> | J <sub>B</sub> | K <sub>B</sub> | J <sub>C</sub> | K <sub>C</sub> | Q <sub>C</sub> | Q <sub>B</sub> | Q <sub>A</sub> |
|-----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| initially       | 1              | 1              | 1              | 1              | 1              | 1              | 0              | 0              | 0              |
| 1 <sup>st</sup> | 1              | 1              | 1              | 1              | 1              | 1              | 0              | 0              | 1              |
| 2 <sup>nd</sup> | 1              | 1              | 1              | 1              | 1              | 1              | 0              | 1              | 0              |
| 3 <sup>rd</sup> | 1              | 1              | 1              | 1              | 1              | 1              | 0              | 1              | 1              |
| 4 <sup>th</sup> | 1              | 1              | 1              | 1              | 1              | 1              | 1              | 0              | 0              |
| 5 <sup>th</sup> | 1              | 1              | 1              | 1              | 1              | 1              | 1              | 0              | 1              |
| 6 <sup>th</sup> | 1              | 1              | 1              | 1              | 1              | 1              | 1              | 1              | 0              |
| 7 <sup>th</sup> | 1              | 1              | 1              | 1              | 1              | 1              | 1              | 1              | 1              |
| 8 <sup>th</sup> | 1              | 1              | 1              | 1              | 1              | 1              | 0              | 0              | 0              |

30.  $\text{output frequency} = \frac{\text{input frequency}}{\text{MOD}} = \frac{1\text{kHz}}{8} = 0.125\text{kHz}$

# Digital Logic-III

## Computer Science Engineering

Test ID: 

|   |   |   |   |
|---|---|---|---|
| 2 | 1 | 2 | 6 |
|---|---|---|---|

Duration: 90 minutes

Maximum Marks: 50

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**Read the following instructions carefully:**

1. Write your roll number, your name and name of the examination center at the specified locations of the ORS.
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11. Rough work can be done on the question paper itself.

**Q. No. 1 – 10 Carry One Mark Each**

1. Select the derivation with minimum number of literals for the function represented by the following K-map.

(A)  $X_1Y_1' + X_0Y_1'Y_0' + X_1X_0Y_0'$

(B)  $X_1Y_1 + X_0Y_1Y_0 + X_1X_0Y_0$

(C)  $X_1'Y_1 + X_0'Y_1Y_0 + X_1'X_0'Y_0$

(D) None of these

|          |    | $Y_1Y_0$ |    |    |    |
|----------|----|----------|----|----|----|
| $X_1X_0$ |    | 00       | 01 | 11 | 10 |
|          | 00 |          |    |    |    |
|          | 01 | 1        |    |    |    |
|          | 11 | 1        | 1  |    | 1  |
|          | 10 | 1        | 1  |    |    |

2. What is the minimal canonical sum of products representation of the function  $f(x, y, z) = xy' + y(x + z)$ ?

(A)  $f(x, y, z) = xy' + xy + yz$

(B)  $f(x, y, z) = xy'z + xy'z' + xyz + x'yz + xyz'$

(C)  $f(x, y, z) = x + yz$

(D)  $f(x, y, z) = (x + y + z)(x + y + z')(x + y' + z)$

3. Essential prime implicant is

(A) A sub-cube that is not contained within any other sub-cube

(B) A sub-cube that includes a 1-minterm that is not included in any other subcube.

(C) Both A and B

(D) None of these

4. What is the binary equivalent of the decimal number  $(13.375)_{10}$ ?

(A)  $(1101.110)_2$       (B)  $(1101.010)_2$       (C)  $(1101.011)_2$       (D)  $(1101.0101)_2$

5. For which value of  $r$  the following equation will be satisfied?

$$\sqrt{(100)_r} = (8)_{10}$$

(A) 9

(B) 10

(C) 11

(D) 8

6. What is the 2's complement representation of 60?

(A) 10111100

(B) 11000100

(C) 11000011

(D) None of these

7. A four bit down counter can count from

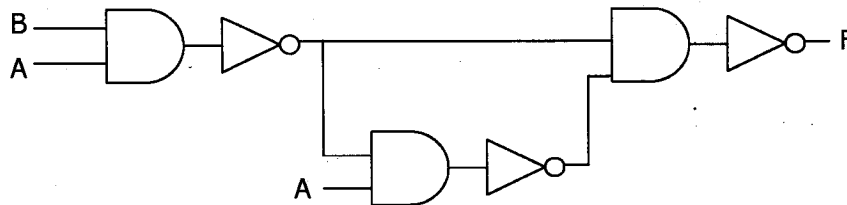
(A) 0000 to 1111

(B) 1111 to 0000

(C) 000 to 111

(D) 111 to 000

8. In the following logic circuit, the function F is



- (A) A (B) B (C)  $A+B$  (D)  $A + \bar{B}$
9. Consider the representation of 6-bit numbers by 2's complement, 1's complement, or by signed magnitude. In which of the representation, overflow occurs from the addition of the integers 011100 and 011100?
- (A) 2's complement only  
(B) Signed magnitude and 1's complement only  
(C) 2's complement and 1's complement only  
(D) All three representations
10. What is the minimum numbers of gates required to evaluate the Boolean expression  $AB + BC(B + C)$  ?
- (A) 2 (B) 3 (C) 1 (D) 4

**Q. No.11-30 Carry Two Marks Each**

11. The k-map shown below illustrates a switching function  $F(A,B,C,D)$  that includes five don't cares.

| AB \ CD |    |    |    |    |
|---------|----|----|----|----|
|         | 00 | 01 | 11 | 10 |
| 00      | X  | X  | 1  | X  |
| 01      | 0  | 0  | 1  | 0  |
| 11      | 1  | 1  | X  | X  |
| 10      | 1  | 0  | 1  | 1  |

Which of the following expressions is / are valid representations of F?

I.  $AB+CD+AD$

II.  $AB + CD + \bar{B}\bar{D}$

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

- (A) I only (B) I and II only (C) II and III only (D) I, II and III

12. How many flip-flops are to be complimented to reach the next count after "101101111" in the counter?

- (A) 5 (B) 6 (C) 7 (D) 8

13. Consider the sequential circuit specified by

$$D_A = AX + BX$$

$$D_B = \bar{A}X$$

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

Which of the following state transition(s) of (A, B) is / are not possible?

- I.  $(0,0) \rightarrow (0,1)$     II.  $(0,1) \rightarrow (1,0)$     III.  $(1,0) \rightarrow (1,1)$

- (A) I only    (B) II only    (C) II and III    (D) None of these

14. What is the input sequence, which will result in the state transitions  $(0,1) \rightarrow (1,1) \rightarrow (0,0)$  in the above circuit?

- (A) 00    (B) 01    (C) 11    (D) 10

15. The initial state of Mod 10 up counter is 1000. After 53 clock pulses the state of the counter will be

- (A) 1000    (B) 0001    (C) 0010    (D) 1001

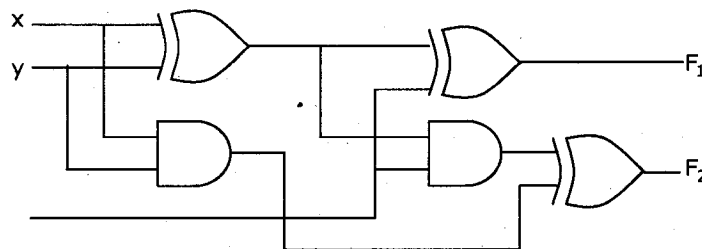
16. A product of sums expression for the function  $B\bar{D} + \bar{C}D$  is

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

17. Given the function  $f(x,y,z,w)$  is equal to  $yw + x'w + x'y' + y'w'$ . Which of the following is / are essential prime implicants?

- I.  $yw$     II.  $x'y'$     III.  $x'w$     IV.  $y'w'$   
(A) I and II only    (B) I, II and III only    (C) I, II, III, IV    (D) I and IV only

- 18.



Which of the following is TRUE about the above logic diagram?

- (A) Implementation of Full Subtractor with two half subtractions  
(B) Implementation of Full Adder with two half Adders  
(C) Implementation of Full Adder with two half adders and an XOR gate  
(D) None of these

19. Match List II with List I

| List I |                | List II |                 |
|--------|----------------|---------|-----------------|
| P      | Decoder        | 1       | Asynchronous    |
| Q      | Encoder        | 2       | Binary to Octal |
| R      | Multiplexer    | 3       | Data Selector   |
| S      | Ripple Counter | 4       | Octal to Binary |

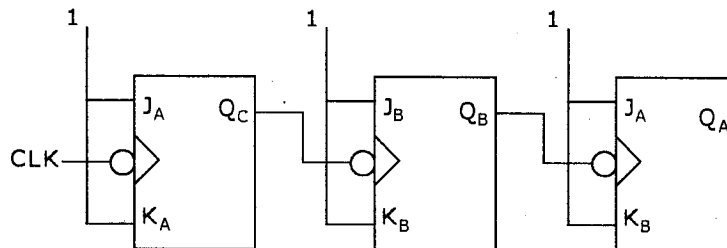
(A) P-2, Q-4, R-3, S-1

(B) P-4, Q-3, R-1, S-2

(C) P-1, Q-2, R-3, S-4

(D) P-2, Q-1, R-3, S-4

20. Determine the modulus of the following



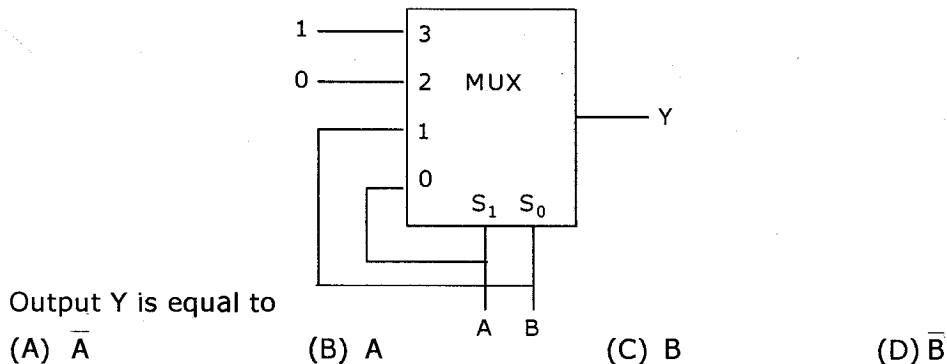
(A) Asynchronous mod 8 Up counter

(B) Synchronous mod 8 Up counter

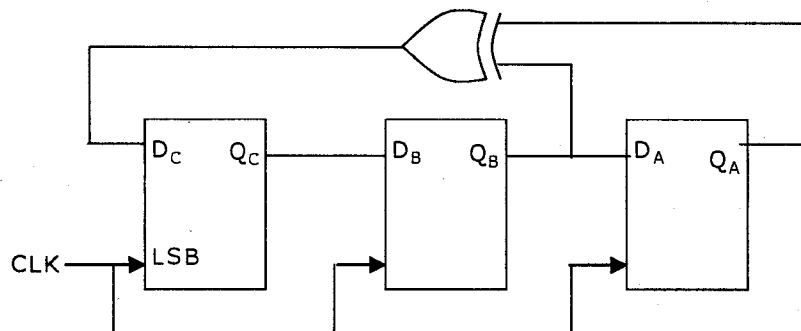
(C) Asynchronous mod 8 Down counter

(D) Synchronous mod 8 Up counter

21. Consider the following Multiplexer



22. Consider the following sequential circuit.





(D) None of these

(D)  $AX\bar{Y} + BY\bar{X} + AB$

(D) 4

(D) 2 in SOP, 2 in POS

26. In majority function in combinational logic, what is the output of three inputs(A,B,C) ?

(A)  $AB+BC$  (B)  $AB+BC+AC$  (C)  $A+BC$  (D)  $A+B\oplus C$

**Common Data Questions: 27 & 28**

Consider a shift register with an initial value of 10110011. Let the serial input be 11100011. The serial input is connected as input of the MSB flip flop.

27. The number of clock pulses to be applied to reach the value 01110110 in register is

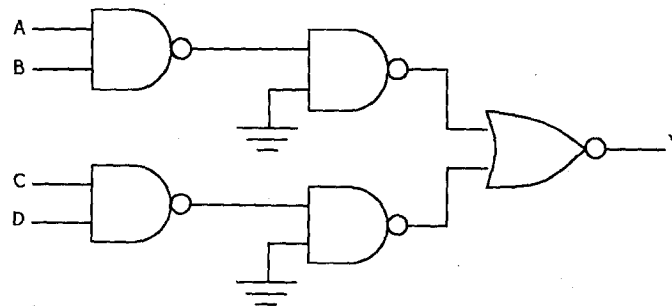
(A) 3 (B) 2 (C) 1 (D) 4

28. What is the value of register after applying 4-clock pulses, starting with the initial value? (Assume that now serial output is connected to serial input)

(A) 11101100 (B) 00111011 (C) 10110011 (D) 10010011

**Statement for Linked Answer Questions: 29 & 30**

Look at the following combinational circuit



29. The output of the given logic circuit is  
(A)  $\bar{A}$  (B) B (C) 1 (D) 0
30. The output obtained in the above is given to two input EX-OR gate with one input EX-OR gate with one input connected to +5V, then output of EX-OR gate is  
(A) A (B) B (C) 0 (D) 1

**Answer Keys**

|    |   |    |   |    |   |    |   |    |   |    |   |    |   |
|----|---|----|---|----|---|----|---|----|---|----|---|----|---|
| 1  | A | 2  | C | 3  | B | 4  | C | 5  | D | 6  | B | 7  | B |
| 8  | A | 9  | D | 10 | A | 11 | C | 12 | B | 13 | C | 14 | D |
| 15 | B | 16 | C | 17 | D | 18 | C | 19 | A | 20 | A | 21 | C |
| 22 | B | 23 | A | 24 | B | 25 | D | 26 | B | 27 | A | 28 | B |
| 29 | D | 30 | D |    |   |    |   |    |   |    |   |    |   |

**Explanations:-**

1.

|           |    |           |    |    |    |
|-----------|----|-----------|----|----|----|
|           |    | $Y_1 Y_0$ |    |    |    |
| $X_1 X_0$ |    | 00        | 01 | 11 | 10 |
|           | 00 |           |    |    |    |
|           | 01 | 1         |    |    |    |
|           | 11 | 1         | 1  |    | 1  |
|           | 10 | 1         | 1  |    |    |

$$o/p = X_1 Y_1' + X_0 Y_1' Y_0' + X_1 X_0 Y_0'$$

2.  $f = xy' + yx + yz, f = x(y' + y) + yz, f = x + yz$

3. The sub-cube which contains one or more distinguished 1's

4.  $13 \rightarrow 1101, 0.375 \rightarrow (1101.011)_2$

5.  $1 \times 8^2 + 0 \times 8^1 + 0 \times 8^0 = (64)_{10} \Rightarrow \sqrt{64} = (8)_{10}$

8.  $((((AB)' . A)' (AB)'))' = (AB)' A + AB = (A' + B') A + AB = AB' + AB = A(B' + B) = A$

11.  $AB + CD + \overline{BD}; F' = A'C' + A'D' + B'C'D, F = (A+C)(A+D)(B+C+D')$

13.

| present |   |   | Next state |   |
|---------|---|---|------------|---|
| A       | B | X | A          | B |
| 0       | 0 | 0 | 0          | 0 |
| 0       | 0 | 1 | 0          | 1 |
| 0       | 1 | 0 | 0          | 0 |
| 0       | 1 | 1 | 1          | 1 |
| 1       | 0 | 0 | 0          | 0 |
| 1       | 0 | 1 | 1          | 0 |
| 1       | 1 | 0 | 0          | 0 |
| 1       | 1 | 1 | 1          | 0 |

$$D_A = AX + BX; D_B = \overline{AX}, (0,0) \text{ to } (0,1) \text{ only possible}$$

14. To change form

(0,1) to (1,1); input is 1. To change from (1,1) to (0,0), input is 0.

$S_0$  is 10

16.  $SOP = BD + \overline{CD}$

$$POS = \overline{F} = CD + \overline{BD}; F = \overline{(CD + \overline{BD})} = (\overline{C} + \overline{D})(B + D)$$

17. Essential are the cubes contains atleast one distinguishable 1's. So they are  $y'w'$  and  $yw$ .

$$21. y = \overline{A}BA + \overline{A}B \cdot B + A\overline{B} \cdot 0 + AB \cdot 1 = 0 + \overline{A}B + AB = (\overline{A} + A)B = B$$

$$23. \overline{A}BX + \overline{A}B\overline{X} + A\overline{B}Y + A\overline{B}\overline{Y}$$

$$\overline{A}[\overline{B}X + B\overline{X}] + A[\overline{B}Y + B\overline{Y}]$$

24. BD and  $B'D'$  are essential prime implicants.

$$25. SOP = X' + Z; POS = XZ'$$

26.

| A | B | C | F |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 |
| 1 | 0 | 0 | 0 |
| 1 | 0 | 1 | 1 |
| 1 | 1 | 0 | 1 |
| 1 | 1 | 1 | 1 |

$$F = AB + BC + AC$$

$o/p$  is equal to 1 when number of one's are more in the input.

27. 10110011

1 → 11011001

1 → 11101100

0 → 01110110

After 3 pulses

28. 10110011 → 11011001 → 11101100 → 01110110

↓  
00111011

# Computer Organization-I

## Computer Science Engineering

Test ID: 

|   |   |   |   |
|---|---|---|---|
| 2 | 1 | 2 | 7 |
|---|---|---|---|

Duration: 90 minutes

Maximum Marks: 50

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**Read the following instructions carefully:**

1. Write your roll number, your name and name of the examination center at the specified locations of the ORS.
2. Using HB pencil, darken the appropriate bubble under each digit of your registration number and the letters corresponding to your paper code.
3. All the questions in this question paper are of objective type.
4. Questions must be answered on Objective Response Sheet (ORS) by darkening the appropriate bubble (marked A, B, C, D) using HB pencil against the question number on the left hand side of the ORS. **Each question has only one correct answer.** In case you wish to change an answer, erase the old answer completely. More than one answer bubbled against a question will be treated as a wrong answer.
5. This question paper contains 30 objective type questions. Q.1 to Q.10 carry **one** mark each and Q.11 to Q.30 carry **two** marks each.
6. Un-attempted questions will carry zero marks.
7. The question pair (27, 28) is common data questions.
8. The questions pair (29, 30) is questions with linked answers. The answer to the second question of the above pair will depend on the answer to the first question of the pair. If the first question in the linked pair is wrongly answered or is un-attempted, then the answer to the second question in the pair will not be evaluated.
9. **NEGATIVE MARKING:** For Q.1 to Q.10, 1/3<sup>rd</sup> mark will be deducted for each wrong answer. For Q. 11 to Q.30, 2/3<sup>rd</sup> mark will be deducted for each wrong answer. For the pair of questions with linked answers, there will be negative marks only for wrong answer to the first question, i.e. for Q.29, 2/3<sup>rd</sup> mark will be deducted for wrong answer. There is no negative marking for Q.30.
10. Calculator without data connectivity is allowed in the examination hall. Charts, graph sheets or tables are NOT allowed in the examination hall.
11. Rough work can be done on the question paper itself.

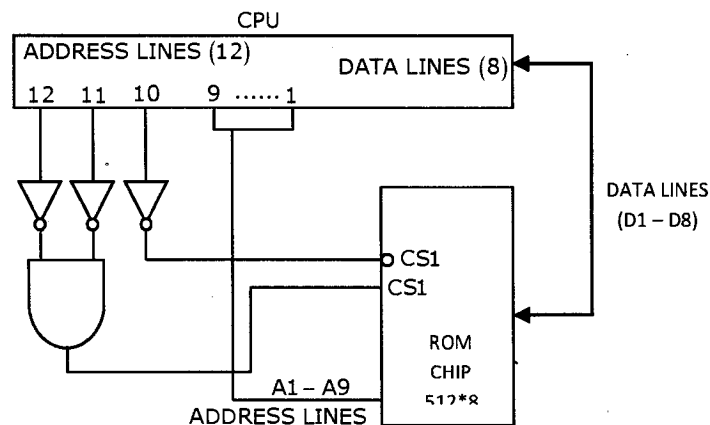
**Q. No. 1 – 10 Carry One Mark Each**

1. Purpose of memory hierarchy is  
(A) To reduce average memory access time  
(B) To reduce memory cost per bit  
(C) Both (A) & (B) (D) None of these
2. A computer uses 1 GB of main memory. Memory is byte addressable.  
How many address lines are required to connect this memory with the computer?  
(A) 10 lines (B) 20 lines (C) 30 lines (D) None of these
3. Which of the following is the slowest mode of input?  
(A) DMA (B) Interrupt driven input  
(C) Program controlled input (D) none of these
4. An input processor has got the following facilities  
(A) DMA (B) Interrupt support  
(C) Both (A) & (B) (D) None of these
5. Which control unit is used to mimic the behavior of the other CPU?  
(A) Hardwired (B) horizontal (C) vertical (D) none of these
6. Assume a CPU takes 17 cycles in worst case to execute an instruction. Number of cycles required to execute current instruction by CPU is 12. If an interrupt occurs while executing current instruction, then after how many cycles it will be recognized?  
(A) 17 (B) 11 (C) 12 (D) 17+12
7. For executing indirect address instructions, the following machine cycles(s) is/are performed.  
(A) Fetch Cycle (B) Indirect Cycle (C) Execute Cycle (D) All
8. Which of the following technique is used for connecting key board devices with the CPU?  
(A) Interrupt driven input (B) DMA request  
(C) Program controlled input (D) None of these
9. What is the name of the technique used for polling the input devices whenever an interrupt occurs?  
(A) Daisy chain technique (B) Interrupt vector technique  
(C) Both (A) and (B) (D) None of these

10. A processor has average instruction execution time as 2 micro seconds, then the MIPS rate of the processor is  
(A) 5 MIPS (B) 2 MIPS (C) 0.5 MIPS (D) None of these

11. Consider a computer with 4 floating point processors suppose that each processor uses a cycle time of 40nsec. How long will it take to perform 400 floating point operations and also what is the time, if the operations are carried out on a single processor with cycle time of 10nsec?  
(A) 400nsec, 4000nsec (B) 4000nsec, 4000nsec  
(C) 4000nsec, 400nsec (D) None of these

12. A ROM chip of capacity  $512 \times 8$  bits is connected to the CPU which has 12 bit address bus. The connection is shown below.



What is the range of addresses allocated to the ROM shown in the diagram?

- (A) 400H-5FFH (B) 200H-3FFH (C) 200H-2FFH (D) 500-6FFH  
(H- Here refers to hexadecimal number)
13. A computer uses 1 GB of main memory. Suppose the memory is word organized and the word size is 64 bits. Then, how many address lines are required to connect the memory with the computer?  
(A) 27lines (B) 30lines (C) 20lines (D) None of these

14. A typical CPU uses the following instruction format  
15-----1312-----1110-----0

|        |                 |               |
|--------|-----------------|---------------|
| Opcode | Addressing mode | Address field |
|--------|-----------------|---------------|

←-----16 bits -----→

Each instruction is stored in one memory word.

What is the maximum capacity of main memory, which can be connected with this CPU?

- (A)  $2^9$  bytes (B)  $2^{10}$  bytes (C)  $2^{12}$  bytes (D) None of these

15. A CPU is operating at 100 Mega Hertz. Assume that 25% of the time the CPU Performs 1 micro operation in one Clock pulse duration, another 25% of the time the CPU Perform 2 micro operations in one clock pulse duration and remaining 50% of the time it performs 3 micro operations in one clock pulse duration. The CPU requires performing 5 micro operations on the average to fetch, execute and execute on machine language instruction. Calculate the speed of the CPU in MIPS.

(A) 50 MIPS (B) 45 MIPS (C) 60 MIPS (D) None of these

16. Match the following:

|    | A                       |    | B                   |
|----|-------------------------|----|---------------------|
| 1. | int *p\$a;              | a. | Index addressing    |
| 2. | while (i++ ≤ 0);        | b. | Auto increment      |
| 3. | for(i = 0; i < 10; i++) | c. | Indirect addressing |

(A) 1-a; 2-b; 3-c (B) 1-a; 2-c; 3-b (C) 1-c; 2-b; 3-a (D) 1-c; 2-a; 3-b

17. There are 64 general purpose register in a system and instruction size is 16bits. If there are 10 two-address instructions, then how many one address instructions are possible?

(A)  $6 \times 2^6$  (B)  $5 \times 2^6$  (C)  $7 \times 2^6$  (D)  $2^{14}$

18. If we want to read 1024 bytes in programmed input mode CPU, then the time required to read the data is (neglect seek and rotational latency)

(A) 630  $\mu$ s (B) 620  $\mu$ s (C) 625  $\mu$ s (D) 600  $\mu$ s

19. Number of bits required in control word for horizontal and vertical micro programming with following signal specification is

S1=10 Signal

S2=33 Signal

S3=13 Signal

(A) 33,10 (B) 33,14 (C) 56,14 (D) 56,13

20. Which of the following control unit is the fastest?

(A) Hardwired (B) horizontal (C) vertical (D) Both (B) and (C)

21. A HDD has the following specifications

Number of surface = 8

Number of track / surface = 128

Number of sectors / track=128

No. of bytes /sector = 512

RPM=3000

Assume DMA initialization takes 200ms and bus speed is 8GHz. Time taken in  $\mu$ s to read 1024 bytes in cycle steering is \_\_\_\_\_. Assume bus is 32bit.

(A) 200 (B) 200.64 (C) 200.128 (D) 200.32



22. A HDD has the following specifications  
Number of surface = 4  
Number of track / surface = 128  
Number of sectors / track = 128  
No. of bytes / sector = 512  
RPM = 6000  
If we neglect the DMA initialization time, percentage of CPU time saved in operating in DMA mode v/s Programmed I/O mode (assume bus is 8GHz with 32 bit wide)  
(A) 5000 times (B) 2000 times (C) 6000 times (D) 8000 times
23. Zero-address instruction is which CPU organization?  
(A) Stack Organization (B) General Register  
(C) Single register organization (D) None of these
24. In a 32-bit floating point number with normalized mantissa and Excess-64 exponent Base 16, the number  $16^{-65}$  denotes  
(A) Floating point overflow (B) Negative floating point overflow  
(C) All 0's in exponent and mantissa field  
(D) The minimum re-presentable positive number
25. A micro-program control unit is required to generate a total of 25 control signals. Assume that during any micro-instruction at most two control signals are active, minimum number of bits required in the control word to generate the required control signal will be  
(A) 2 (B) 2.5 (C) 10 (D) 12
26. How many separate address and data lines are needed for a memory of  $8K \times 16$ ?  
(A) 13 address, 3 data lines (B) 13 address, 16 data lines  
(C) 12 address, 4 data lines (D) 13 address, 4 data lines

**Common Data Questions: 27 & 28**

A PC – Relative mode branch instruction is 3 bytes long. The address of the instruction in decimal is 342038.

27. Determine the branch target address, if the signed displacement in the instruction is -31.  
(A) 342031 (B) 342010 (C) 342007 (D) 342069
28. What is the branch address, if the base and index registers contain the values 480220 and 9 respectively?  
(Assume base with index addressing mode is used)  
(A) 480198 (B) 480229 (C) 480250 (D) 480220

**Statement for Linked Answer Questions: 29 & 30**

27. The content of accumulator (AC) and the extra bit E initially has hexadecimal 079C and 1 respectively. A subroutine is executed to circulate E and AC four times to the right.

29. What are the contents of AC and E respectively in Hexadecimal?

- (A) 9079, 1      (B) 20F3, 0      (C) C232, 0      (D) 9079, 0

30. What is the content of AC after circular shift left is performed on AC and E for the correct option above?

- (A) 90F0      (B) 20F3      (C) 20F2      (D) 8465

**Answer Keys**

|    |   |    |   |    |   |    |   |    |   |    |   |    |   |
|----|---|----|---|----|---|----|---|----|---|----|---|----|---|
| 1  | C | 2  | C | 3  | C | 4  | C | 5  | B | 6  | C | 7  | D |
| 8  | A | 9  | A | 10 | C | 11 | B | 12 | B | 13 | A | 14 | C |
| 15 | B | 16 | C | 17 | A | 18 | C | 19 | C | 20 | A | 21 | D |
| 22 | A | 23 | A | 24 | D | 25 | C | 26 | B | 27 | B | 28 | A |
| 29 | A | 30 | B |    |   |    |   |    |   |    |   |    |   |

**Explanation:-**

5. Horizontal control unit is used to mimic the behaviour of other CPU

6. 12 cycles after executing current instruction CPU checks for the interrupt

16. Pointer indirect with auto

17. bits for register =  $\log_2 64 = 6$

Total Bits=16

number of registers 64

each register address requires 6 bits

Two address instructions =10

4+6+6

remaining =  $4 \times 2^6$

18. bytes / track =  $128 \times 512 = 2^9 \times 2^7 = 2^{15}$

$$\text{RPM} = \frac{60}{3000} = \frac{1}{50} \text{ sec}$$

Xffer rate =  $2^{15} \times 50 \text{ bytes/sec}$

$$\text{Time to transfer 1024 bytes} = \frac{1024}{2^{15} \times 50} = 625 \mu\text{s}$$

19. Horizontal =  $10 + 33 + 13 = 56$

$$\text{Vertical} = \lceil \log_2 10 \rceil + \lceil \log_2 33 \rceil + \lceil \log_2 13 \rceil = 4 + 6 + 4 = 14$$

20. Hardwired is the fastest as it is made up of hardware

21. Transfer rate =  $128 \times 512 \times 50 \text{ bytes/sec} = 128 \times 512 \times 4 \times 12.5$

$$1024 \text{ bytes will take how much time bus} = \frac{1024}{4} = 256 \text{ times}$$

bus speed 8GHz means

$$1 \text{ bus transfer require} = \frac{1}{8 \times 10^9} \text{ sec; So for 256 require} = \frac{256}{8 \times 10^9} = 32 \text{ n sec}$$

$$\text{Total time} = 200 \mu\text{s} + 32 \text{ ns} = 200.32 \mu\text{s}.$$

22. In programmed Input output mode, to transfer  $128 \times 512 \times 100$  bytes time required

Transfer rate of HDD =  $128 \times 512 \times 100$  bytes/sec

time required = 1 sec.

In DMA mode, we require

$$\frac{128 \times 512 \times 100}{4 \times 8 \times 10^9} = \frac{1024 \times 2 \times 100}{10^9} = 2 \times 10^{-4} \text{ sec} = 200 \mu\text{s}$$

$$\text{Time saved} = \frac{1}{200 \mu\text{s}} = \frac{10^6}{200} = 5000 \text{ times}$$

25. 2-bits required for active one's, 5-bits are required for remaining 23 bits.  
Therefore 7 bits are required. Among the options 10 is the minimum one. So is the answer is Option (C)

26. memory size =  $8k \times 16 = 2^{13} \times 16$ , So, address line = 13, data line = 16

27. Branch address = PC + Displacement

Instruction Occupies 3 bytes

Then PC =  $342038 + 3 = 342041$

Target branch address =  $342041 + (-31) = 342010$

28. Branch address in base indexed

Addressing mode = base + Index + Displacement =  $480220 + 9 + (-31) = 480198$

- 29.

|                             | E             | AC                                                            |
|-----------------------------|---------------|---------------------------------------------------------------|
| Initial                     | → 1           | → 0000 0111 1001 1100                                         |
| After 1 <sup>st</sup> shift | → 0           | → 10000011 1100 1110                                          |
| After 2 <sup>nd</sup> shift | → 0           | → 0100000111100111                                            |
| After 3 <sup>rd</sup> shift | → 1           | → 0010000011110011                                            |
| After 4 <sup>th</sup> shift | $\frac{1}{4}$ | $\frac{100}{9} \frac{10000}{0} \frac{0111}{7} \frac{1001}{9}$ |

- 30.

After circular left

|               |                                                       |
|---------------|-------------------------------------------------------|
| → 1           | 1001 0000 0111 1001                                   |
| $\frac{1}{E}$ | 0010                      0000 $\frac{1111}{AC}$ 0011 |

AC = 20F3

# Computer Organization-II

## Computer Science Engineering

Test ID: 

|   |   |   |   |
|---|---|---|---|
| 2 | 1 | 2 | 8 |
|---|---|---|---|

Duration: 90 minutes

Maximum Marks: 50

---

### Read the following instructions carefully:

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**Q. No. 1 – 10 Carry One Mark Each**

1. Instruction level parallelism is achieved through  
(A) Multi processors (B) Array processors  
(C) Pipelined processors (D) None of these
2. The advantage of pipeline processing is  
(A) Design of control unit is simplified (B) Design of ALU is simplified  
(C) Instruction throughput is increased (D) None of these
3. The reasons which prevent the pipeline from operating at its maximum speed are  
(A) Resource conflict (B) Branch problem  
(C) Data dependency (D) All of these
4. Re ordering of instructions by the compilers can be useful  
(A) for avoiding NOPs (B) for improving the throughput  
(C) both (A) and (B) (D) none of these
5. In case of write back policy if data is not available in cache  
(A) It is directly written over RAM  
(B) It is first brought into cache and then update both cache and RAM  
(C) It is first brought into cache and update only cache  
(D) None of these
6. Amount of time required to access L1 cache is 4ns, having hit ratio as 80% and main memory access time is 1ms. What is average access time?  
(A) 200005ns (B) 200006ns (C) 200007ns (D) 200004ns
7. A cache needs an access time of 20ns and main memory 120nsec, what is the average access time of CPU (assume hit ratio = 80%)?  
(A) 30nsec (B) 44nsec (C) 35nsec (D) 45nsec
8. Which of the following is similar to EEPROMS?  
(A) Disk (B) Tape (C) CDROM (D) Flash Drives
9. Which of the following result in data hazard?  
(A) Output of previous instruction required by current  
(B) Unavailability of instruction  
(C) Unavailability of Hardware resource (D) None of these
10. Assume there are 4 stages in pipeline with each stage taking 1ns, 2ns, 1ns, 3ns. Operating system in pipeline mode over non-pipelining mode will be benefited by  
(A) 1.33 (B) 1.66 (C) 2 (D) 2.33

**Q. No. 11 – 30 Carry Two Marks Each**

11. Match the following:

**LIST I****LIST II**

- |                        |                        |
|------------------------|------------------------|
| (a) Activation record  | (1) Linking loader     |
| (b) Location counter   | (2) Garbage collection |
| (c) Reference counts   | (3) Subroutine call    |
| (d) Address relocation | (4) Assembler          |

- |                              |                              |
|------------------------------|------------------------------|
| (A) a-3    b-4    c-1    d-2 | (B) a-4    b-3    c-1    d-2 |
| (C) a-4    b-3    c-2    d-1 | (D) a-3    b-4    c-2    d-1 |

12. Consider the following program:

```
int array A(1...4,1.....10);
sum = 0;
for int i = 0 to 9;
 sum := sum + A(0,i);
```

Consider following specification.

Data cache size is eight blocks. Also assume that each block contains 16 bit word; data and memory is word addressable. Now suppose a 4 x 10 array of number each occupying one word, is stored in main memory of size 40 word in column major order.

If direct mapping is used, which one of the following set will be mapped into 0 block?

- |                            |                            |
|----------------------------|----------------------------|
| (A) A(0,0), A(0,4), A(0,8) | (B) A(0,0), A(0,2), A(0,4) |
| (C) Both (A) & (B)         | (D) None of these          |

13. RAM is called DRAM (Dynamic RAM) when

- (A) It is always moving around data
- (B) It require periodic refreshing
- (C) It can do several things simultaneously
- (D) None of these

14. Using a sequential implementation, it takes a total of 320ns for each instruction:- 300ns for the combinational logic to complete, and 20ns to store the result (in register). This means that the throughput will be about 3.12MIPS. You switch to a 3 stage pipeline by splitting the combinational logic into three equal units taking 100ns per unit, and each registers take 20ns to store the result.

How long will it take for the first instruction to execute in the pipelined implementation?

- |           |           |           |           |
|-----------|-----------|-----------|-----------|
| (A) 300ns | (B) 360ns | (C) 260ns | (D) 200ns |
|-----------|-----------|-----------|-----------|

15. We are to simulate a cache of 16 words, 2-way set associate cache with 2 word cache lines and LRU replacement policy is used; assume the cache is initially empty. The following sequence of addresses are generated (the addresses are given in hexadecimal), where all references are instruction or data fetches (no stores):

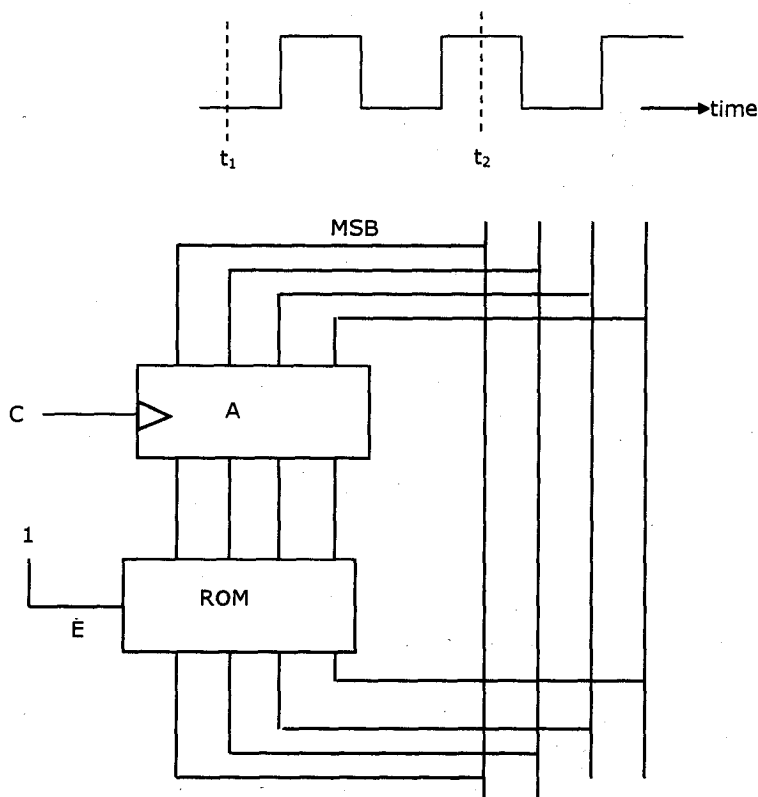
62 63 64 98 65 99 66 99 67 68 69 6A 63 64 108 65 109 66 109 67 68 69 6B

Which of the following is correct?

- (A) Set 1 Contains 63 (B) Set 0 Contains 64  
(C) Both (A) and (B) (D) None of these

16. In the figure, A is a parallel – in, parallel – out 4 bit register which loads at the rising edge of the clock C. The input lines are connected to a 4 bit bus W. Its output acts as the input to a 16 × 4 ROM whose output is floating when the enable input E is a 0. A partial table of the contents of the ROM is as follows:

| Address | 0    | 2    | 4    | 6    | 8    | 10   | 11   | 14   |
|---------|------|------|------|------|------|------|------|------|
| Data    | 0011 | 1111 | 0100 | 1010 | 1011 | 1000 | 0010 | 1000 |



The clock to the register is shown and the data on the W bus at time  $t_1$  is 0110. The data on the bus at time  $t_2$  is:

- (A) 1111 (B) 1011 (C) 1000 (D) 0010



17. Following gives the code on which you have to evaluate the cache performance of different cache designs. For all cases you should assume that the address of the array foo is 0, cache is initially empty and an integer takes one byte of space. Assume that i, j, tot, zcnt are in registers (the only memory access are to foo).

```
int foo[256][2]
int i, j;
int tot = 0;
int zcnt = 0;
for(i = 0; i < 256; i++) {
 for(j = 0; j < 2; j++) {
 tot += foo[i][j];
 }
}
for(i = 0; i < 256; i++) {
 for(j = 0; j < 2; j++) {
 if(foo[i][j] == 0)
 zcnt++;
 }
}
```

Suppose array is stored in row major order in main memory of size 4096 byte and block size is 8 byte and cache size is 1024 byte and block size is 8 byte. Which of the following element will be mapped in to cache block zero?

- (A) foo[129][1]      (B) foo[64][0]      (C) foo[128][0]      (D) Both (B) & (C)

18. Assume we have two dimensional arrays as size 100 x 100 each element occupying 4-bytes and array is stored in row major order. Further assume RAM is 1MB and cache is 4k with each block size of 32 bytes.

```
X: for(i=0; i<100; i++)
{
 for(j = 0; j < 100; j++)
 {
 print(a[i][j]);
 }
}

Y: for(i=99; i ≥ 0; i--)
{
 {
 for(j = 99; j ≥ 0; j--)
 {
 print(a[i][j]);
 print(a[i][j]);
 }
 }
}
```

How many cache miss will occur in case of associative mapping assuming initial cache is empty.

- (A) 2371 (B) 2372 (C) 2373 (D) 2374

19. Assume that the times required for the five functional units, which operate in each of the five cycles are as follows: 10ns, 8ns, 10ns, 10ns and 7ns. Assume that pipelining adds 1ns of overhead. What is the speed up factor?

- (A) 4.5 times (B) 4.8 times (C) 4.1 times (D) 6.5 times

20. In a non pipelined processor if  $a$  and  $b$  represents throughput and latency respectively then which of the following is true?

- (A)  $a < 1/b$  (B)  $a = 1/b$  (C)  $a > 1/b$  (D) none of these

21. Hazard free form of  $f(w, x, y, z)$  is

- (A)  $x'z + y'z + xy'$  (B)  $x'z + y'z'$  (C)  $x'z + y'z$  (D) none of these

22. A CPU has 32-bit memory address & a 256KB cache memory the cache is organized, as a 4-way set associative cache with cache block size of 16Bytes and 1 word is equal to 1 byte. What is the size of comparator required for tag matching?

- (A) 4-19 bit comparator (B) 4-16 bit comparators  
(C) 16-16 bit comparators (D) 16-12 bit comparators

23. What can be solution to conflict miss (in cache)?

- (A) Increase cache size (B) Increase associativity  
(C) Both (A) and (B) (D) None of these

24. A CPU has 32-bit memory address and a 256KB cache memory. The cache is organized as a 4-way set associative cache with block size of 16 bytes.

What is the number of sets in cache?

- (A)  $2^{12}$  sets (B)  $2^{16}$  sets (C)  $2^{32}$  sets (D) None of these

25. A digital computer has a memory unit of  $64K \times 16$  and a cache memory of 1 K words. The cache uses direct mapping with a block size of 4 words. What is the size of the cache by including tag bits?

- (A) 1024 bytes (B) 2048 bytes (C) 2240 bytes (D) None of these

26. Assume innermost track has diameter 1cms and outermost track has diameter 10 and if there are 10 tracks in disk and disk is rotating with constant angular velocity with capacity of innermost track 1MB. Total capacity of disk is

- (A) 10MB (B) 55MB (C) 9MB (D) 54MB

# Theory of Computation-I

## Computer Science Engineering

Test ID: 

|   |   |   |   |
|---|---|---|---|
| 2 | 1 | 2 | 9 |
|---|---|---|---|

Duration: 90 minutes

Maximum Marks: 50

---

**Read the following instructions carefully:**

1. Write your roll number, your name and name of the examination center at the specified locations of the ORS.
2. Using HB pencil, darken the appropriate bubble under each digit of your registration number and the letters corresponding to your paper code.
3. All the questions in this question paper are of objective type.
4. Questions must be answered on Objective Response Sheet (ORS) by darkening the appropriate bubble (marked A, B, C, D) using HB pencil against the question number on the left hand side of the ORS. **Each question has only one correct answer.** In case you wish to change an answer, erase the old answer completely. More than one answer bubbled against a question will be treated as a wrong answer.
5. This question paper contains 30 objective type questions. Q.1 to Q.10 carry **one** mark each and Q.11 to Q.30 carry **two** marks each.
6. Un-attempted questions will carry zero marks.
7. The question pair (27, 28) is common data questions.
8. The questions pair (29, 30) is questions with linked answers. The answer to the second question of the above pair will depend on the answer to the first question of the pair. If the first question in the linked pair is wrongly answered or is un-attempted, then the answer to the second question in the pair will not be evaluated.
9. **NEGATIVE MARKING:** For Q.1 to Q.10,  $1/3^{\text{rd}}$  mark will be deducted for each wrong answer. For Q. 11 to Q.30,  $2/3^{\text{rd}}$  mark will be deducted for each wrong answer. For the pair of questions with linked answers, there will be negative marks only for wrong answer to the first question, i.e. for Q.29,  $2/3^{\text{rd}}$  mark will be deducted for wrong answer. There is no negative marking for Q.30.
10. Calculator without data connectivity is allowed in the examination hall. Charts, graph sheets or tables are NOT allowed in the examination hall.
11. Rough work can be done on the question paper itself.

**Q.No.1-10 Carry One Mark Each**

1. Finite automata can be used in  
~ (A) Lexical Analysis (B) Syntax Analysis  
(C) Semantic Analysis (D) None of these
2. Finite automata can be used for  
~ (A) Editing the text  
(B) Implementing recursive function calls  
(C) Evaluating arithmetic expression  
(D) Infix to postfix conversion
3. Identify the equivalent machines from NFA, DFA and E-NFA.  
~ (A) NFA and DFA only (B) DFA and E-NFA only  
(C) E-NFA and DFA only (D) NFA, DFA and E-NFA
4. Infinite languages are  
~ (A) All regular languages (B) All non-regular languages  
(C) Some regular languages (D) None of these
5.  $\phi^* =$  \_\_\_\_\_  
~ (A)  $\phi$  (B)  $\{\phi\}$  (C)  $\{\epsilon\}$  (D) None of these
6. Star height of  $(a^*)^*$  is  
~ (A) 1 (B) 2 (C) 3 (D) 0
7. Regular languages are not closed under \_\_\_\_\_ Operation.  
~ (A) Concatenation (B) Substitution (C) Subset (D) Cycle
8. Identify the Regular expression which denotes all strings of a's and b's where each string contains at least two b's.  
(A)  $(a+b)^*ba^*b$  (B)  $(a+b)^*ba^*ba$   
(C)  $(a+b)^*ba^*b(a+b)^*$  (D) None of these
9. For given NFA with  $q$  states. It is possible to construct equivalent DFA with maximum of \_\_\_\_\_ states.  
~ (A) 1 (B)  $q$  (C) 0 (D)  $2^q$
10. More and mealy machines are used to act as  
~ (A) Language recognizers (B) Output generators  
(C) Both (A) and (B) (D) None of these

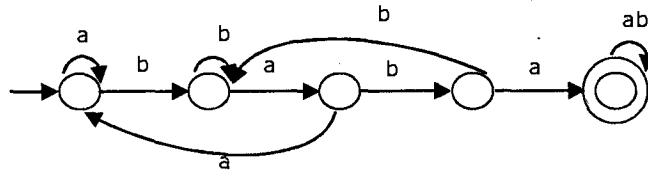
**Q. No. 11 – 30 Carry Two Marks Each**

11. Chose the correct statement for the following regular expression over the symbols 0 and 1.

$0(0+1)^*0 + 1(0+1)^*1$

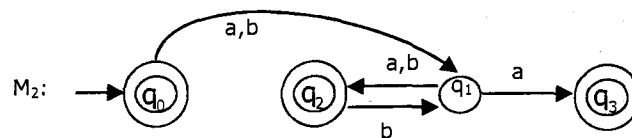
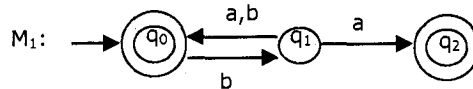
- (A) To represent all strings over 0's and 1's  
(B) To represent all strings at least one least  
(C) To represent all strings which start and end with same symbol  
(D) To represent all strings that starts and ends regular expression 1's
12. If any language is described by a regular expression, then that language is  
(A) Regular Language (B) CFL  
(C) CSL (D) Recursive Language

13. Consider the following DFA:



Which of the following is true for the above DFA?

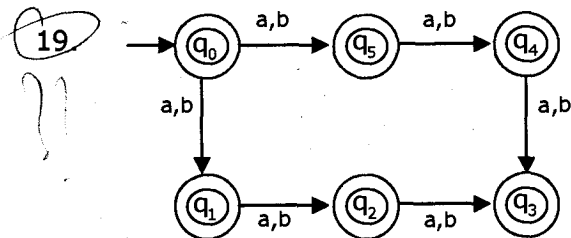
- (A) It recognizes the strings which contains 'ababa' as substring  
(B) It recognizes the strings which contains 'abbaba' as substring  
(C) It recognizes the strings which contains 'abbabaa' as substring  
(D) It recognizes the strings which contains 'baba' as substring
14. Consider the following two finite state automata  $M_1$  and  $M_2$



Which of the following statement is true?

- (A)  $M_1$  and  $M_2$  are equal (B)  $M_1$  and  $M_2$  are not equal  
(C) Not decidable (D) None of these

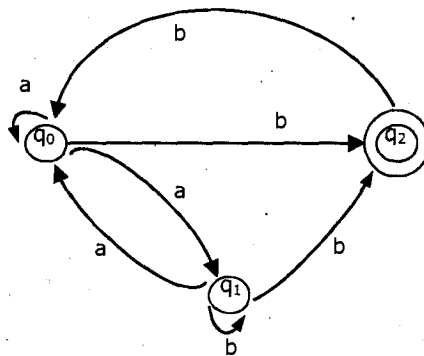
15. The minimal DFA that accepts all the strings of a's and b's ending with 'aa' contains  
(A) 3 states (B) 4 states (C) 5 states (D) 6 states
16. Let  $q_0$  and  $q_1$  are two states and  $q_0$  is always initial state over the alphabet  $\{a,b\}$ , the possible number of DFA's with two states  $q_0$  and  $q_1$  are  
(A) 16 (B) 32 (C) 64 (D) 80
17. Consider the language  $L = \{ab^2wb^3 / w \in (a+b)^*\}$ ; L is  
(A) Regular (B) CFL but not regular  
(C) CSL but not CFL (D) None of these
18. The minimal finite automata that accepts all strings of a's and b's, where the number of a's is at least 'n' contains  
(A) n states (B) (n+1) states (C) (n+2) states (D) (n+3) states



The language accepted by the above DFA over a's and b's is where

- i) Length of the string is divisible by 2  
ii) Length of the string is divisible by 3  
(A) i only (B) ii only (C) i and ii (D) i or ii or both
20. For a given two finite automaton  $M_1$  and  $M_2$ , which of the following is not decidable?  
(A) Whether  $M_1$  accepts empty language or not?  
(B) Whether  $M_1$  accepts finite language or not?  
(C) Whether  $M_1$  and  $M_2$  accept equal language or not?  
(D) None of these

21. Consider the following NFA:



The equivalent DFA for the given NFA is

(A)

|                     | A                                  | b                                  |
|---------------------|------------------------------------|------------------------------------|
| → [q <sub>0</sub> ] | [q <sub>0</sub> , q <sub>2</sub> ] | [q <sub>2</sub> ]                  |
| [q <sub>1</sub> ]   | [q <sub>0</sub> ]                  | [q <sub>1</sub> ]                  |
| [q <sub>2</sub> ]   | [Dead]                             | [q <sub>0</sub> , q <sub>1</sub> ] |

(B)

|                                    | A                                  | B                                  |
|------------------------------------|------------------------------------|------------------------------------|
| → [q <sub>0</sub> ]                | [q <sub>0</sub> , q <sub>1</sub> ] | [q <sub>2</sub> ]                  |
| [q <sub>0</sub> , q <sub>1</sub> ] | [q <sub>0</sub> , q <sub>1</sub> ] | [q <sub>1</sub> , q <sub>2</sub> ] |
| [q <sub>2</sub> ]                  | [Dead]                             | [q <sub>0</sub> , q <sub>1</sub> ] |
| [q <sub>1</sub> , q <sub>2</sub> ] | [q <sub>0</sub> ]                  | [q <sub>0</sub> , q <sub>1</sub> ] |
| [Dead]                             | [Dead]                             | [Dead]                             |

(C)

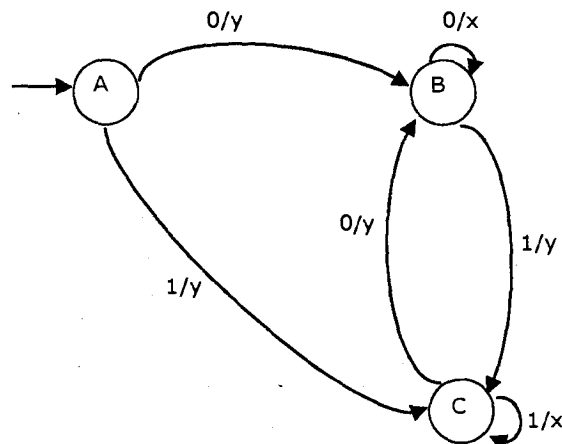
|                                    | a                                  | B                                  |
|------------------------------------|------------------------------------|------------------------------------|
| → [q <sub>0</sub> ]                | [q <sub>0</sub> , q <sub>2</sub> ] | [q <sub>2</sub> ]                  |
| [q <sub>0</sub> , q <sub>1</sub> ] | [q <sub>0</sub> , q <sub>1</sub> ] | [q <sub>1</sub> , q <sub>2</sub> ] |
| [q <sub>2</sub> ]                  | [Dead]                             | [q <sub>0</sub> , q <sub>1</sub> ] |
| [q <sub>1</sub> , q <sub>2</sub> ] | [q <sub>0</sub> ]                  | [q <sub>0</sub> , q <sub>1</sub> ] |
| [Dead]                             | [Dead]                             | [Dead]                             |

(D)

|                                    | a                                  | B                                  |
|------------------------------------|------------------------------------|------------------------------------|
| → [q <sub>0</sub> ]                | [q <sub>0</sub> , q <sub>1</sub> ] | [q <sub>2</sub> ]                  |
| [q <sub>0</sub> , q <sub>1</sub> ] | [q <sub>0</sub> , q <sub>1</sub> ] | [q <sub>1</sub> , q <sub>2</sub> ] |
| [q <sub>2</sub> ]                  | [Dead]                             | [Dead]                             |
| [Dead]                             | [Dead]                             | [Dead]                             |

22. Which of the following regular expression generates the set of all strings not containing "baa" as a substring over input alphabet {a,b}?
- (A)  $a^*(b^*a)^*$  (B)  $a^*b^*ab$  (C)  $a^*baba^*$  (D)  $a^*(ba+b)^*$
23. An NFA has 10 states out of which 3 are final states. Maximum number of final states in converted DFA is
- (A) 895 (B) 894 (C) 896 (D) 897
24. Find the number of possible finite automaton with two states  $q_0$  and  $q_1$ , where  $q_0$  is always initial state over the alphabet {a, b} which accept empty language.
- (A) 4 (B) 8 (C) 16 (D) 20
25. For the given input symbol  $\epsilon$ , the output produced by the Moore machine is 'A' and the output produced by the Mealy machine is 'B', then which of the following is true?
- (A) A = the output associated with initial state, B =  $\epsilon$   
 (B) A =  $\epsilon$ , B = the output associated with initial state  
 (C) A = the output associated with input symbol, B =  $\epsilon$   
 (D) A =  $\epsilon$ , B = the output associated with input symbol

26. Consider the following Mealy machine.



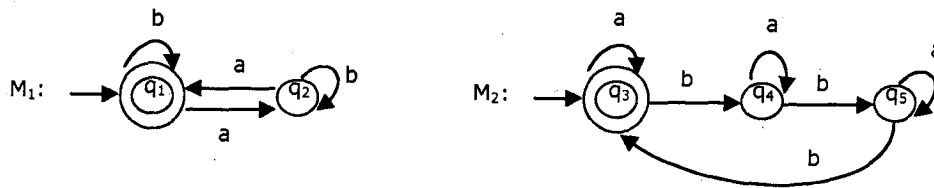
Which of the following is true for the above machine?

- (A) Produces output as 'x' and 'y' alternatively  
 (B) Produces output as 'y' if the last two symbols are same otherwise 'x'  
 (C) Produces output as 'x' if the last two symbols are same, otherwise 'y'  
 (D) None

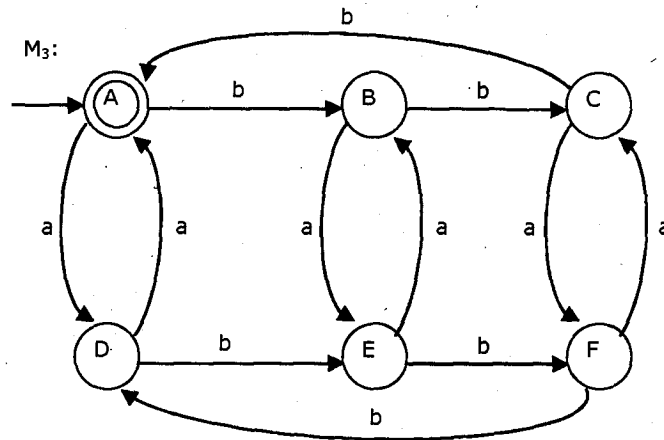
### Common Data Questions: 27 & 28

Following two FA's  $M_1$  and  $M_2$ , accepts all strings of a's and b's where the number of a's divisible by 2 and number of b's divisible by 3 respectively.





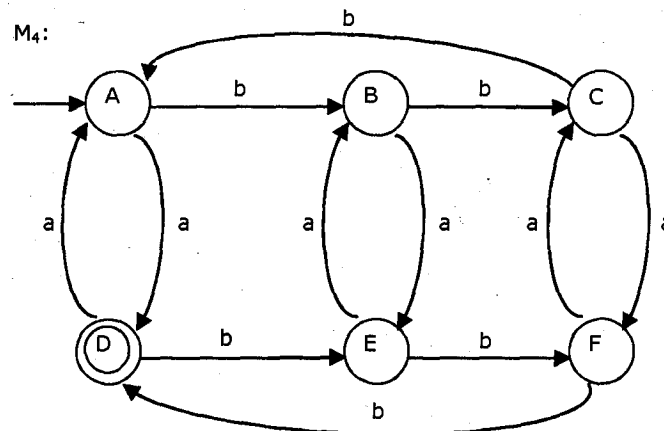
27. Consider the following FA:  $M_3$



Which of the following is true for the above FA?

- (A)  $M_3 = M_1 - M_2$  (B)  $M_3 = M_2 - M_1$  (C)  $M_3 = M_1 \cup M_2$  (D)  $M_3 = M_1 \cap M_2$

28. Consider the following FA:  $M_4$

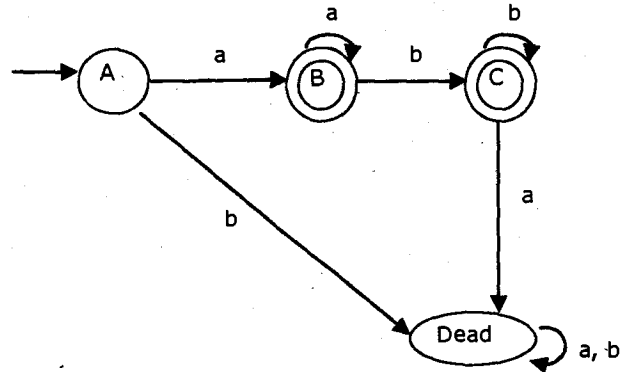


Which of the following is true for the above FA?

- (A)  $M_4 = M_1 - M_2$  (B)  $M_4 = M_2 - M_1$  (C)  $M_4 = M_1 \cup M_2$  (D)  $M_4 = M_1 \cap M_2$

**Statement for Linked Answer Questions: 29 & 30**

Consider the following FA:



29. The language accepted by above FA is
- (A)  $L = \{a^m b^n / m \geq 0, n \geq 0\}$       (B)  $L = \{a^m b^n / m \geq 0, n \geq 1\}$
- (C)  $L = \{a^m b^n / m \geq 1, n \geq 1\}$       (D)  $L = \{a^m b^n / m \geq 1, n \geq 0\}$
30. Above L accepted by FA is
- (A) Regular      (B) Non-regular      (C) Not decidable      (D) None of these

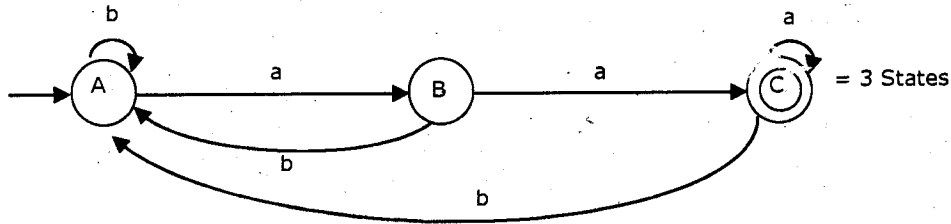
**Answer Keys**

|    |   |    |   |    |   |    |   |    |   |    |   |    |   |
|----|---|----|---|----|---|----|---|----|---|----|---|----|---|
| 1  | A | 2  | A | 3  | D | 4  | C | 5  | C | 6  | A | 7  | C |
| 8  | C | 9  | D | 10 | B | 11 | C | 12 | A | 13 | D | 14 | B |
| 15 | A | 16 | C | 17 | A | 18 | B | 19 | D | 20 | D | 21 | B |
| 22 | D | 23 | C | 24 | D | 25 | A | 26 | C | 27 | D | 28 | B |
| 29 | D | 30 | A |    |   |    |   |    |   |    |   |    |   |

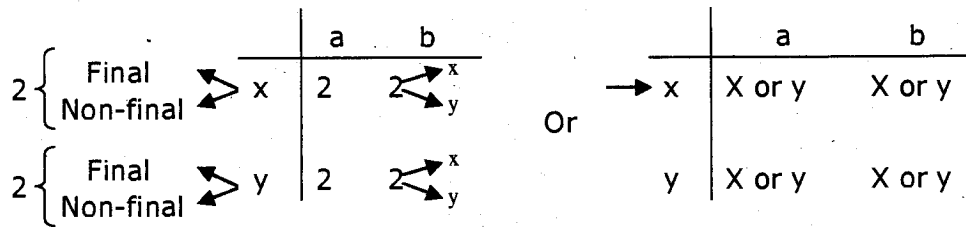
**Explanations:-**

1. FA is used in lexical analysis to recognize tokens.
2. FA used as text editor to edit the text
3. NFA, DFA and E-NFA are equivalent
4. Infinite languages may or may not be regular  
Ex: -  $a^n b^n$  is not regular for  $n \geq 1$   $(a+b)^*$  is regular
6. Start height over one symbol is always 1  $(a^*)^* = a^*$
7. Regular languages are not closed under subset but closed under finite subset  
 $L_1 = \{a^n b^n / n \leq 10\}$  finite  
 $L_2 = (a+b)^*$  is regular  
 $L_1 \subset L_2$  is closed  
 $L_3 = \{a^n b^n / n \geq 1\}$  is non-regular  
 $L_2 = (a+b)^*$  is regular  
 $L_3 \subset L_2$  is not closed – under subset
8. a)  $(a+b)^*ba^*b \rightarrow$  It will not generate bba  
 b)  $(a+b)^*ba^*ba \rightarrow$  It will not generate bbaa  
 c)  $(a+b)^*ba^*b(a+b)^* \rightarrow$  It will generate all the strings containing at least 2 b's
9. Maximum  $2^n$  states, minimum 1 state required
12. For any regular expression, we can construct an equivalent FA; the language accepted by FA is called regular language
13. Given FA recognizes the strings which contain baba as substring
14.  $M_2$  accepts string 'aa' but  $M_1$  doesn't

15.



16.



$2 \times 2 \times 2 \times 2 \times 2 \times 2 = 64$  Possible DFA's

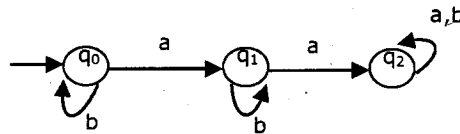
17.

$$L = \{ab^2 w b^3 / w \in (a+b)^*\}$$

For given language, equivalent DFA is possible, therefore given Language is Regular language

18.

Example: No. of a's at least '2' Contains 3 states



No. of a's at least 'n' Contain (n+1) states

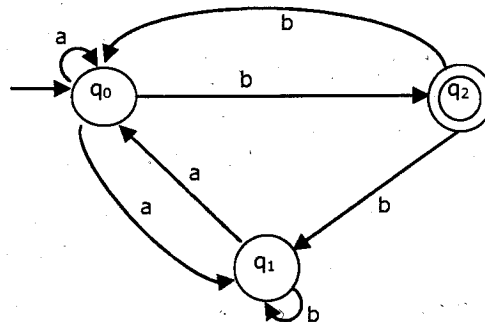
19.

The given DFA accepts the language where the length of each string is divisible by 2 or divisible by 3 or by both

20.

Emptiness, finiteness and equivalence are possible in FA

21.



Initial state of given NFA is also initial state of equivalent DFA

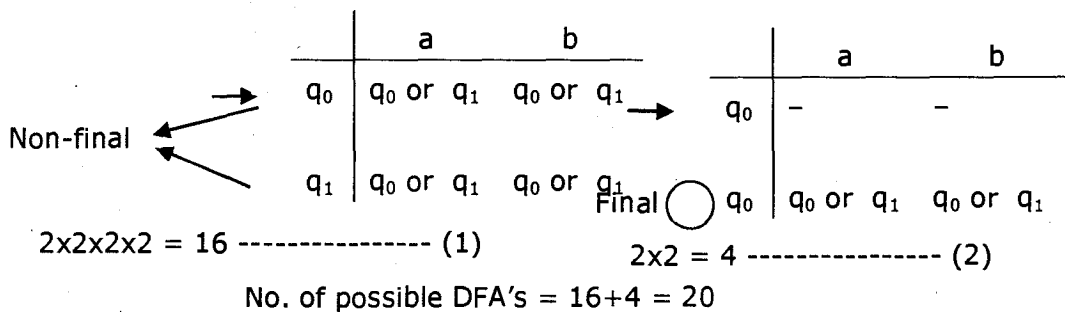
|                     | A            | B            |
|---------------------|--------------|--------------|
| $\rightarrow [q_0]$ | $[q_0, q_1]$ | $[q_2]$      |
| $[q_0, q_1]$        | $[q_0, q_1]$ | $[q_1, q_2]$ |
| $[q_2]$             | [Dead]       | $[q_0, q_1]$ |
| $[q_1, q_2]$        | $[q_0]$      | $[q_0, q_1]$ |
| [Dead]              | [Dead]       | [Dead]       |

Are New States

New State

Make all the states are final which contain final state of NFA

22.  $a^* (ba+b)^* = \{\epsilon, a, b, aa, ab, ba, bb, \dots\}$  Doesn't contain strings with 'baa' as Substring
23. An NFA with 10 states the converted DFA will have utmost  $2^{10} = 1024$  states.  
The NFA has 3 final states. So number of subset of remaining 7 elements are  $2^7 = 128$ . Maximum no. of final states in converted DFA =  $1024 - 128 = 896$
- 24.



25. By reading  $\epsilon$ , the output produced by Moore machine is the output associated with the initial state  
By reading  $\epsilon$ , the output produced by mealy machine is  $\epsilon$

# Theory of Computation-II

## Computer Science Engineering

Test ID: 

|   |   |   |   |
|---|---|---|---|
| 2 | 1 | 3 | 0 |
|---|---|---|---|

Duration: 90 minutes

Maximum Marks: 50

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### Read the following instructions carefully:

1. Write your roll number, your name and name of the examination center at the specified locations of the ORS.
2. Using HB pencil, darken the appropriate bubble under each digit of your registration number and the letters corresponding to your paper code.
3. All the questions in this question paper are of objective type.
4. Questions must be answered on Objective Response Sheet (ORS) by darkening the appropriate bubble (marked A, B, C, D) using HB pencil against the question number on the left hand side of the ORS. **Each question has only one correct answer.** In case you wish to change an answer, erase the old answer completely. More than one answer bubbled against a question will be treated as a wrong answer.
5. This question paper contains 30 objective type questions. Q.1 to Q.10 carry **one** mark each and Q.11 to Q.30 carry **two** marks each.
6. Un-attempted questions will carry zero marks.
7. The question pair (27, 28) is common data questions.
8. The questions pair (29, 30) is questions with linked answers. The answer to the second question of the above pair will depend on the answer to the first question of the pair. If the first question in the linked pair is wrongly answered or is un-attempted, then the answer to the second question in the pair will not be evaluated.
9. **NEGATIVE MARKING:** For Q.1 to Q.10,  $\frac{1}{3}$ <sup>rd</sup> mark will be deducted for each wrong answer. For Q. 11 to Q.30,  $\frac{2}{3}$ <sup>rd</sup> mark will be deducted for each wrong answer. For the pair of questions with linked answers, there will be negative marks only for wrong answer to the first question, i.e. for Q.29,  $\frac{2}{3}$ <sup>rd</sup> mark will be deducted for wrong answer. There is no negative marking for Q.30.
10. Calculator without data connectivity is allowed in the examination hall. Charts, graph sheets or tables are NOT allowed in the examination hall.
11. Rough work can be done on the question paper itself.

**Q.No.1-10 Carry One Mark Each**

1. Push down automata is equivalent to  
N (A) FA (B) FA with one stack  
(C) FA with two stacks (D) FA with three stacks
2. PDA can be used as  
U (A) Lexical analyzer (B) Syntax analyzer  
(C) Semantic analyzer (D) Code generator
3. PDA can be used for  
N (A) Infix to postfix conversion  
(B) Implementing recursive function calls  
(C) Evaluating arithmetic expressions (D) All of these
4. Which of the following statement is correct?  
N (A) DPDA and NPDA both are equal  
(B) DPDA and NPDA are not comparable  
(C) DPDA < NPDA (D) NPDA < DPDA
5. For every context free language, we can construct an equivalent  
N (A) DPDA (B) NPDA  
(C) DPDA and NPDA (D) None of these
6. CFL's are \_\_\_\_\_ languages  
(A) Type 0 (B) Type 1 (C) Type 2 (D) Type 3
7. Which of the following order of elimination from the given grammar produces "simplified CFG?"  
N (A) Useless symbols,  $\epsilon$ -productions, and unit productions  
(B) Useless symbols, unit productions and  $\epsilon$ -productions  
(C) Null productions, useless symbols and unit productions  
(D) Null productions, unit productions and useless symbols
8. Consider the following grammar:  
S  $\rightarrow$  aAB  
A  $\rightarrow$  bBb  
B  $\rightarrow$  A /  $\epsilon$   
The above grammar is  
(A) Free from unit productions (B) Free from null productions  
(C) Ambiguous grammar (D) Simplified grammar

9. Which of the following operation is closed under DCFL but not closed under CFL?  
 (A) Intersection (B) Concatenation  
 (C) Complementation (D) Substitution
10. The language  $L = \{a^n b^n \mid n \geq 1\}$  is  
 (A) Regular (B) CFL but not regular  
 (C) CFL but not DCFL (D) Non-CFL

**Q. No. 11 – 30 Carry Two Marks Each**

11. Identify the simplified CFG for the following grammar.  
 $S \rightarrow AOA \mid 1A$   
 $A \rightarrow AOA \mid A1A \mid \epsilon$   
 (A)  $S \rightarrow AOA \mid 1A$  (B)  $S \rightarrow AOA \mid 1A$   
 $A \rightarrow AOA \mid A1A \mid A0 \mid A1 \mid 0A \mid 1A$  (C)  $S \rightarrow AOA \mid A0 \mid 0A \mid 1A$  (D)  $S \rightarrow AOA \mid A0 \mid 0A \mid 1A \mid 0 \mid 1$   
 $A \rightarrow AOA \mid A1A \mid A0 \mid A1 \mid 1A \mid 0 \mid 1$  (E)  $S \rightarrow AOA \mid A0 \mid A1 \mid 0A \mid 1A \mid 0 \mid 1$
12. Number of productions in an equivalent CNF for the following CFG is  
 $S \rightarrow aAD$   
 $A \rightarrow aB \mid BAB$   
 $B \rightarrow b$   
 $D \rightarrow d$   
 (A) 8 (B) 7 (C) 6 (D) 5
13. CNF grammar may contain  
 (A) Null productions (B) Unit productions  
 (C) Use less symbols (D) All of these
14. Which of the following problem is undecidable for CFL?  
 (A) Equivalence problem (B) Ambiguity problem  
 (C) Inherently ambiguity problem (D) All of these
15. The complement of the following language is  
 $L = \{WCW^R \mid W \in (a+b)^*\}$  and  $W^R$  is reversal of  $W$   
 $C$  is input symbol  
 (A) DCFL (B) CFL but not DCFL  
 (C) Not CFL (D) None of these
16. The language  $L = \{a^n b^n \mid n \geq 1\} \cup \{c^m d^m \mid m \geq 0\}$  is  
 (A) DCFL (B) CFL but not DCFL  
 (C) Non-CFL (D) None of these
17. The language  $L = \{a^n b^n \mid n \geq 1\} \cup \{a^m b^{2m} \mid m \geq 1\}$  is  
 (A) DCFL (B) CFL but not DCFL  
 (C) Non-CFL (D) None of these



18. The language  $L = \{WCW \mid W \in (a+b)^*\}$  is  
 (A) DCFL (B) CFL but not DCFL  
 (C) Non-CFL (D) None of these
19. The language  $L = \{a^n b^n c^n \mid n \geq 1\}$  is  
 (A) DCFL (B) CFL but not DCFL  
 (C) Non CFL (D) None of these
20. Consider the following CFG:  
 $S \rightarrow AB$   
 $A \rightarrow BC \mid a$   
 $B \rightarrow CC \mid b$   
 $C \rightarrow a \mid AB$   
 The rank of variable A is  
 (A) 2 (B) 3 (C) 4 (D) None of these
21. If  $A \rightarrow XY$  is the non redundant CNF, then the rank of A is  
 (A) Less than rank of X and less than rank of Y  
 (B) Greater than rank of X and greater than Rank of Y  
 (C) Less than Rank of X and greater than Rank of Y  
 (D) Greater than Rank of X and less than Rank of Y
22. Transition function ' $\delta$ ' for PDA is  
 (A)  $Q \times \Sigma \times \Gamma \rightarrow Q \times \Gamma$  (B)  $Q \times \Sigma \cup \{\epsilon\} \times \Gamma \rightarrow Q \times \Gamma$   
 (C)  $Q \times \Sigma \cup \{\epsilon\} \times \Gamma \rightarrow Q \times \Gamma^*$  (D)  $Q \times \Sigma \times \Gamma \rightarrow Q \times \Gamma^*$
23. CYK algorithm is used for CFG's to test the problem of  
 (A) Finiteness (B) Equivalence (C) Emptiness (D) Membership
24. To generate ' $\ell$ ' length string, the height of the derivation of tree in CNF grammar is  
 (A)  $\log_2' + 1$  (B)  $\log_2^{(\ell+1)}$  (C)  $\log_2' - 1$  (D)  $\log_2^{(\ell-1)}$
25. Consider the following grammar G  
 $E \rightarrow E + E \mid E - E \mid E * E \mid (E) \mid id$   
 The number of derivation trees for the string  $id + id * id - id$  is  
 (A) 5 (B) 6 (C) 7 (F) 8
26. Consider the following grammar  
 $S \rightarrow abA$   
 $A \rightarrow aA \mid bA \mid B$   
 $B \rightarrow bb$   
 The language generated by the above grammar is  
 (A) All the strings which start with 'ab' and end with 'bb'  
 (B) All the strings which start with 'ab' and 'bb' as substring  
 (C) All the strings which start and end with different letter  
 (D) All the strings which start and end with 'bb' and 'ab' respectively

**Common Data Questions: 27 & 28**

Consider  $L_1 = \{a^n b^n c^m d^m \mid m, n \geq 1\}$

$L_2 = \{a^n b^n \mid n \geq 1\}$

$L_3 = \{(a+b)^*\}$

27. Intersection of  $L_1$  and  $L_2$  is  
(A) Regular (B) CFL but not regular (C) CSL but not CFL (D) None of these
28.  $L_1 - L_3$  is  
(A) Regular (B) CFL but not regular (C) CSL but not CFL (D) None of these

**Statement for Linked Answer Questions: 29 & 30**

Consider the following grammar

$S \rightarrow aAB$

$A \rightarrow bBb$

$B \rightarrow A \mid \epsilon$

29. Which of the following is a valid string from above grammar?  
(A) abbabb (B) bbabb (C) abbbb (D) bbbbb
30. Number of derivation trees possible for above valid string is  
(A) 2 (B) 3 (C) 4 (D) 5

**Answer Keys**

|    |   |    |   |    |   |    |   |    |   |    |   |    |   |
|----|---|----|---|----|---|----|---|----|---|----|---|----|---|
| 1  | B | 2  | B | 3  | D | 4  | C | 5  | B | 6  | C | 7  | D |
| 8  | C | 9  | C | 10 | B | 11 | D | 12 | A | 13 | C | 14 | D |
| 15 | A | 16 | A | 17 | B | 18 | C | 19 | C | 20 | D | 21 | B |
| 22 | C | 23 | D | 24 | A | 25 | A | 26 | A | 27 | A | 28 | A |
| 29 | C | 30 | A |    |   |    |   |    |   |    |   |    |   |

**Explanations:-**

1.  $PDA \cong FA + 1 \text{ stack}$
4. No. of languages accepted by DPDA are lesser than the no. of languages accepted by NPDA
5. Every CFL can be constructed with NPDA
6. CFL'S are type 2 languages in Chomsky hierarchy
7. (A) Eliminate null productions  
(B) Eliminate unit productions  
(C) Eliminate useless symbols  
The resultant grammar after applying in the above order to the given grammar is called "simplified grammar"
11.  $S \rightarrow AOA \mid 1A$   
 $A \rightarrow AOA \mid A1A \mid \epsilon$   
 First eliminate null production  
 $S \rightarrow AOA \mid A0 \mid OA \mid 1A \mid 1 \mid 0$   
 $A \rightarrow AOA \mid A1A \mid A0 \mid A1 \mid OA \mid 1A \mid 0 \mid 1$   
 Next eliminate unit productions and use less symbols, but already free from unit productions and use less symbols
12.  $S \rightarrow a AD$   
 $A \rightarrow aB \mid BAB$   
 $B \rightarrow b$   
 $D \rightarrow d$   
 Equivalent CNF grammar for the above grammar is  
 $S \rightarrow CE$   
 $C \rightarrow a$   
 $E \rightarrow AD$   
 $A \rightarrow CB \mid BF$   
 $F \rightarrow AB$   
 $B \rightarrow b$   
 $D \rightarrow d$   
 Total 8 productions

13. CNF grammar may contain useless symbols but not contain null productions and unit productions

15.  $L = \{wcw^R \mid w \in (a+b)^*\}$  is DCFL. We can construct an equivalent DPDA and DCFL's are closed under complementation.

16.  $L_1 = \{a^n b^n \mid n \geq 1\}$  is DCFL

$L_2 = \{c^m d^m \mid m \geq 0\}$  is DCFL

Here  $L_1 \cup L_2$  is also DCFL

**Note:** Union of two DCFL's may or may not be DCFL

17.  $L_1 = \{a^n b^n \mid n \geq 1\}$  is DCFL

$L_2 = \{a^m b^{2m} \mid m \geq 1\}$  is DCFL

Here,  $L_1 \cup L_2$  is CFL but not DCFL.

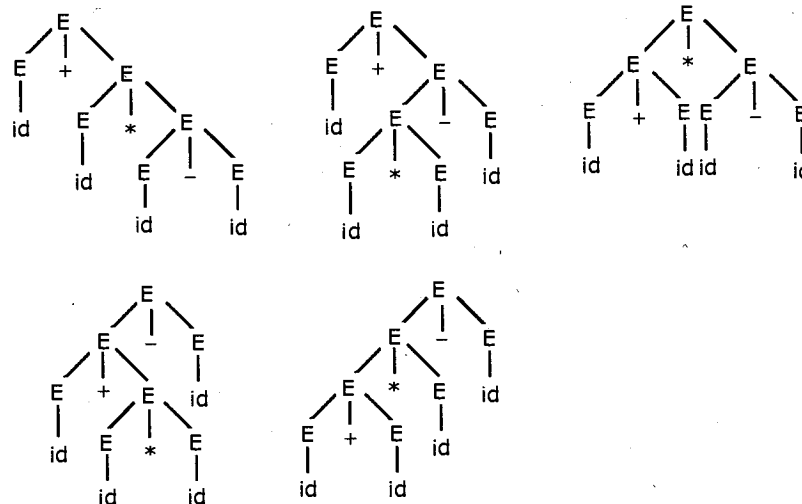
20. Given, CFG is not finite; therefore rank of variable A is not possible for infinite language

21.  $A \rightarrow XY$

$R(A) > R(X)$  and  $R(A) > R(Y)$

22.  $\delta: Q \times \Sigma \cup \{\epsilon\} \times \Gamma \rightarrow Q \times \Gamma^*$

25.  $id + id * id - id$



Hence, 5 derivation trees

27.  $L_1 = \{a^m b^m c^m d^m \mid m, n \geq 1\}$  is CFL

$L_2 = \{a^n b^n \mid n \geq 1\}$  is CFL

Here,  $L_1 \cap L_2 = \emptyset = \text{regular}$

28.  $L_1 = \{a^n b^n c^m d^m \mid m, n \geq 1\}$  is CFL

$L_3 = \{(a + b)^*\}$  is regular

$L_1 - L_3 = \emptyset = \text{regular}$

29.  $S \rightarrow a \underline{A} B$

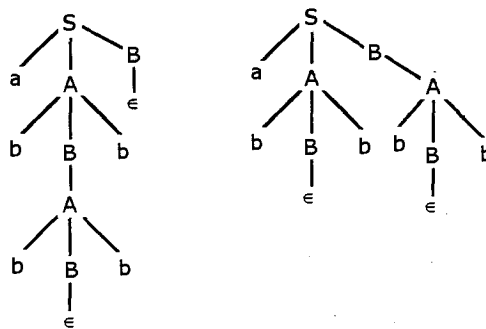
$\rightarrow ab \underline{B} b B$

$\rightarrow ab \underline{A} b B$

$\rightarrow ab b \underline{B} b b B$

$\rightarrow abbb b$  is valid

30.



Hence, 2 derivation trees

# Theory of Computation-III

## Computer Science Engineering

Test ID: 

|   |   |   |   |
|---|---|---|---|
| 2 | 1 | 3 | 1 |
|---|---|---|---|

Duration: 90 minutes

Maximum Marks: 50

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### Read the following instructions carefully:

1. Write your roll number, your name and name of the examination center at the specified locations of the ORS.
2. Using HB pencil, darken the appropriate bubble under each digit of your registration number and the letters corresponding to your paper code.
3. All the questions in this question paper are of objective type.
4. Questions must be answered on Objective Response Sheet (ORS) by darkening the appropriate bubble (marked A, B, C, D) using HB pencil against the question number on the left hand side of the ORS. **Each question has only one correct answer.** In case you wish to change an answer, erase the old answer completely. More than one answer bubbled against a question will be treated as a wrong answer.
5. This question paper contains 30 objective type questions. Q.1 to Q.10 carry one mark each and Q.11 to Q.30 carry two marks each.
6. Un-attempted questions will carry zero marks.
7. The question pair (27, 28) is common data questions.
8. The questions pair (29, 30) is questions with linked answers. The answer to the second question of the above pair will depend on the answer to the first question of the pair. If the first question in the linked pair is wrongly answered or is un-attempted, then the answer to the second question in the pair will not be evaluated.
9. **NEGATIVE MARKING:** For Q.1 to Q.10,  $\frac{1}{3}$ <sup>rd</sup> mark will be deducted for each wrong answer. For Q. 11 to Q.30,  $\frac{2}{3}$ <sup>rd</sup> mark will be deducted for each wrong answer. For the pair of questions with linked answers, there will be negative marks only for wrong answer to the first question, i.e. for Q.29,  $\frac{2}{3}$ <sup>rd</sup> mark will be deducted for wrong answer. There is no negative marking for Q.30.
10. Calculator without data connectivity is allowed in the examination hall. Charts, graph sheets or tables are NOT allowed in the examination hall.
11. Rough work can be done on the question paper itself.

**Q. No. 1 – 10 Carry One Mark Each**

1. ✓ "Read and write head" of TM (Turing Machine) moves to the right direction only (no left direction) then the language accepted by TM is  
(A) Regular language (B) CFL  
(C) CSL (D) Recursive
2. ✓ Recursive enumerable languages are recognized by  
(A) Finite automata (B) Pushdown Automata  
(C) Linear bounded automata (D) Turing machine
3. ~ By reading any string, which of the following may be possible for Turing machine?  
(A) TM halts in final state (B) TM halts in non final state  
(C) TM enters into infinite loop (D) All of these
4. ✓ The languages recognized by halting turning machine are called as  
(A) Regular languages (B) Recursive languages  
(C) Recursive enumerable language (D) P – language
5. ✓ If the language L is recursive enumerable but not recursive, then complement of L is  
(A) Recursive (B) Not recursive  
(C) Recursive enumerable (D) Not recursive enumerable
6. ✓ Which of the following problem is decidable for recursive languages?  
(A) Equivalence (B) Finiteness (C) Membership (D) None of these
7. ~ Which of the following operation is closed under recursive languages but not closed under recursive enumerable languages?  
(A) Intersection (B) Complementation  
(C) Substitution (D) Homomorphism
8. ✓ If L and  $\bar{L}$  are recursive enumerable, then L is  
(A) Recursive (B) Regular (C) CFL (D) None of these
9. ✓ Turing machine can act as  
(A) Language recognizer (B) Transducer  
(C) Enumerator (D) All of these
10. ~ If all the strings of a language are generated in alphabetical order, then the language is  
(A) Regular (B) CFL but not regular  
(C) CSL but not CFL (D) Recursive but not CSL

**Q. No. 11-30 Carry Two Marks Each**

11. Consider the following turing machine

|                  | a                       | b                       | B                       |
|------------------|-------------------------|-------------------------|-------------------------|
| → q <sub>0</sub> | (q <sub>1</sub> , B, R) | (q <sub>4</sub> , B, R) | (q <sub>6</sub> , B, R) |
| q <sub>1</sub>   | X                       | (q <sub>1</sub> , b, R) | (q <sub>2</sub> , b, L) |
| q <sub>2</sub>   | Y                       | —                       | —                       |
| q <sub>3</sub>   | (q <sub>3</sub> , a, L) | (q <sub>3</sub> , b, L) | (q <sub>0</sub> , B, R) |
| q <sub>4</sub>   | (q <sub>4</sub> , a, R) | (q <sub>4</sub> , b, R) | Z                       |
| q <sub>5</sub>   | —                       | W                       | —                       |
| Ⓠ q <sub>6</sub> | —                       | —                       | —                       |

Identify the entries of W, X, Y and Z to accept all even length palindromes over the alphabet {a, b} and the blank symbol B

- (A) (q<sub>1</sub>, B, L), (q<sub>2</sub>, a, R), (q<sub>2</sub>, B, L), (q<sub>5</sub>, B, L) respectively  
 (B) (q<sub>2</sub>, B, L), (q<sub>1</sub>, a, R), (q<sub>2</sub>, B, L), (q<sub>5</sub>, B, L) respectively  
 (C) (q<sub>3</sub>, B, L), (q<sub>1</sub>, a, R), (q<sub>3</sub>, B, L), (q<sub>5</sub>, B, L) respectively  
 (D) (q<sub>4</sub>, B, L), (q<sub>1</sub>, a, R), (q<sub>4</sub>, B, L), (q<sub>5</sub>, B, L) respectively

12. Which of the following statement is true?

- (A) The post correspondence problem over one symbol is decidable  
 (B) The post correspondence problem is undecidable except over one symbol  
 (C) The modified post correspondence problem over one symbol is decidable  
 (D) All of these

13. If the language L<sub>1</sub> is polynomially reduced to the language L<sub>2</sub> and L<sub>2</sub> is polynomially reduced to L<sub>1</sub>, then which of the following cannot be true?

- (A) L<sub>1</sub> is decidable and L<sub>2</sub> is undecidable  
 (B) L<sub>1</sub> is regular and L<sub>2</sub> is CFL  
 (C) L<sub>1</sub> is recursive and L<sub>2</sub> is recursively enumerable  
 (D) None of these

14. Which of the following is correct statement?

- (A) A problem is called NP complete if and only if it is NP hard and NP problem  
 (B) A problem is called NP complete if and only if it is NP hard and P problem  
 (C) A problem is called NP complete if and only if it is NP and P problem  
 (D) All of these



15. Which of the following statement is false?  
 (A) If the problem  $\pi_1 \propto \pi_2$  then satisfies  $\pi_1 \propto \pi_1$   
 (B) If  $\pi_1 \propto \pi_2$  and  $\pi_2 \propto \pi_3$  then satisfies  $\pi_1 \propto \pi_3$   
 (C) If  $\pi_1 \propto \pi_2$  then satisfies  $\pi_2 \propto \pi_1$   
 (D) All of these
16. Which of the following problems is NP complete?  
 (A) 1 - SAT (B) 2 - SAT (C) 3 - SAT (D) All of these
17. Let  $L_1, L_2$  and  $L_3$  are same type languages and  $L_1 \cap L_2 = L_3$   
 For which of the following languages the above intersection operation is undecidable?  
 (A) Type 0 (B) Type 1 (C) Type 2 (D) Type 3
18. Total recursive functions are similar to  
 (A) Recursive languages  
 (B) Recursive enumerable languages  
 (C) Can't relate  
 (D) None of these
19. Partial recursive functions are similar to  
 (A) Recursive languages (B) Recursive enumerable languages  
 (C) Can't relate (D) None of these
20. Recursive languages are closed under  
 (A) Kleene closure (B) Substitution  
 (C) Homomorphism (D) None of these
21. Recursive enumerable languages are not closed under  
 (A) Union (B) Intersection (C) Max (D) Homomorphism
22. Ambiguity problem is decidable for  
 (A) Regular languages (B) CFL  
 (C) Recursive languages (D) None of these
23. Halting problem of Turing machine is  
 (A) Decidable (B) Undecidable but partially decidable  
 (C) We can't say (D) None of these
24. Consider the following instance of PCP with two lists  
 $A = \{001, 011, 11, 101\}$   
 $B = \{01, 111, 111, 010\}$   
 Which of the following sequence is a solution to the above instance of PCP?  
 (A) 3, 1, 4 (B) 3, 4, 3 (C) 3, 4, 1 (D) No solution
25. If the problem  $\pi_1$  reduced to the problem  $\pi_2$  and  $\pi_1$  is undecidable then  $\pi_2$  is  
 (A) Decidable (B) Undecidable (C) We can't say (D) None of these
26. If Hamiltonian circuit problem is reduced to the problem  $\pi$ , then  $\pi$  is  
 (A) P but not NP (B) NP but not NP hard  
 (C) NP hard but not NP completes (D) NP complete

**Common Data Questions: 27 & 28**

Let  $G_1$  and  $G_2$  are regular grammars and  $G_3$  and  $G_4$  are context free grammars. The language generated by any grammar  $G$  is represented by  $L(G)$

27. Is  $L(G_1 \cap G_2) = \phi$ ?

(A) Decidable problem

(B) Undecidable problem

(C) We can't say

(D) None of these

28. IS  $L(G_1) \subseteq L(G_3)$ ?

(A) Decidable

(B) Undecidable

(C) We can't say

(D) None of these

**Statement for Linked Answer Questions: 29 & 30**

Let  $L_1$  and  $L_2$  are regular languages,  $L_3$  is CFL and  $L_4$  is recursive enumerable language,  $L_4^R$  is reversal of  $L_4$

29.  $L_5 = (L_3 / x) \cap L_4^R$  and  $x$  is input alphabet, then  $L_5$  is

(A) Regular language

(B) CFL

(C) Recursive enumerable language

(D) Non recursive enumerable language

30.  $L_5 \cap (\overline{L_1} \cap L_2)$  is

(A) Regular language

(B) CFL

(C) Recursive enumerable language

(D) Non recursive enumerable language

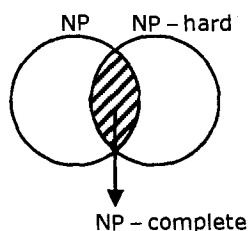
**Answer Keys**

|    |   |    |   |    |   |    |   |    |   |    |                |    |   |
|----|---|----|---|----|---|----|---|----|---|----|----------------|----|---|
| 1  | A | 2  | D | 3  | D | 4  | B | 5  | D | 6  | C              | 7  | B |
| 8  | A | 9  | D | 10 | D | 11 | C | 12 | D | 13 | <del>A</del> D | 14 | A |
| 15 | C | 16 | C | 17 | C | 18 | A | 19 | B | 20 | D              | 21 | C |
| 22 | A | 23 | B | 24 | C | 25 | B | 26 | D | 27 | A              | 28 | B |
| 29 | C | 30 | C |    |   |    |   |    |   |    |                |    |   |

**Explanations:-**

1. If head moves only in one direction, then Turing machine can accept regular languages.
3. Turing machine may halt in final or non final state or it can enter into infinite loop by reading the string from given language
4. Halting Turing machine always halts either in final state or non final state. The language accepted by halting turing machine is called as recursive languages.
5. Recursive enumerable languages are not closed under complement operation, but recursive languages are closed under complement.  
Given language is recursive enumerable language only but not recursive; therefore complement of the language is not REL.
8. If  $L$  and  $\bar{L}$  are recursive enumerable then  $L$  must be recursive.
9. TM can act as recognizer, transducer and enumerator
10. If strings are generated in any particular order, then that language is recursive
12. PCP and MPCP are undecidable except over one symbol.
13. If  $L_1$  is decidable, then  $L_2$  is also decidable

14.



NP complete problems are in NP and also in NP hard

15. Symmetric property doesn't satisfy for reduction. Hence if  $\pi_1 \alpha \pi_2$ , then it may not satisfy  $\pi_2 \alpha \pi_1$
16. 1 – SAT and 2 – SAT problems are P – class 3 – SAT is NP complete
17. CFL's are not closed under intersection.  $L_1 \cap L_2 =$  may or may not CFL  
Therefore  $L_3$  is undecidable for CFL's  
**Note:** Regular, CSL and R.E.L's are closed under intersection
20. Recursive languages are not closed under kleene closure, substitution and homorphism.
21. REL is not closed under complement, and max
22. Ambiguity problem is decidable for regular languages only, because regular languages are by default unambiguous.
23. Halting problem of TM is undecidable but partially decidable  
For recursive languages, it is decidable  
For recursive enumerable languages, it is undecidable
24.  $A = \{001, 0011, 11, 101\}$   
 $B = \{01, 11, 111, 010\}$   
Sequence  $\langle 3, 4, 1 \rangle$  generates the string 11101001 for both lists. Hence  $\langle 3, 4, 1 \rangle$  is one solution.
25.  $\pi_1 \alpha \pi_2$   
If  $\pi_1$  is undecidable then  $\pi_2$  is also undecidable
26. Hamiltonian circuit problem is NP complete problem. This NP complete problem is reduced to the problem  $\pi$ . Therefore  $\pi$  is also NP complete problem.
27.  $L(G_1 \cap G_2)$  is regular language and emptiness problem for the regular language is decidable
28. Subset problem is undecidable except for regular languages.  $L(G_1) \subseteq L(G_3)$   
 $\Rightarrow$  Regular language  $\subseteq$  CFL is undecidable  
Note:  $L(G_1) \subseteq L(G_2)$  is decidable

29.  $L_3 / x$  is always CFL and  $L_4^R$  is REL  $(L_3 / x) \cap L_4^R = \text{CFL} \cap \text{REL} = \text{REL}$   
 $\therefore L_5$  is REL

30.  $L_5$  is REL from above question

$\overline{L_1}$  is regular

$\overline{L_1} \cap L_2$  is also regular

$L_5 \cap (\overline{L_1} \cap L_2) = \text{REL} \cap \text{regular} = \text{REL}$

$\therefore L_5 \cap (\overline{L_1} \cap L_2)$  is recursive enumerable

# Data Structure and Algorithms-I

## Computer Science Engineering

Test ID: 

|   |   |   |   |
|---|---|---|---|
| 2 | 1 | 3 | 2 |
|---|---|---|---|

Duration: 90 minutes

Maximum Marks: 50

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2. Using HB pencil, darken the appropriate bubble under each digit of your registration number and the letters corresponding to your paper code.
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5. This question paper contains 30 objective type questions. Q.1 to Q.10 carry one mark each and Q.11 to Q.30 carry two marks each.
6. Un-attempted questions will carry zero marks.
7. The question pair (27, 28) is common data questions.
8. The questions pair (29, 30) is questions with linked answers. The answer to the second question of the above pair will depend on the answer to the first question of the pair. If the first question in the linked pair is wrongly answered or is un-attempted, then the answer to the second question in the pair will not be evaluated.
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11. Rough work can be done on the question paper itself.

**Q. No.1-10 Carry One Mark Each**

1. What is the output of the following program?

```
int function(int n)
{
 int i=0, j=5;
 if(n<0) return 0;
 while (($\frac{n}{j}$) > 0)
 {
 ($i += \frac{n}{j}$);
 (j*= 5);
 }
 return i;
}

int main(){
 printf("%d", function(85));
}
```

(A) 18                      (B) 19                      (C) 20                      (D) 21

2. What is the output of the following program?

```
int operation(int x, int y){
 if(y == 0) return x;
 return operation (x^y, (x&y) << 1);
}

int main(){
 printf("%d", operation(12,15));
}
```

(A) 21                      (B) 18                      (C) 28                      (D) None of these

3. Two linked lists having n and m elements are stored in sorted order. What is worst case time complexity of program to print common elements of two lists?

(A)  $O(n)$                       (B)  $\max(m,n)$                       (C)  $\min(m,n)$                       (D)  $m+n$

4. The Best case time complex of finding an element in a Binary search tree is

(A)  $O(n)$                       (B)  $O(\log n)$                       (C)  $O(1)$                       (D)  $O(n \log n)$

5. What is the output of the following program?

```
int fun(int a){
 if(n & (n-1)) return 1;
 return 0;
}
int main(){
 int (*p)(int);
 p = fun; printf("%d",p(1025)); return 0;
}
```

- (A) 1 (B) 0  
(C) Compiler dependent (D) Compilation error

6. What is the output of the following code snippet?

```
int Add(int x, int y){
 return x+y;
}
int main(){
 printf("%d", Add(7,3) + Add(1,2));
}
```

- (A) Compilation error (B) Compiler dependent  
(C) 13 (D) None of these

7. How many stacks are required to implement a queue?

- (A) 1 (B) 2 (C) 3 (D) Not possible

8. To store the string "Graduate Aptitude Test for Engineers" in a character array, total number of bytes required is

- (A) 32 (B) 33 (C) 31 (D) 30

9. Evaluate the following post fix expression  $3422 * + 2 - /$

- (A) 6 (B) 2 (C) 9 (D) None of these

10. A 2-dimensional array is declared as  $A[-8...12, -4...16]$ . Calculate the address of  $A[1,3]$  assuming that it is stored in row major order. Each element occupies 4-bytes and starting address of array is 2000.

- (A) 2780 (B) 2776 (C) 2784 (D) None of these

11. You are given an array which contains both positive and negative integers in it and asked to design an algorithm, to find the maximum sum which does not contain two consecutive numbers. What is the time complexity of efficient-algorithm?

- (A)  $\theta(n)\log n$  (B)  $\theta(n)$  (C)  $\theta(n^2)$  (D)  $\theta(n^2 \log n)$



12. What is the output of the following program?

```
int main(){
char i, *s="GATE %s", *d="FORUM";
for(i=126; i<=127;i++)
printf("%d",printf(s,d));
}
```

- (A) Compilation error  
(B) GATE FORUM 10, GATE FORUM 10  
(C) GATEFORUM 10, is printed continuously  
(D) None of these

13. We want to reverse the elements of singly linked list. Assume Remove (head) will remove the first element from linked list and Insert (head, X) will insert X at last element of link list:

```
Do reverse (LinkList * head)
{
If (!IsEmpty (head))
{
temp = Remove(head);
Do reverse (head);
X : _____
}
}
```

What should be the statement X?

- (A) Remove(tmp) (B) Remove(head)  
(C) Insert(head, tmp) (D) None of these

14. Output of the following program will be

```
int main()
{
int i, a[8]={000, 001, 010, 011, 100, 101, 110, 111};
for(i=0;i<8;i++)
printf("%d", a[i]);
}
```

- (A) 0, 1,2,3,4,5,6,7 (B) 0,1,10, 11, 100, 101, 110, 110  
(C) 0,1,8,9,100,101,110,111 (D) None of these

15. Output of the following program will be

```
int main()
{
char *p1="Graduate";
char *p2=p1;
printf("%c, %d", *(++p2), sizeof(R));
}
```

- (A) G, 8 (B) r, 7 (C) r, 4 (D) r, 8

16. Match the following:

| List I |                  | List II |                     |
|--------|------------------|---------|---------------------|
| 1      | Quick Sort       | a       | Divide and Conquer  |
| 2      | Graph colouring  | b       | Greedy              |
| 3      | String editing   | c       | Dynamic Programming |
| 4      | Prim's Algorithm | d       | Back tracking       |

(A) 1-a, 2-c, 3-b, 4-d

(B) 1-b, 2-a, 3-d, 4-c

(C) 1-a, 2-d, 3-c, 4-b

(D) None of these

17. Complexity of algorithm to interchange the
- $n^{\text{th}}$
- and
- $m^{\text{th}}$
- element (node) of singly linked list is

 (A)  $m+n$ 

 (B)  $m$  if  $m \geq n$  otherwise  $n$ 

 (C)  $m$  if  $m \leq n$  otherwise  $n$ 

 (D)  $m + \min(m, n)$ 

18. What is the time complexity of the following algorithm?

```

int Algorithm (int n){
 if(n == 1 || n == 2) return 1
 return Algorithm(n-1) + Algorithm(n-2)
}

```

 (A)  $\theta(n)$ 

 (B)  $\theta(n \log n)$ 

 (C)  $\theta(n^2)$ 

 (D)  $\theta(n^2 \log n)$ 

19. Given matrix A of size
- $n \times n$
- such that element in each row is in increasing order and element in each column is in increasing order. The function to find given value in matrix A is

```

Find(int* A, int val)

```

```

{
 int found = 0
 for(i=0; i<n; i++)
 {
 /* for each row in A */
 found = found _____
 }
}

```

Which of the following can fit in the blank?

 (A) `Find(A[i][0], val)`

 (B) `Find(A[0][i], val)`

 (C) `Binary Search(A[i], val)`

(D) None of these

20. An array
- `A[10][20]`
- starts at base address of 1000 decimal. Each element in array occupies 1 byte and array is stored in row major order, then address of
- `A[5][6]`
- is

(A) 1105

(B) 1107

(C) 1106

(D) 1108

21. To find the maximum element in a min-heap represented by an array can be computed in \_\_\_\_\_ time.  
(A)  $\theta(n)$  (B)  $\theta(n^2)$  (C)  $\theta(n \log n)$  (D)  $\theta(1)$
22. An array of size  $n$  consists of 0's and 1's in random order. We have to write an algorithm to sort such that all 1's comes at one side and all 0's comes at the other side what can be the worst case time complexity  
(A)  $\Omega(\log n)$  (B)  $\theta(\log n)$  (C)  $\theta(n^2)$  (D)  $\theta(n)$
23. Which of the following data structures is useful in traversing a Graph using, Depth first search and Breadth first search?  
(A) Queue, Stack (B) Queue, Queue (C) Stack, Queue (D) Stack, Linked List
24. Given an array of size  $m$  is represented as  $a[a[0], a[1], a[2], \dots, a[m-1]]$ , then one temporary swap( $x, y$ ) of elements  $x$  and  $y$  from the array takes:  
(A)  $\frac{(m+1)}{2}$  temporary variable of type  $a$  (B)  $\frac{m}{2}$  temporary variable of type  $a$   
(C) one temporary variable of type  $a$  (D) None of these
25. The pre-order traversal of binary tree  
Preorder(struct node \*node)  
{  
if (node == NULL) return;  
X:  
Y:  
Z:  
}  
What will be X,Y and Z?  
(A) X: Print(node) Y: Preorder(node  $\rightarrow$  left) Z: Preorder(node  $\rightarrow$  right)  
(B) X: Preorder(node  $\rightarrow$  left) Y: Print(node) Z: Preorder(node  $\rightarrow$  right)  
(C) X: Preorder(node  $\rightarrow$  left) Y: Preorder(node  $\rightarrow$  right) Z: Print(node)  
(D) X: Preorder(node  $\rightarrow$  left) Y: Preorder(node  $\rightarrow$  right) Z: Preorder(node  $\rightarrow$  left)
26. Given two singly linked lists L1 and L2 with  $n$  and  $m$  elements respectively. We need to create a singly linked L having all elements of L1 and L2. The complexity of the algorithm is  
(A)  $O(n+m)$  (B)  $O(n)$  (C)  $O(m)$  (D)  $O(\max(n,m))$

**Common Data Questions: 27 & 28**

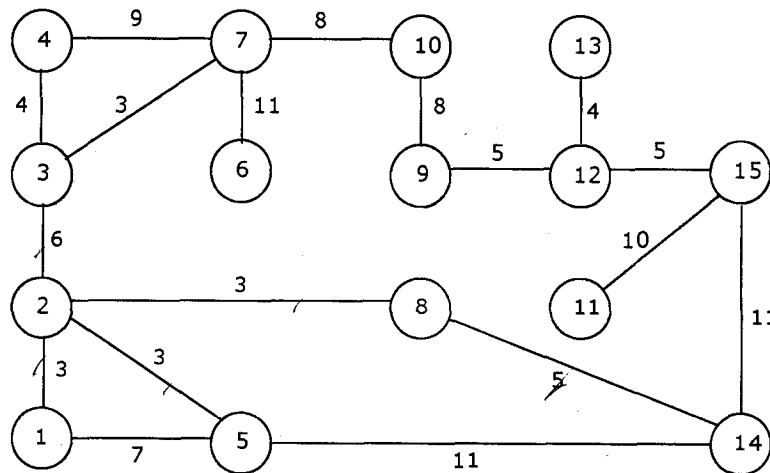
Consider the following elements in the construction of AVL tree

21, 26, 30, 9, 4, 14, 28, 18, 15, 10, 2, 3, 7

27. How many RR RL imbalances occurred during the construction of AVL tree?  
 (A) 1, 4 (B) 2, 3 (C) 1, 3 (D) 2, 4
28. What is root element of AVL tree?  
 (A) 21 (B) 14 (C) 4 (D) 15

**Statement for Linked Answer Questions: 29 & 30**

Consider the following graph



29. Run Prim's algorithm from node 1, what is the cost from 1 to 15?  
 (A) 29 (B) 21 (C) 23 (D) None of these
30. Using Prim's algorithm, the minimum cost of spanning tree is  
 (A) 78 (B) 68 (C) 65 (D) None of these

**Answer Keys**

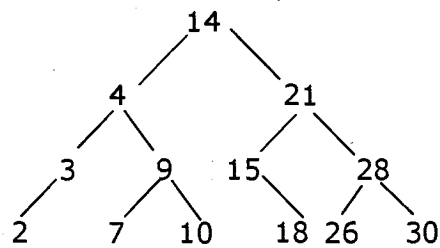
|    |   |    |   |    |   |    |   |    |   |    |   |    |   |
|----|---|----|---|----|---|----|---|----|---|----|---|----|---|
| 1  | C | 2  | C | 3  | D | 4  | C | 5  | A | 6  | B | 7  | B |
| 8  | B | 9  | B | 10 | C | 11 | B | 12 | C | 13 | C | 14 | C |
| 15 | C | 16 | C | 17 | B | 18 | C | 19 | C | 20 | C | 21 | A |
| 22 | C | 23 | C | 24 | C | 25 | A | 26 | D | 27 | C | 28 | B |
| 29 | D | 30 | A |    |   |    |   |    |   |    |   |    |   |

**Explanations:-**

3.  $m + n$ . Two lists can be completely common.  
Then  $m+n$  operations are required to print
10.  $2000 + [(1+8) * (20+1) + (3+4)] * 4 = 2784$
13. We are removing all elements from list when going in forward direction, while coming back we should insert them.
14. 0, 1, 8, 9, 100, 101, 110, 111  
010 → is a octal number format
17.  $m$  if  $m \geq n$ ; otherwise  $n$ . We need to traverse the linked list till  $m$ .
18.  $\theta(n^2)$ ; (Fibonacci example)
19. As each row is in increasing order, we can do Binary Search( $A[i]$ , val)
20.  $a[5][6] = 1000 + 5 \times 20 + 6 = 1106$
24. One temporary variable of type  $a$

```
for (1; i < $\frac{m}{2}$; i++)
{
 temp = a[i];
 a[i] = a[m-i];
 a[m-i] = temp;
}
```

28. 14 is the root



# Data Structure and Algorithms-II

## Computer Science Engineering

Test ID: 

|   |   |   |   |
|---|---|---|---|
| 2 | 1 | 3 | 3 |
|---|---|---|---|

Duration: 90 minutes

Maximum Marks: 50

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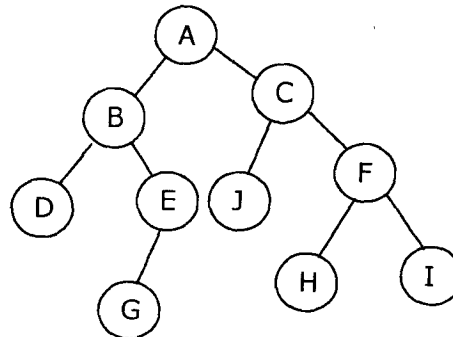
**Q.No.1-10 Carry One Mark Each**

1. Constant time taken to delete a minimal element in priority queue is  
(A)  $O(N \log N)$  (B)  $O(N)$  (C)  $O(\log N)$  (D) None of these
2. The worst case time complexity of searching an element in Hash table of size  $m$  with linear probing is  
(A)  $O(m)$  (B)  $O(m^2)$  (C)  $O(1)$  (D)  $O(\log m)$
3. Time complexity required to determine, if a given number is even or odd is  
(A) linear (B) exponential (C) logarithmic (D) constant
4. Consider two trees A and B with 9 and 15 nodes respectively, then which of these can be a full binary tree?  
(A) Tree 'A' (B) Tree 'B'  
(C) Both tree 'A' & tree 'B' (D) None of these
5. In order to match the parenthesis of C program, which of the following is the best data structure?  
(A) Queue (B) Linked list (C) Stack (D) Heap
6. The technique of introducing linked lists in each entry of hash table is called  
(A) Rehashing (B) Order-preserving hash function  
(C) Hash collision (D) Chaining
7. The logarithmic time to perform search operation in balanced tree is  
(A)  $O(n \log n)$  (B)  $O(\log n)$  (C)  $O(2^n)$  (D)  $O(n^2)$
8. ' $\Omega$ ' is an asymptotic notation which specifies  
(A) Upper bound (B) Lower bound  
(C) Tight upper bound (D) Tight lower bound
9. The average case and best case performance of merge sort is  
(A)  $O(n)$  and  $O(n \log n)$  (B)  $O(n \log n)$  and  $O(n)$   
(C)  $O(n \log n)$  (D)  $O(n)$
10. The number of nodes in a binary tree of height ' $h$ ' (Assume root is at level '0')  
(A)  $2^h + 1$  (B)  $2^{h+1} - 1$  (C)  $2^h$  (D) None of these



**Q. No.11-30 Carry Two Marks Each**

11. The empty sub trees of the binary tree are rooted at



- (A) D, G, C, E      (B) E, C      (C) E, G      (D) D, G, H, J, I
12. Consider the following sequence (50, 17, 14, 8, 13, 10, 2, 5, 7, 12). What is the minimum number of interchanges required to make it max heap?  
(A) 1      (B) 2      (C) 3      (D) 0
13. A max heap has following elements in it  
100 50 70 20 30 40 60 10  
After deleting 100, what is the new heap?  
(A) 70 60 50 20 30 40 10      (B) 70 50 60 20 30 40 10  
(C) 70 60 50 40 30 20 10      (D) 70 50 60 20 40 30 10
14. Suppose that  
 $f_1(x)$  is  $O(g_1(x))$  and  $f_2(x)$  is  $O(g_2(x))$   
Then  $(f_1(x) + f_2(x))$  is  
(A)  $O(g_1(x) + g_2(x))$       (B)  $O(\min(g_1(x), g_2(x)))$   
(C)  $O(\max(g_1(x), g_2(x)))$       (D)  $O(g_1(x) \times g_2(x))$
15. The time complexity of function given below with constants is  
Void f(int a[], int n)  
{  
  int i;  
  Printf("%d", n);  
  For (i=0, i<n; i++)  
  {  
    Printf("%d", a[i]);  
  }  
  Printf("n");  
}

- (A)  $O(1)$       (B)  $O(N)$       (C)  $O(1) + O(N)$       (D)  $2 * O(1) + O(N)$

16. A complete binary tree is implemented by using an array 'A' with the following properties

Suppose  $A[i]$  contains the root, then which of the following statement(s) is/are correct?

- i. has left child at  $A[2*i+1]$  and right child at  $A[2*i+2]$
- ii. has left child at  $A[2*i]$  and right child at  $A[2*i+1]$
- iii. if a node is at  $A[i]$ , then its parent will be at  $A[i/2]$

(A) i (B) I & iii (C) ii & iii (D) ii

17. The number of comparisons required to search 28 in hash table with bucketing is  
pos. =  $x \% 10$

|   |                          |
|---|--------------------------|
| 0 | → 0 → 100 → 50 → 20 → 10 |
| 1 |                          |
| 2 | → 22 → 32 → 12           |
| 3 |                          |
| 4 |                          |
| 5 |                          |
| 6 |                          |
| 7 |                          |
| 8 | → 38 → 18 → 98 → 28      |
| 9 |                          |

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

18. Probe sequence of method open addressing is

- i. Putting them in only next empty space
- ii. Used to solve collision problem
- iii. The list of locations which produces an alternatives in case of collision

(A) I (B) ii (C) I, iii (D) ii, iii

19. Exponential computing time is

(A)  $O(1+1+1+...+n)$  (B)  $O(2 \times 2 \times 2 \times 2 \times ... \times n)$   
(C)  $O(n)$  (D)  $O(2_e + 2_e + ... n_e)$

20. Consider the following C program

```
DoX(int n)
{
 if(n == 0 || n == 1)
 return n;
 return DoX(n-1) + DoX(n-2);
}
```

What is the recursive function equivalent to above?

- (A)  $\alpha T(n) + \beta T(n+1) = T(n)$   $\alpha, \beta \geq 1$  (B)  $T(n-1) + T(n+2) + 1 = T(n)$   
(C)  $T(n) = T(n-1) + T(n-2) + 3$  (D)  $T(n) = T(n-1) + T(n-2)$

21. The time required to search an element with key 'k' in a binary search tree of height 'h' and 'n' nodes.

- (A)  $O(n)$  (B)  $O(\log n)$   
(C)  $O(n)$  to  $O(\log n)$  (D)  $O(h)$

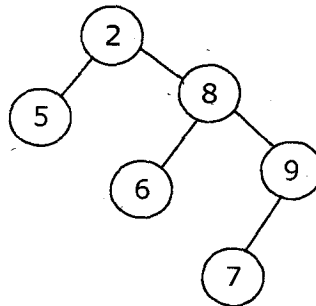
22. The asymptotic behavior of polynomial in 'n' of the form

$$f(n) = \sum_{i=0}^m a_i n^i$$

Where  $a_m > 0$  then  $f(n)$  is

- (A)  $O(\log m)$  (B)  $O(n^m)$  (C)  $O(n \log m)$  (D) None of these

23. For the given binary tree, at which location you store node 7 in an array



- (A)  $a[6]$  (B)  $a[10]$  (C)  $a[13]$  (D)  $a[12]$

24. What is the time complexity of a polynomial time algorithm upper bounded by a polynomial of degree 'k'?

- (A)  $T(n) = O(n+k)$  (B)  $O(n^k)$  (C)  $O((\log n)^k)$  (D) None of these

25. The space complexity of quick sort in worst case is

- (A)  $O(n \log n)$  (B)  $O(\log n)$  (C)  $O(n \log n^2)$  (D)  $O(n^2 \log n)$

26. Match the following

| List I |                             | List II |               |
|--------|-----------------------------|---------|---------------|
| 1      | $T(n) = 9T(n/3) + n$        | a       | $O(\log n)$   |
| 2      | $T(n) = T(2n/3) + 1$        | b       | $O(n \log n)$ |
| 3      | $T(n) = 3T(n/4) + n \log n$ | c       | $\theta(n^2)$ |

- (A) 1-b; 2-a; 3-c (B) 1-d; 2-b; 3-a (C) 1-a; 2-b; 3-c (D) 1-c; 2-a; 3-b

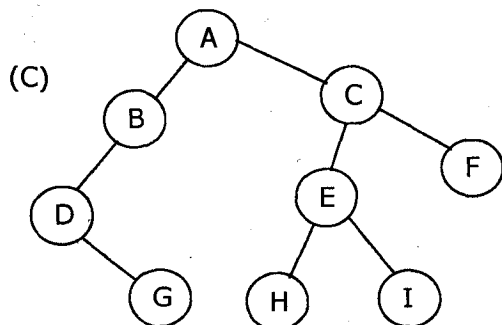
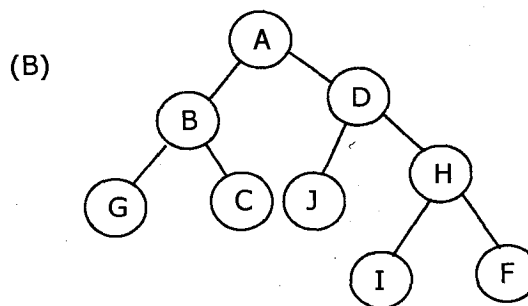
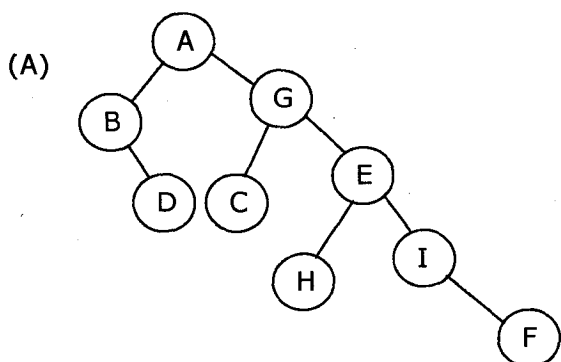
**Common Data Questions: 27 & 28**

List of keys (k) 81, 64, 25, 36 are inserted into the hash table using the hash function  $H = K \bmod \text{table size}$ , where table size = 10

27. A new element 1 hashes into the location  
(A) 1 (B) Collision occurs (C) 2 (D) None of these
28. A new element 16 hashes into hash table and linear probing is used for collision resolution. The new element position is  
(A) 0 (B) 2 (C) 7 (D) None of these

**Statement for Linked Answer Questions: 29 & 30**

29. The preorder traversal of a Binary tree 'B' is ABDGCEHIF and in order traversal is DGBAHEICF. The binary tree 'B' is



(D) None of these

30. The post order traversal for the above binary tree B is  
(A) DGBHIEFCA (B) DBACHFIEGA (C) GDBHIEFCA (D) None of these

**Answer Keys**

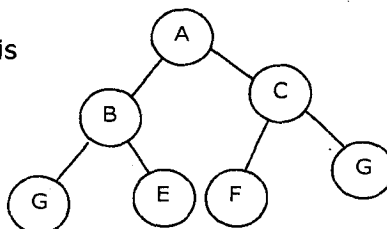
|    |   |    |   |    |   |    |   |    |   |    |   |    |   |
|----|---|----|---|----|---|----|---|----|---|----|---|----|---|
| 1  | C | 2  | A | 3  | D | 4  | B | 5  | C | 6  | D | 7  | B |
| 8  | B | 9  | C | 10 | B | 11 | D | 12 | D | 13 | B | 14 | C |
| 15 | D | 16 | C | 17 | D | 18 | D | 19 | B | 20 | D | 21 | D |
| 22 | B | 23 | C | 24 | B | 25 | B | 26 | D | 27 | B | 28 | C |
| 29 | C | 30 | C |    |   |    |   |    |   |    |   |    |   |

**Explanations:-**

- Deleting a minimal element in priority queue takes a constant time, after that heap structure has to be adjusted, and this requires  $O(\log N)$  time.
- Only one operation is required to check if the number is even or odd, that is divide the number with zero. If we get zero as the remainder then it is even otherwise it is odd. Hence  $O(1)$
- A full binary tree should contain  $2^h - 1$  nodes, where  $h$  is the height of the tree.  
Let height be 3 then  
Number of nodes should be  $2^3 - 1 = 8 - 1 = 7$   
Let height be 4 then  
Number of nodes should be  $2^4 - 1 = 16 - 1 = 15$   
This shows that with 9 nodes we cannot construct a full binary tree.

10.  $2^{h+1} - 1$

For example height of the tree is  
Height = 2

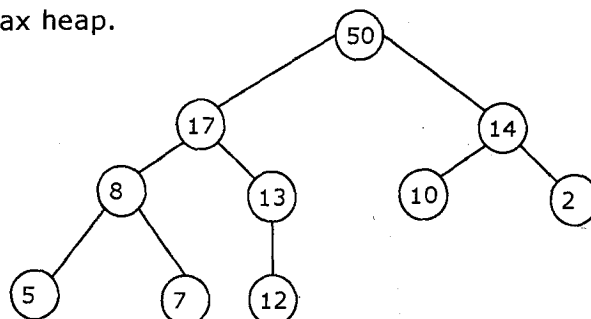


Then binary tree is said to be full binary tree if it contains  $2^{h+1} - 1$  nodes where level starts from 0

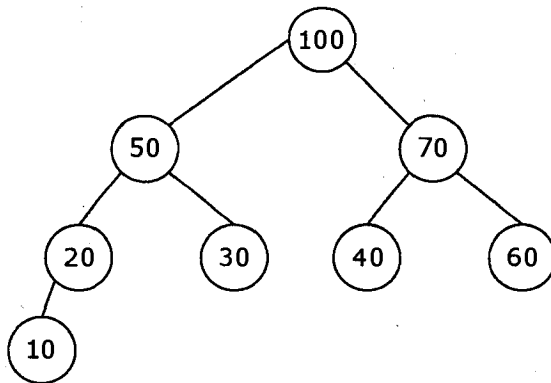
$$\therefore 2^{h+1} - 1 = 8 - 1 = 7.$$

- The absence of a branch indicates an empty sub tree. So, the left sub tree of the binary tree rooted at C and right sub tree of binary tree rooted E are both not empty  
So, the binary tree rooted at D, G, H, J, I have empty right and left sub trees.

- It is already max heap.



13.



14. This is one of the properties of Big oh notations.

If  $(f_1(x)) = O(g_1(x))$  and

$(f_2(x)) = O(g_2(x))$ , then

$f_1(x) + f_2(x) = O(\max(g_1(x), g_2(x)))$

15. The two printf ("") calls outside the loop are said to have a constant time complexity i.e.,  $O(1)$ . The loop has no. of steps equal to size of array, the loop linear time complexity  $O(N)$ . The entire function 'f' has a time complexity of  $2*O(1)+O(N)$ . If constants are removed then  $O(N)$ .

17.  $28\%10 = 8$ . We have to linear search bucket 8, which requires 4 searches to find.

20. The C-program calculates Fibonacci series

22. Given  $f(n) = \sum_{i=0}^m a_i n^i = a_m n^m + a_{m-1} n^{m-1} + \dots + a_1 n + a_0$

Where  $a_m > 0$  then  $f(n) = O(n^m)$

Each of the terms in summation is of the form  $a_i n^i$ . Since, 'n' is non-negative, a particular term will be negative only if  $a_i < 0$ . Hence for each term the summation  $a_i n^i \leq |a_i| n^i$

23. The array position of element '7' in Binary tree is

$a[0] \ a[1] \dots\dots\dots a[13]$

|   |   |   |  |  |   |   |  |  |  |  |  |  |   |
|---|---|---|--|--|---|---|--|--|--|--|--|--|---|
| 2 | 5 | 8 |  |  | 6 | 9 |  |  |  |  |  |  | 7 |
|---|---|---|--|--|---|---|--|--|--|--|--|--|---|

26. By Master Theorem

27. Hash 1  
Into hash table  
Collision occurs

|   |    |
|---|----|
| 0 |    |
| 1 | 81 |
| 2 |    |
| 3 |    |
| 4 | 64 |
| 5 | 25 |
| 6 | 36 |
| 7 |    |
| 8 |    |
| 9 |    |

By using hash function  $H = k \text{ mod table size}$

Element 81 is inserted into the position = 1

64 is inserted into the position = 4

25 is inserted into the position = 5

36 is inserted into the position = 6

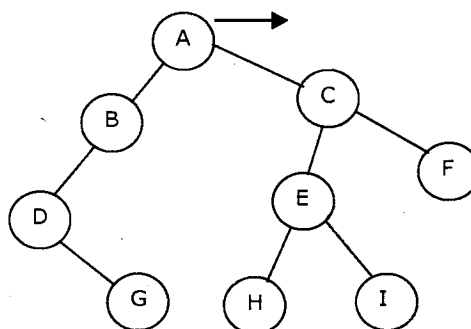
New element 1 position is 1, but that position is already occupied by element 81. So there will be collision.

28. New element 16 hashes to the position 6 which are already occupied by 36. Here we are using linear probing for collision resolution; hence next position 7 is allotted for the newly inserted element. Resultant hash table is shown in below figure.

|   |    |
|---|----|
| 0 |    |
| 1 | 81 |
| 2 |    |
| 3 |    |
| 4 | 64 |
| 5 | 25 |
| 6 | 36 |
| 7 | 16 |
| 8 |    |
| 9 |    |

29. By trail and error method, we can find the answer as option 'C'

30. The above Binary tree 'B' is



For post order traversal visit left subtree right subtree and then visit the node.

# Data Structure and Algorithms-III

## Computer Science Engineering

Test ID: 

|   |   |   |   |
|---|---|---|---|
| 2 | 1 | 3 | 4 |
|---|---|---|---|

Duration: 90 minutes

Maximum Marks: 50

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### Read the following instructions carefully:

1. Write your roll number, your name and name of the examination center at the specified locations of the ORS.
2. Using HB pencil, darken the appropriate bubble under each digit of your registration number and the letters corresponding to your paper code.
3. All the questions in this question paper are of objective type.
4. Questions must be answered on Objective Response Sheet (ORS) by darkening the appropriate bubble (marked A, B, C, D) using HB pencil against the question number on the left hand side of the ORS. **Each question has only one correct answer.** In case you wish to change an answer, erase the old answer completely. More than one answer bubbled against a question will be treated as a wrong answer.
5. This question paper contains 30 objective type questions. Q.1 to Q.10 carry **one** mark each and Q.11 to Q.30 carry **two** marks each.
6. Un-attempted questions will carry zero marks.
7. The question pair (27, 28) is common data questions.
8. The questions pair (29, 30) is questions with linked answers. The answer to the second question of the above pair will depend on the answer to the first question of the pair. If the first question in the linked pair is wrongly answered or is un-attempted, then the answer to the second question in the pair will not be evaluated.
9. **NEGATIVE MARKING:** For Q.1 to Q.10, 1/3<sup>rd</sup> mark will be deducted for each wrong answer. For Q. 11 to Q.30, 2/3<sup>rd</sup> mark will be deducted for each wrong answer. For the pair of questions with linked answers, there will be negative marks only for wrong answer to the first question, i.e. for Q.29, 2/3<sup>rd</sup> mark will be deducted for wrong answer. There is no negative marking for Q.30.
10. Calculator without data connectivity is allowed in the examination hall. Charts, graph sheets or tables are NOT allowed in the examination hall.
11. Rough work can be done on the question paper itself.

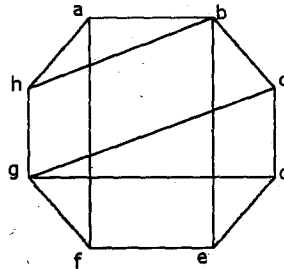


**Q. No. 1 – 10 Carry One Mark Each**

1. The algorithm time complexity of Kruskal's algorithm for MST is  
(Assume  $E$  = no. of edges and  $V$  = number of vertices)  
(A)  $O(E \log E)$  (B)  $O(E^2)$  (C)  $O(V \log V)$  (D) None of these

2. For inorder traversal of BST, which of the following is true?  
(A) Output will always be in sorted decreasing order  
(B) Output will always be in sorted increasing order  
(C) It does not sort the number  
(D) None of these

3. DFS of the following graph starting from a will be



- (A) ahg fedcb (B) abdce fgh (C) ahg fedcb (D) ahbgc fde
4. The best suitable data structure for binary search is  
(A) max heap (B) linked list (C) array (D) B tree
5. Which of the following is necessary to uniquely determine binary tree?  
(A) Inorder and pre-order (B) Inorder and post-order  
(C) Pre-order and post-order (D) Either A or B
6. Let weight of minimum spanning tree of given graph  $G$  as per Kruskal's algorithm is  $w_k$ , and as per Prim's algorithm is  $w_p$ , then  
(A)  $w_k \leq w_p$  (B)  $w_k \geq w_p$  (C)  $w_k = w_p$  (D) None of these
7. The worst input for insertion sort is  
(A) Already sorted array (B) Random array  
(C) Array sorted in reverse order (D) None of these
8. The time complexity of searching an element in a linked list is  
(A)  $O(n)$  (B)  $O(n^2)$  (C)  $O(\log n)$  (D)  $O(1)$
9. Which of the following technique is called in place sort technique?  
(A) Quick Sort (B) Merge Sort (C) Heap Sort (D) All of these

10. Suppose that

$f_1(x)$  is  $O(g_1(x))$  and  $f_2(x)$  is  $O(g_2(x))$

Then  $(f_1(x) + f_2(x))$  is

(A)  $O(g_1(x) + g_2(x))$

(B)  $O(\min(g_1(x), g_2(x)))$

(C)  $O(\max(g_1(x), g_2(x)))$

(D)  $O(g_1(x) \times g_2(x))$

11. Finding independent set of simple graph is

(A) P with time complexity  $O(n^2)$  where  $|U| = n$

(B) P with time complexity  $O(n^2)$  where  $|U| = n$

(C) It is NP but not NP complete

(D) NP complete

12. Match the following

| A |                  | B |                  |
|---|------------------|---|------------------|
| 1 | DFS              | a | Queue            |
| 2 | BFS              | b | Stack            |
| 3 | Huffman encoding | c | Network topology |
| 4 | Articulation     | d | Binary tree      |

(A) 1-b; 2-a; 3-d; 4-c

(B) 1-a; 2-b; 3-c; 4-d

(C) 1-d; 2-c; 3-b; 4-a

(D) 1-b; 2-a; 3-c; 4-d

13. A binary tree has 10 nodes. The inorder and pre-order traversal of tree is

Preorder: A B D E H J C F I G

Inorder: D B H J E A I F C G

How many leaf nodes are there in the above binary tree?

(A) 4

(B) 5

(C) 3

(D) 6

14. What is post-fix expression for the following expression?

$a \wedge b \wedge c * d * e / f + g - h$

(A)  $abc \wedge \wedge d * e * f / g + h -$

(B)  $ab \wedge c \wedge d * e * f / g + h -$

(C)  $\wedge \wedge abc * d * e / f + g - h$

(D)  $\wedge ab \wedge c * d * e / f + g - h$

15. Consider a simple graph G with k components and each component has  $n_1, n_2, \dots, n_k$  vertices, then maximum number of edges in G is

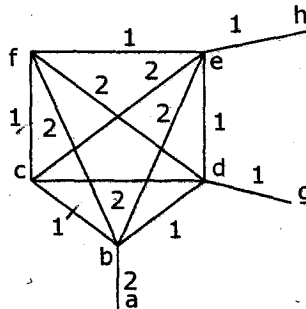
(A)  $\left(\frac{n}{2}\right)$  where  $n \leq \sum_{i=1}^k n_i$

(B)  $\left(\frac{n}{2}\right) - k$  where  $n = \sum_{i=1}^k n_i$

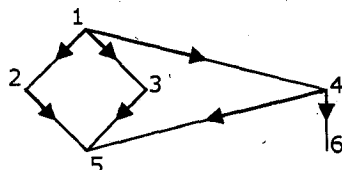
(C)  $\sum_{i=1}^k n_i C_2$

(D)  $\left(\frac{n}{2}\right) = k$  where  $n = \sum_{i=1}^k n_i$

16. The complexity of DFS of graph with 'V' vertices and 'E' edges is  
 (A)  $\Theta(V)$  (B)  $\Theta(E)$  (C)  $\Theta(V+E)$  (D) none of these
17. Let  $T(n)$  be the function defined by  
 $T(1) = 1$ ;  $T(n) = 2T(n/2) + \sqrt{n}$  for  $n \geq 2$ . Which of the following is true?  
 (A)  $T(n) = O(\sqrt{n})$  (B)  $T(n) = \Theta(n)$  (C)  $T(n) = O(\log n)$  (D) None of these
18. The best case and worst case run time complexity of merge sort is  
 (A)  $O(n)$ ;  $O(n^2)$  (B)  $O(n \log n)$ ;  $O(n^2)$   
 (C)  $O(n \log n)$ ;  $O(n)$  (D)  $O(n \log n)$ ;  $O(n \log n)$
19. In quick sort, if pivot is the smallest element, then it will become  
 (A) Insertion sort (B) Selection sort (C) Bubble sort (D) none of these
20. What is the weight of minimum spanning tree for following graph as per Prim's algorithm?



- (A) 8 (B) 9 (C) 10 (D) 11
21. In which order given numbers 4,8,6,7,10,12,18,13,9,15,17 should be inserted in binary search tree to get inorder and preorder traversal same?  
 (A) 18,17,15,13,12,10,9,8,7,6,4 (B) 4,6,7,8,9,10,12,13,15,17,18  
 (C) 4,6,7,8,9,12,10,13,15,17,18 (D) any order
22. Determine the resultant array after first iteration of bubble sort on 10 20 6 5 30 8.  
 (A) 10 20 5 6 30 8 (B) 10 20 6 5 8 30  
 (C) 20 20 6 5 8 30 (D) 10 6 5 20 8 30
23. Consider the directed acyclic graph with  $\sigma = \{1, 2, 3, 4, 5, 6\}$  shown as below:



Which of the following represents topological ordering of given DAG?

- (A) 2,1,3,4,5,6      (B) 1,5,2,3,4,6      (C) 1,2,3,4,6,5      (D) 1,2,3,5,6,4

24. The post order traversal of binary tree is

Postorder(strct node\*node)

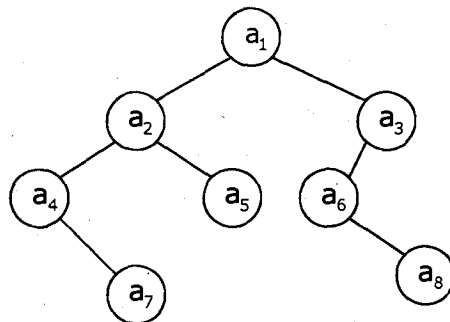
```
{
if(node == NULL)
return;
X: _____
Y: _____
Z: _____
}
```

- (A) X: Postorder(node → left) Y: Postorder(node → right) Z: print(node)  
 (B) X: Postorder(node → left) Y: print(node) Z: Postorder(node → right)  
 (C) X: Postorder(node → left) Y: postorder(node) Z: print(node)  
 (D) X: print(node) Y: Postorder(node → right) Z: Postorder(node → left)

25. After second pass of straight selection sort on 30 10 20 8 6 7, the resultant array will be

- (A) 7 10 20 8 6 30      (B) 7 10 6 8 20 30  
 (C) 7 10 8 6 20 30      (D) 7 10 6 8 30 20

26. An operation swap tree takes a binary tree and swaps the left and right children of each node. Consider the following binary tree given below.



What is post order traversal of the tree after applying swap operation?

- (A) a<sub>7</sub> a<sub>4</sub> a<sub>5</sub> a<sub>2</sub> a<sub>8</sub> a<sub>6</sub> a<sub>3</sub> a<sub>1</sub>      (B) a<sub>8</sub> a<sub>6</sub> a<sub>3</sub> a<sub>5</sub> a<sub>7</sub> a<sub>4</sub> a<sub>2</sub> a<sub>1</sub>  
 (C) a<sub>7</sub> a<sub>4</sub> a<sub>5</sub> a<sub>3</sub> a<sub>8</sub> a<sub>6</sub> a<sub>2</sub> a<sub>1</sub>      (D) a<sub>7</sub> a<sub>5</sub> a<sub>4</sub> a<sub>3</sub> a<sub>8</sub> a<sub>6</sub> a<sub>2</sub> a<sub>1</sub>

### Common Data Questions: 27 & 28

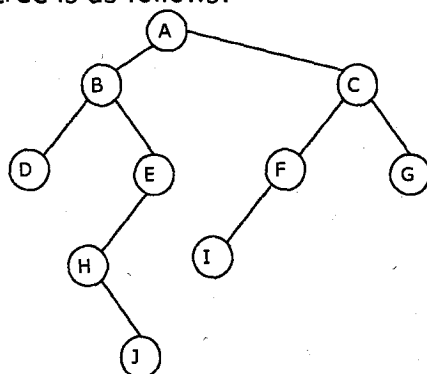
Assume that we have ternary tree means each node can have at most 3 children, namely left, middle and right. Consider the following function to calculate total number of nodes with exactly 3 children.

**Answer Keys**

|    |   |    |   |    |   |    |   |    |   |    |   |    |   |
|----|---|----|---|----|---|----|---|----|---|----|---|----|---|
| 1  | A | 2  | B | 3  | C | 4  | C | 5  | D | 6  | C | 7  | C |
| 8  | A | 9  | C | 10 | C | 11 | D | 12 | A | 13 | A | 14 | A |
| 15 | C | 16 | C | 17 | B | 18 | D | 19 | B | 20 | A | 21 | B |
| 22 | D | 23 | C | 24 | A | 25 | B | 26 | B | 27 | D | 28 | D |
| 29 | A | 30 | B |    |   |    |   |    |   |    |   |    |   |

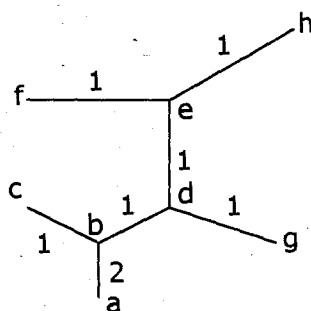
**Explanations:**

2. The inorder traversal of BST always sorts the number in increasing order.
5. Given inorder and post order or inorder and pre-order traversal, we can find binary tree.
11. Finding independent set of simple graph is NP complete problem.
12. DFS uses stack. BFS uses queue. Huffman encoding uses binary tree and articulation point is network topology.
13. The binary tree is as follows:



15. Each component can be complete graph in itself. After that no edges can be added in G, Maximum number of edges possible =  $\sum_{i=1}^k n_i C_2$
17. By master theorem.

20.

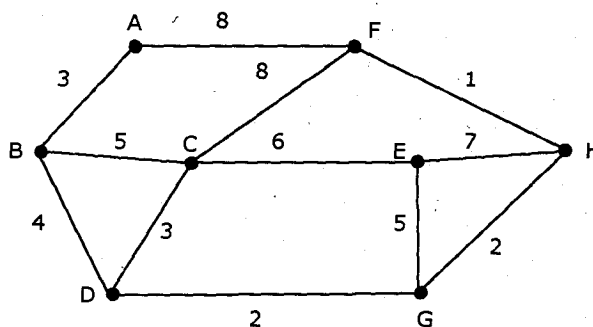


```
int find3Child(Node *T)
{
 int i; if (T==NULL) return 0;
 i=T → left &&T → middle &&T → right ?1:0
 return _____;
}
```

27. What should be in blank?
- (A) i  
(B) i + find3Child(T → left);  
(C) i + find3Child(T → left) + find3Child(T → middle);  
(D) i + find3Child(T → left) + find3Child(T → middle) + find3Child(T → right);
28. What is running cost of above algorithm? Assume total number of nodes in tree is n.
- (A)  $O(n^2)$       (B)  $O(n^3)$       (C)  $O(n \log n)$       (D)  $O(n)$

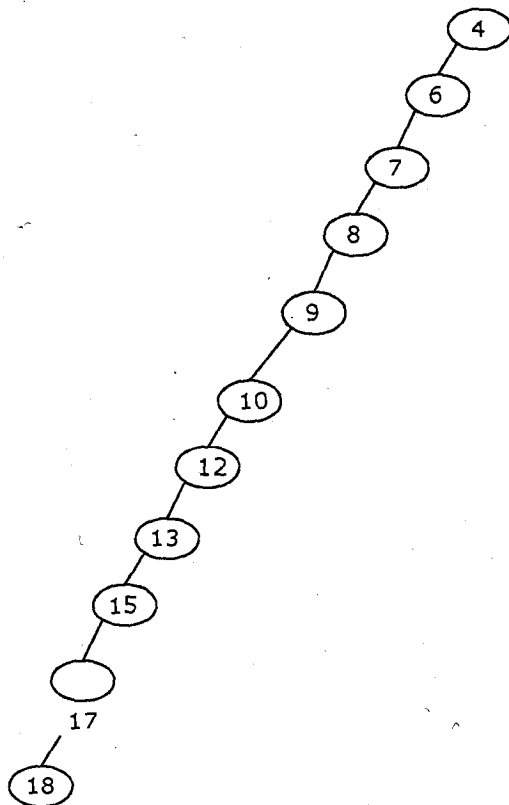
**Statement for Linked Answer Questions: 29 & 30**

Consider the following graph



29. The weight of the minimal spanning tree by applying Prim's algorithm starting at vertex 'E' is
- (A) 20      (B) 23      (C) 21      (D) None of these
30. The order of edges that are inserted in construction of minimal spanning tree in the above problem is
- (A) EG, GD, DC, DB, BA, AF, FH      (B) EG, GD, GH, HF, DC, DB, BA  
(C) EG, GD, DC, CB, BA, AF, FH      (D) None of these

21.



23. Topological ordering of a directed acyclic graph (DAG) is a linear ordering of its nodes in which each node comes before all nodes to which it has outbound edges. Every DAG has one or more topological sorts

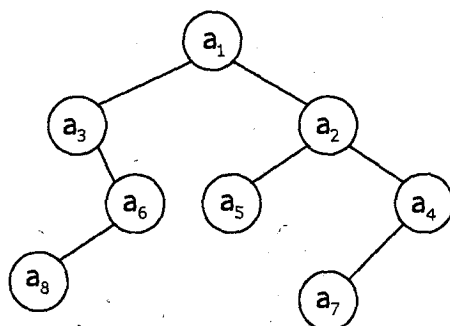
24. Post order is "visit left subtree in post order, visit right subtree in post order and then visit node

25. First pass will give

I 7 10 20 8 6 30

II 7 10 6 8 20 30

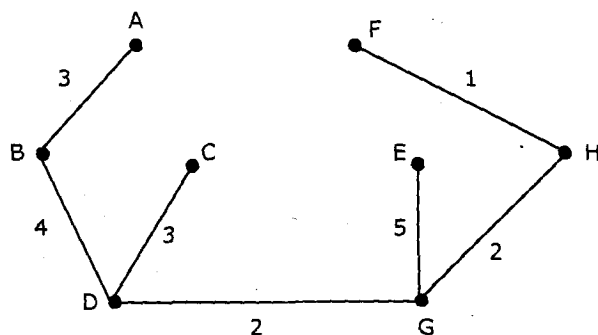
26. After swap tree is



Post order traversal:  $a_8 a_6 a_3 a_5 a_7 a_4 a_2 a_1$

27. We have to count  $i$  and nodes having 3 children in left, middle and right subtree.

28. For each node the function is called.
29. If we run prim's algorithm starting at vertex E, we will get the spanning tree as





# Operating Systems-I

## Computer Science Engineering

Test ID: 

|   |   |   |   |
|---|---|---|---|
| 2 | 1 | 3 | 5 |
|---|---|---|---|

Duration: 90 minutes

Maximum Marks: 50

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### Read the following instructions carefully:

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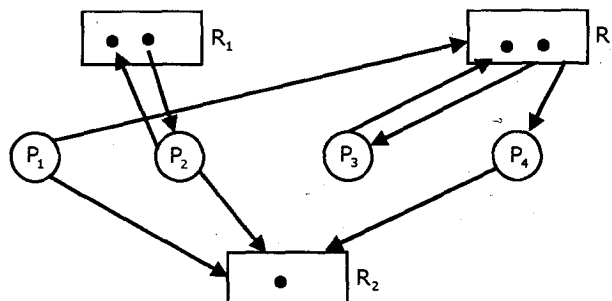
**Q. No. 1 – 10 Carry One Mark Each**

1. When a context switch happens between two threads of the same process, then which of the following values will be changed in the execution environment?  
(A) Program counter and Stack pointers  
(B) Memory management information and Stack pointers  
(C) Memory management information and Program counter  
(D) Nothing will be changed
2. What is the principal objective of time-sharing system?  
(A) To maximize the processor's use  
(B) To minimize the waiting time  
(C) To minimize the response time  
(D) None of these
3. Which of the following statements is true?  
(a) Circular waiting for resources describes the situation of a deadlock  
(b) Deadlock implies a starvation situation  
(c) Starvation implies a deadlock situation  
(A) a and b                      (B) a and c                      (C) a only                      (D) None of these
4. Which of the following statement is true about thread?  
(A) A thread has thread-specific heap or data segments  
(B) Context switch between threads requires more CPU cycles than switching processes  
(C) If a thread dies, its stack will remain in memory till all the threads of a process dies  
(D) None of these
5. When does the condition 'rendezvous' arise?  
(A) In message passing, it is the condition in which, both, the sender and receiver are blocked until the message is delivered  
(B) The condition where CPU is not engaged in any real productive activity during this period, and the process does not progress toward completion  
(C) This happens in virtual memory schemes, when the processor spends most of its time swapping pages, rather than executing instructions  
(D) None of these

6. System call is  
 (A) Hardware interrupts (B) Software interrupt  
 (C) Exception (D) None of these
7. Semaphores are used for  
 (A) Mutual exclusion  
 (B) Conditional synchronization  
 (C) Both Mutual exclusion and Conditional Synchronization  
 (D) None of these
8. Which of the following statements are true?  
 a. Creating a thread is more efficient than creating a process  
 b. Creating a thread is less efficient than creating a process.  
 c. Each thread has its own set of registers  
 d. Communication between threads easier than between processes  
 (A) Options "a", "c" and "d" (B) Options "b", "c" and "d"  
 (C) Options "a" and "c" (D) Options "c" and "d"
9. Which the following conditions are necessary for deadlock?  
 (A) Mutual exclusion & Hold and Wait (B) No pre-emption  
 (C) Circular wait (D) All of these
10. Which of following is a deadlock prevention technique?  
 (1) Acquire all resource before execution  
 (2) Release all resource before waiting for new resource  
 (3) Give unique number to each resource and a process can acquire resource x, if resource acquired by process y  $\forall yF(y) < F(x)$   
 (A) 1, 2 (B) 2, 3 (C) 1, 3 (D) 1, 2, 3

**Q. No. 11 – 30 Carry Two Marks Each**

11. Consider the following resource allocation graph.



Which of the following is TRUE?

- (A) The above allocation system is unsafe
- (B) The system is safe and the safety order is  $P_2, P_4, P_1$ , and  $P_3$
- (C) The system is safe and the safety order is  $P_1, P_2, P_3$ , and  $P_4$
- (D) The system is safe and the safety order is  $P_3, P_2, P_1$ , and  $P_4$

12. Suppose two processes P and Q are as follows:

|                                                                                                       |                                                                                                       |
|-------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|
| <p>P:</p> <pre>while(l) {     wait (mutex);     Print '0';     Print '1';     signal (mutex); }</pre> | <p>Q:</p> <pre>while(l) {     wait (mutex);     Print '1';     Print '0';     signal (mutex); }</pre> |
|-------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|

The correct pattern of the strings generated by the above two processes is

- (A)  $(10+01)^*$
- (B)  $(01)^*+(10)^*$
- (C)  $(0110)^*$
- (D)  $(1001)^*$

13. Let 'X' be the counting semaphore with initial value of 1. There are four active processes P, Q, R and S. The following events happen in order

P executes P (mutex), Q executes P (mutex)

R executes P(mutex), S executes P (mutex)

P executes V(mutex), Q executes V(mutex)

At the end how many processes will be blocked?

- (A) 1
- (B) 2
- (C) 3
- (D) None of these

14. A system has 6 processes sharing 7 resources. If each process needs maximum 3 units, then

- (A) Deadlock can never occur
- (B) Deadlock may occur
- (C) Starvation will occur
- (D) None of these

15. How many times the word "PROCESS" will be printed when executing the following program?

```
main () {
 printf("PROCESS");
 fflush ();
 fork ();
 fork ();
}
```

*sum of max req. of all the process  
should be < (total process +  
total resources)  
to make sure deadlock would not occur.*

*$6 \times 3 > 6+7$*

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

16. In which of the following scenario that a process changes the state from "User mode" to "Privileged mode"?
- (A) On interrupt handling (B) During Exceptions  
(C) System calls (D) All of these

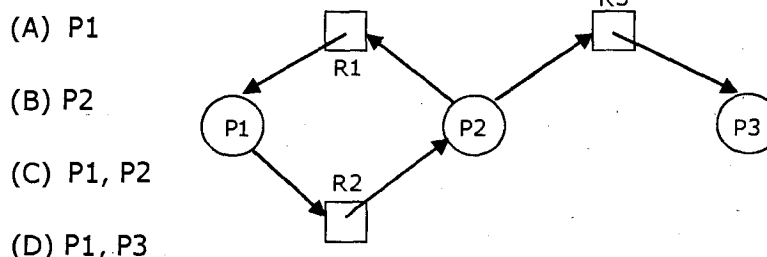
17. In which of the following case process will be in a zombie state?
- (A) When the parent process dies before the child process calls exit (), in this case the child process becomes a zombie process  
(B) When the parent process has not yet called the wait (), but the child has called exit (), in this case the child process becomes a zombie process  
(C) When the parent process dies before the child and it hasn't called wait (), in this case the child process becomes a zombie process  
(D) None of these

18. A, B, C resource has 7 instances, 2 instances and 6 instances respectively.

|                | Allocation | Request | Available |
|----------------|------------|---------|-----------|
|                | ABC        | ABC     | ABC       |
| P <sub>0</sub> | 010        | 000     | 000       |
| P <sub>1</sub> | 200        | 202     |           |
| P <sub>2</sub> | 303        | 000     |           |
| P <sub>3</sub> | 211        | 100     |           |
| P <sub>4</sub> | 002        | 002     |           |

- (A) The system is in safe state with safe sequence  $\langle P_0, P_2, P_3, P_1, P_4 \rangle$   
(B) The system is in safe state with safe sequence  $\langle P_1, P_2, P_3, P_4, P_0 \rangle$   
(C) The system is in safe state with safe sequence  $\langle P_1, P_3, P_2, P_4, P_0 \rangle$   
(D) The system is in deadlock
19. Semaphore is a non-negative integer variable with two operations. What is the property of those two operations?
- (A) Both operations should be serializable  
(B) Both operations should be atomic  
(C) Both operations should be concurrent (D) None of these

20. Which of the following process are in deadlock?



21. Four processes P1, P2, P3, P4 has resource requirement of resource R1, R2 as  $\langle 4, 3 \rangle, \langle 2, 4 \rangle, \langle 3, 6 \rangle, \langle 2, 8 \rangle$ . What should be minimum instance of R1 and R2 to ensure system is deadlock free.

- (A)  $\langle 8, 21 \rangle$  (B)  $\langle 8, 18 \rangle$  (C)  $\langle 11, 21 \rangle$  (D)  $\langle 11, 18 \rangle$

22. A process P makes n times call to fork system call as

fork ( );

fork ( );

.

.

fork ( );

How many child processes are created by P?

- (A)  $2^n$  (B)  $2^n + 1$  (C)  $2^n - 1$  (D) n

23. The solution to critical section for 2 processes P1 and P2 with code for

do{

flag[i] = true;

while(flag[j]);

C.S.

flag[i] = false;

R.S.

}while(1);

- (A) The solution satisfies mutual exclusion, progress and bounded wait  
(B) The solution satisfies mutual exclusion, but has deadlock  
(C) The solution satisfies mutual exclusion, and no deadlock  
(D) The solution satisfies mutual exclusion and bounded wait

24. Consider the code used by the processes P and Q for accessing their critical sections. The initial values of shared Boolean variables S and T are false

| Code of P                                     | Code of Q                              |
|-----------------------------------------------|----------------------------------------|
| While (S == T); critical section S = not (T); | While(S! = T); critical section S = T; |

Which of the following statements is TRUE?

- (A) Code will violate the mutual exclusion  
(B) Process P can go into critical section multiple times without the single entry of Q into critical section.  
(C) Process Q can go into critical section after exactly one entry by process P into its critical section  
(D) None of these

25. Resource allocation graph can have deadlock if
- (A) There is cycle in graph and each resource has multiple instances
  - (B) There is cycle in graph and each resource has single instance
  - (C) There is cycle in graph with at most 2 process involved in cycle
  - (D) There is cycle in graph
26. What happens to a child process, when the parent process exits before the child?
- (A) When the parent process is exiting, it sets the init process as a parent process for the child
  - (B) The parent process should not exit before any of its child processes
  - (C) The parent process will be in zombie state until child process exits
  - (D) None of these

**Common Data Questions: 27 & 28**

Assume in a system, there are 3 processes  $P_0, P_1, P_2$  with max need of resource R as

|       | Max. need | Current allocation |
|-------|-----------|--------------------|
| $P_0$ | 13        | 10                 |
| $P_1$ | 9         | 7                  |
| $P_2$ | 18        | 7                  |

27. If there are 26 instances of Resource R, then system is in
- (A) Safe state with  $\langle P_1, P_0, P_2 \rangle$
  - (B) Safe state with  $\langle P_1, P_2, P_0 \rangle$
  - (C) Either A or B
  - (D) Unsafe state
28. If there are 28 instances of Resource R, then system is in
- (A) Safe state with  $\langle P_1, P_0, P_2 \rangle$
  - (B) Safe state with  $\langle P_1, P_2, P_0 \rangle$
  - (C) Safe state with  $\langle P_0, P_1, P_2 \rangle$
  - (D) All of them are possible

**Statement for Linked Answer Questions: 29 & 30**

Consider a disk of size 128MB. Size of the disk block is 2kB and disk block address will be of 2 bytes. Assume that the disk is free initially.

29. The number of disk blocks that will be consumed for free space management using free list approach is
- (A) 64
  - (B) 128
  - (C) 32
  - (D) None of these
30. The percentage of disk consumed to implement free list approach is
- (A) 0.01
  - (B) 0.001
  - (C) 0.005
  - (D) None of these

**Answer Keys**

|    |   |    |   |    |   |    |   |    |   |    |   |    |   |
|----|---|----|---|----|---|----|---|----|---|----|---|----|---|
| 1  | A | 2  | C | 3  | A | 4  | D | 5  | A | 6  | B | 7  | C |
| 8  | A | 9  | D | 10 | D | 11 | B | 12 | A | 13 | B | 14 | B |
| 15 | A | 16 | D | 17 | B | 18 | A | 19 | B | 20 | C | 21 | B |
| 22 | C | 23 | B | 24 | C | 25 | B | 26 | A | 27 | A | 28 | D |
| 29 | A | 30 | B |    |   |    |   |    |   |    |   |    |   |

**Explanations:**

- The values of registers, PC and stack pointers will be changed. Memory management information doesn't change
- The principal objective of time-sharing system is to minimize the response time
- Deadlock implies starvation, but not the other way.
- In message passing, the condition in which, both, the sender and receiver are blocked until the message is delivered is called rendezvous.  
The condition where CPU is not engaged in any real productive activity during this period, and the process does not progress toward completion is called busy-waiting.  
The phenomenon in virtual memory schemes when the processor spends most of its time swapping pages, rather than executing instructions is called thrashing. This is due to an inordinate number of page faults.

11.

| Allocation     |                |                |                | Need           |                |                | Available      |                |                |
|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
|                | R <sub>1</sub> | R <sub>2</sub> | R <sub>3</sub> | R <sub>1</sub> | R <sub>2</sub> | R <sub>3</sub> | R <sub>1</sub> | R <sub>2</sub> | R <sub>3</sub> |
| P <sub>1</sub> | 0              | 0              | 0              | 0              | 1              | 1              | 1              | 1              | 0              |
| P <sub>2</sub> | 1              | 0              | 0              | 1              | 1              | 0              |                |                |                |
| P <sub>3</sub> | 0              | 0              | 1              | 0              | 0              | 1              |                |                |                |
| P <sub>4</sub> | 0              | 0              | 1              | 0              | 1              | 0              |                |                |                |

 So, we execute P<sub>2</sub>, P<sub>4</sub>, P<sub>1</sub> and P<sub>3</sub>. (Safe)

- The number of processes being created in the above program = 4.  
Since there is a call to fflush() in the above program, it flushes the buffers and hence the child processes inherit the empty buffers from the parent process. So, the buffer is printed only with the parent process.
- When the parent process is available and it has not yet called the wait(), then the child process becomes a zombie process.



18. With given data, we can satisfy  $P_0$  and  $P_2$ . Once they are done, rest can be satisfied.
20.  $P_1, P_2$  has a cycle over  $R_1$  and  $R_2$ . So deadlock
21.  $R_1 = (4-1) + (2-1) + (3-1) + (2-1) + 1 = 3+1+2+1+1 = 8$   
 $R_2 = (3-1) + (4-1) + (6-1) + (8-1) + 1 = 18$
22.  $2^n - 1$  child process will be created.
23. The solution satisfies mutual exclusion but it has deadlock when both process set the flag.
24. Process P cannot go into critical section multiple times without the entry of Q
26. It is the parent process's responsibility to set the init process as parent process for all of its child processes before it exits.
29. Total number of blocks in disk =  $\frac{128\text{MB}}{2\text{kB}} = \frac{2^{27}}{2^{11}} = 2^{16} = 64\text{k blocks}$   
Number of addresses in one disk block =  $\frac{2\text{kB}}{2\text{B}} = 1\text{k}$   
Total number of blocks required =  $64\text{k}/1\text{k} = 64$
30. Total number of blocks in the disk = 64k  
Number of blocks to store addresses of free blocks using free list approach = 64  
% of space consumed =  $\frac{64}{64\text{k}} = \frac{1}{1000} = 0.001\%$

# Operating Systems-II

## Computer Science Engineering

Test ID: 

|   |   |   |   |
|---|---|---|---|
| 2 | 1 | 3 | 6 |
|---|---|---|---|

Duration: 90 minutes

Maximum Marks: 50

---

### Read the following instructions carefully:

1. Write your roll number, your name and name of the examination center at the specified locations of the ORS.
2. Using HB pencil, darken the appropriate bubble under each digit of your registration number and the letters corresponding to your paper code.
3. All the questions in this question paper are of objective type.
4. Questions must be answered on Objective Response Sheet (ORS) by darkening the appropriate bubble (marked A, B, C, D) using HB pencil against the question number on the left hand side of the ORS. **Each question has only one correct answer.** In case you wish to change an answer, erase the old answer completely. More than one answer bubbled against a question will be treated as a wrong answer.
5. This question paper contains 30 objective type questions. Q.1 to Q.10 carry **one** mark each and Q.11 to Q.30 carry **two** marks each.
6. Un-attempted questions will carry zero marks.
7. The question pair (27, 28) is common data questions.
8. The questions pair (29, 30) is questions with linked answers. The answer to the second question of the above pair will depend on the answer to the first question of the pair. If the first question in the linked pair is wrongly answered or is un-attempted, then the answer to the second question in the pair will not be evaluated.
9. **NEGATIVE MARKING:** For Q.1 to Q.10,  $1/3^{\text{rd}}$  mark will be deducted for each wrong answer. For Q. 11 to Q.30,  $2/3^{\text{rd}}$  mark will be deducted for each wrong answer. For the pair of questions with linked answers, there will be negative marks only for wrong answer to the first question, i.e. for Q.29,  $2/3^{\text{rd}}$  mark will be deducted for wrong answer. There is no negative marking for Q.30.
10. Calculator without data connectivity is allowed in the examination hall. Charts, graph sheets or tables are NOT allowed in the examination hall.
11. Rough work can be done on the question paper itself.

**Q. No. 1 – 10 Carry One Mark Each**

1. Working set model is useful in  
(A) Limiting the thrashing (B) Removing the thrashing completely  
(C) Increasing the thrashing (D) None of these

2. Match the following two lists

✓

**List-I**

- a. Seek time  
b. Response time  
c. Dispatch latency  
d. Throughput  
(A) a – 4, b – 3, c – 1, d – 2  
(C) a – 3, b – 3, c – 4, d – 1

**LIST-II**

1. Context switch  
2. Disk scheduling  
3. CPU scheduling  
4. System performance  
(B) a – 2, b – 3, c – 1, d – 4  
(D) a – 1, b – 2, c – 3, d – 4

3. Which of the following scheduling algorithm does not suffer from starvation?

✓

- (A) Shortest remaining time first algorithm  
(B) Shortest seek time first algorithm  
(C) Priority preemptive scheduling algorithm  
(D) Round robbing scheduling algorithm

4. If the size of the page is 2kB and logical address is 25 bits, then the number of entries in the page table is

✓

- (A) 16 K (B) 32M (C) 11 K (D) None of these

5. Consider the following snapshot of a system:

| Process | Arrival time | Burst time |
|---------|--------------|------------|
| A       | 0            | 4          |
| B       | 1            | 2          |
| C       | 2            | 1          |
| D       | 3            | 3          |

What is the completion time of process A if the burst time is in milliseconds?

(Using shortest remaining time first scheduling)

- (A) 4<sup>th</sup> millisecond (B) 10<sup>th</sup> millisecond  
(C) 7<sup>th</sup> millisecond (D) 6<sup>th</sup> millisecond

6. In a system, with virtual memory the memory access time is 200 nano second, if the page fault service time is double the memory access time, then what is the effective memory access time for 50 percent of page faults?

✓

- (A) 250 nano seconds (B) 300 nano seconds  
(C) 350 nano seconds (D) 400 nano seconds

7. Which of the following statements are TRUE?  
S<sub>1</sub>: Second chance algorithm is used for page replacement  
S<sub>2</sub>: Dynamic file access is not possible in contiguous file allocation system  
S<sub>3</sub>: Paged memory access time is double the normal memory access time  
(A) S<sub>1</sub> and S<sub>3</sub> only (B) S<sub>2</sub> and S<sub>3</sub> only  
(C) S<sub>2</sub> only (D) S<sub>1</sub>, S<sub>2</sub>, S<sub>3</sub>
8. What is the final content of memory when a process needs 4 pages 1, 2, 3 & 4 in the following order 3, 4, 2, 1, 4, 2, 1, 3, 4 using least recently used page replacement policy? (Assume number of free frames = 3 which are initially empty)  
(A) 1, 3, 4 (B) 1, 2, 4 (C) 4, 3, 1 (D) 3, 4, 2
9. In order to correctly interpret the data on a disk, a FAT12 file system needs to be able to determine the number of bytes per sector and the number of sectors per cluster. In which of the four major sections of the disk does it find that data?  
(A) Boot Sector (B) Root Directory (C) FAT1 (D) FAT2
10. Consider the following Assertion (A), Reasoning(R) statements:  
**Assertion (A):** Optimal page replacement algorithm is not possible for implementation  
**Reasoning (R):** It requires the knowledge of future page reference string  
(A) Both A and R is TRUE but R is not the correct reason for A  
(B) Both A and R is TRUE and R is the correct reason for A  
(C) Only A is TRUE and R is false (D) None of these

**Q. No. 11 – 30 Carry Two Marks Each**

11. Considering a Virtual memory system with a page size of 32K bytes, virtual address with 32 bits, what is the size of the page table when protection bit is added in book keeping? (The physical memory is assumed to be 1G byte)  
(A) 32 K Bytes (B) 256 K Bytes (C) 512 K Bytes (D) 1024 K Bytes
12. A user process of size 17 K Bytes is divided into five pages. The size of the page in a paging system is 4 K Bytes. What is the internal fragmentation?  
(A) 1 K Bytes (B) 2 K Bytes (C) 3 K Bytes (D) No fragmentation
13. Consider the following process, with their CPU Burst time given in milliseconds
- | Process        | Burst time |
|----------------|------------|
| P <sub>1</sub> | 4          |
| P <sub>2</sub> | 3          |
| P <sub>3</sub> | 2          |
| P <sub>4</sub> | 1          |

Assume that all the process are arrived into the ready queue at time 0, in the above order what is the average waiting time for these processes using round robin scheduling with a time slice of 2 Milliseconds.

- (A) 3.0 milliseconds (B) 5.5 milliseconds  
(C) 5.25 milliseconds (D) None of these
14. Assume that you have a memory consisting of the following free chunks 15 Bytes, 5 Bytes, 20 Bytes, 25 Bytes, respectively. There were different allocations requests for the memory by the processes in the following order. Allocate 7 Bytes, Allocate 22 Bytes, allocate 15 Bytes allocate 10 Bytes which one of the following is correct  
(A) First-Fit algorithm satisfy all the request  
(B) Best-Fit algorithm satisfy all the request  
(C) Both first-Fit and Best-fit algorithms fail to satisfy all the requests  
(D) None of these
15. There were four processes P, Q, R and S with their CPU burst times 10, 15, 8, 7 respectively. These processes are arrived into the ready queue at times 1, 0, 2, 3 milliseconds respectively. What is the number of processes that are taken more than one slot for execution using preemptive shortest job first CPU scheduling?  
(A) 1 process (B) 2 processes (C) 3 processes (D) 4 processes
16. A hard disk rotates at 6000rpm. It has 2 surfaces with 128 tracks each. Each track has 256 sectors and each sector can store 512bytes. What is the Transfer rate of HDD?  
(A) 12.5kB/sec (B) 25kB/sec (C) 12.5 MB/sec (D) 25 MB/sec
17. Consider the following statements.  
S<sub>1</sub>: Contiguous file allocation system is suffering from external fragmentation  
S<sub>2</sub>: Linked file allocation system is more convenient for dynamic access.  
Which of the above statement(s) are false?  
(A) S<sub>1</sub> and S<sub>2</sub> (B) S<sub>1</sub> only (C) S<sub>2</sub> only (D) None of these
18. Consider a paging system with page size of 4 K bytes, physical address space of 128 M Bytes. The logical address space 1 G Bytes. If each entry of the page table contains 3 bytes, how many bits can be used for protection and other information?  
(A) 6 bits (B) 9 bits (C) 12 bits (D) 15 bits
19. Consider the following page reference string  
4, 3, 4, 1, 2, 5, 3, 1, 2, 5, 3  
If optimal page replacement is used and number of frames is 4, then the percentage of page fault is?  
(A) 45% (B) 54% (C) 36% (D) None of these
20. Which of the following page replacement algorithm is best when there are three page frames and the reference pages are "0 1 2 3 0 1 4 0 1 2 3 4"?  
(A) FIFO  
(B) LRU  
(C) Both FIFO and LRU has the same page fault rate (D) None of these
21. In a paging system with a page table stored in memory, each memory reference takes 100 ns. The TLB hit ratio is 85% and time needed for searching TLB is 20 n, sec. What is the effective memory reference time?  
(A) 115 nano sec (B) 125 nano sec (C) 130 nano sec (D) 135 nano sec

22. In a disk system with 200 cylinders, the pending requests are in the following order for cylinder numbers 37, 20, 40, 2, 80, 192 and 34. Assume that the head is currently at cylinder 100, what is the time required to satisfy all requests if it takes 2 ms to move from one cylinder to adjacent one, using shortest seek time first policy?  
(A) 288 ms (B) 576 ms (C) 199 ms (D) None of these
23. C2 level security provides for  
(A) Discretionary Access Control (B) Identification and Authentication  
(C) Resource reuse (D) All of these
24. In a system with 150 free frames, there are two processes running, 'P' of size 35 K and 'Q' of size 80 K. How many frames will be allocated to each process if proportional allocation scheme is taken?  
(A) 75 frames each (B) 46 frames to P and 104 frames to Q  
(C) 60 frames to P and 90 frames to Q (D) None of these
25. A floppy disk which is formatted for use with a FAT12 file system consists of four major sections given below.  
Match the following four sections on the left side with the appropriate sector numbers on the right side?
- |                        |                         |
|------------------------|-------------------------|
| 1. Boot                | A. Disk sector 0        |
| 2. Root Directory      | B. Disk sectors 1 - 9   |
| 3. FAT 1               | C. Disk sectors 10 - 18 |
| 4. FAT 2               | D. Disk sectors 19 - 32 |
| (A) 1-A, 2-D, 3-B, 4-C | (B) 1-D, 2-C, 3-A, 4-B  |
| (C) 1-D, 2-C, 3-B, 4-A | (D) 1-C, 2-D, 3-B, 4-A  |
26. Which of the following problems can be overcome by virtual memory segmentation?  
(A) Segments for overlays to deal with lack of physical memory  
(B) Relocation of code and data addresses can be made segment local  
(C) Protection of access e.g., read, write, and execute segments  
(D) All of these

**Common Data Questions: 27 & 28**

Disk requests come into the disk queue for cylinders 95, 25, 5, 80, 70 (in order). The disk head is currently positioned over cylinder 65 before that it was servicing the request at cylinder 50.

27. How many times will the head change its direction using FCFS disk scheduling strategy?  
(A) 4 (B) 3 (C) 2 (D) None of these
28. How far must the head travel to satisfy the requests in the queue using the SSTF scheduling strategy?  
(A) 120 cylinders (B) 140 cylinders (C) 135 cylinders (D) 125 cylinders

**Statement for Linked Answer Questions: 29 & 30**

Consider a system with three physical memory frames (initially empty), and the following reference string over four pages: 1, 4, 3, 2, 1, 2, 3, 4, 1, 2, and 4

29. How many page faults will occur for the above reference string using optimal page replacement policy?  
(A) 4                      (B) 7                      (C) 6                      (D) 5
30. How many more page faults will occur using LRU for the same reference string (Assume LRU is the practical approximation for optimal)  
(A) 8                      (B) 4                      (C) 3                      (D) 2

**Answer Keys**

|    |   |    |   |    |   |    |   |    |   |    |   |    |   |
|----|---|----|---|----|---|----|---|----|---|----|---|----|---|
| 1  | A | 2  | B | 3  | D | 4  | A | 5  | C | 6  | B | 7  | A |
| 8  | A | 9  | A | 10 | B | 11 | B | 12 | C | 13 | B | 14 | C |
| 15 | B | 16 | C | 17 | C | 18 | B | 19 | A | 20 | A | 21 | D |
| 22 | B | 23 | D | 24 | B | 25 | A | 26 | D | 27 | B | 28 | A |
| 29 | D | 30 | C |    |   |    |   |    |   |    |   |    |   |

**Explanations:-**

4.  $2^{25} = 2^{11} \cdot 2^x$ , where  $x = 25 - 11 = 14$ , i.e.,  $2^{14} = 2^4 k = 16k$

5.

|   |   |   |   |   |
|---|---|---|---|---|
| A | B | C | A | d |
| 0 | 1 | 3 | 4 | 7 |

10

A is finished at 7<sup>th</sup> milliseconds

6.  $EMA = \frac{1}{2} \times 200 + \frac{1}{2} \times 400 = 100 + 200 = 300 \text{ nano sec}$

7. Dynamic access is possible in contiguous file allocation

8. 3 3 3 1 1 1  
4 4 4 3 3  
2 2 2 4

So final content is 1, 3, 4

10. R is the correct reason for A

11. Number of page =  $2^{15} \cdot 2^x = 2^{32}$ ,  $x = 17$ ,  $2^{17}$  entries in the page table  
phy.mem size =  $2^{30}$

Number of frames =  $2^{15} \left( \frac{30}{2} / \frac{15}{2} = 2^{15} \right)$  each entry is 15+1 bit

so  $2^{17} \times 2 \text{ bytes} = 2^{18} \text{ bytes} = 256K \text{ Bytes}$

13.

|                |                |                |                |                |                |
|----------------|----------------|----------------|----------------|----------------|----------------|
| P <sub>1</sub> | P <sub>2</sub> | P <sub>3</sub> | P <sub>4</sub> | P <sub>1</sub> | P <sub>2</sub> |
| 0              | 2              | 4              | 6              | 7              | 9              |

10

A.W.T =  $\frac{5+7+4+6}{4} = \frac{22}{4} = 5.5 \text{ Milli sec}$

15.

|   |   |   |    |    |    |
|---|---|---|----|----|----|
| Q | P | R | S  | P  | Q  |
| 0 | 1 | 2 | 10 | 17 | 26 |

40

Process P and Q have taken more than one slot for execution



16. Data per track =  $256 \times 512 = 2^{17} = 128\text{kB}$

Time to rotate 1 track =  $\frac{60}{6000} = \frac{1}{100} \text{ sec}$

Transfer rate =  $128 \times 100 \text{ kB/sec} = 12.5 \times 128 \times 8 \text{ kB/sec} = 12.5\text{MB /sec}$

18. Number of frames =  $2^{12} \cdot 2^x = 2^{27}$

$x = 15 \text{ bits}$

$2^{15} \text{ frames}$

$15 + x = 3 \times 8 \text{ bits}$

$15 + x = 24 \text{ where } x = 9 \text{ bits}$

19.  $\frac{5 \text{ faults}}{11 \text{ references}} \quad \text{ie., } \frac{5}{11} \times 100 = 45\%$

20. **FIFO:**

|      |   |   |   |   |   |   |   |   |   |   |   |   |
|------|---|---|---|---|---|---|---|---|---|---|---|---|
| Ref: | 0 | 1 | 2 | 3 | 0 | 1 | 4 | 0 | 1 | 2 | 3 | 4 |
| P1   | 0 | 0 | 0 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 4 |
| P2   |   | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 |
| P3   |   |   | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 3 | 3 |
| P/F  | Y | Y | Y | Y | Y | Y | Y | N | N | Y | Y | N |

$P/F = 9/12$

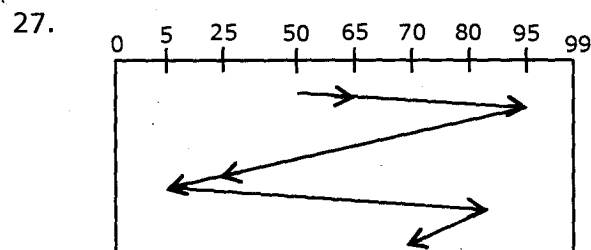
**LRU:**

|      |   |   |   |   |   |   |   |   |   |   |   |   |
|------|---|---|---|---|---|---|---|---|---|---|---|---|
| Ref: | 0 | 1 | 2 | 3 | 0 | 1 | 4 | 0 | 1 | 2 | 3 | 4 |
| P1   | 0 | 0 | 0 | 3 | 3 | 3 | 4 | 4 | 4 | 2 | 2 | 2 |
| P2   |   | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 |
| P3   |   |   | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 4 |
| P/F  | Y | Y | Y | Y | Y | Y | Y | N | N | Y | Y | Y |

$P/F = 10/12$

21.  $\frac{85}{100} 120 + \frac{15}{100} 220, \quad 8.5 \times 12 + 1.5 \times 22 = 135 \text{ nsec}$

23. C2 level security provides for:
- Discretionary Access Control
  - Identification and Authentication
  - Auditing
  - Resource reuse



3 times changes its direction

29.   1   1   1   1   1  
      4   4   2   2  
      3   3   4

Total faults = 5

30.   1   1   1   2   2   2   1   1  
      4   4   4   1   4   4   4  
      3   3   3   3   3   2

Total faults = 8

Difference is  $8 - 5 = 3$  faults

# Database Management Systems-I

## Computer Science Engineering

Test ID: 

|   |   |   |   |
|---|---|---|---|
| 2 | 1 | 3 | 7 |
|---|---|---|---|

Duration: 90 minutes

Maximum Marks: 50

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### Read the following instructions carefully:

1. Write your roll number, your name and name of the examination center at the specified locations of the ORS.
2. Using HB pencil, darken the appropriate bubble under each digit of your registration number and the letters corresponding to your paper code.
3. All the questions in this question paper are of objective type.
4. Questions must be answered on Objective Response Sheet (ORS) by darkening the appropriate bubble (marked A, B, C, D) using HB pencil against the question number on the left hand side of the ORS. **Each question has only one correct answer.** In case you wish to change an answer, erase the old answer completely. More than one answer bubbled against a question will be treated as a wrong answer.
5. This question paper contains 30 objective type questions. Q.1 to Q.10 carry **one** mark each and Q.11 to Q.30 carry **two** marks each.
6. Un-attempted questions will carry zero marks.
7. The question pair (27, 28) is common data questions.
8. The questions pair (29, 30) is questions with linked answers. The answer to the second question of the above pair will depend on the answer to the first question of the pair. If the first question in the linked pair is wrongly answered or is un-attempted, then the answer to the second question in the pair will not be evaluated.
9. **NEGATIVE MARKING:** For Q.1 to Q.10,  $1/3^{\text{rd}}$  mark will be deducted for each wrong answer. For Q. 11 to Q.30,  $2/3^{\text{rd}}$  mark will be deducted for each wrong answer. For the pair of questions with linked answers, there will be negative marks only for wrong answer to the first question, i.e. for Q.29,  $2/3^{\text{rd}}$  mark will be deducted for wrong answer. There is no negative marking for Q.30.
10. Calculator without data connectivity is allowed in the examination hall. Charts, graph sheets or tables are NOT allowed in the examination hall.
11. Rough work can be done on the question paper itself.

**Q. No. 1 – 10 Carry One Mark Each**

1. ? Let R be a relation of degree n. How many different projections on R are possible?  
 (A) n (B) n - 1 (C) n + 1 (D)  $2^n - 1$
2. Cartesian product and join operations are  
 (A) Different in all cases  
 (B) Same with join with a conditional code  
 (C) Same in all cases  
 (D) None of these
3. OUTER JOINS can be classified as  
 (A) LEFT OUTER JOINS (B) RIGHT OUTER JOINS  
 (C) FULL OUTER JOINS (D) All of these
4. ~~3~~ A relation R with two attribute is always in ~~2NF~~ ~  
 (A) 1NF (B) 2NF (C) 3NF (D) BCNF
5. Consider the following relation schema Employee ( Eid, Ename, Dno, salary, address) and Department(Dno,Dname), then what does the following SQL query retrieve?  

```

SELECT Dname, COUNT (*)
FROM DEPARTMENT D, EMPLOYEE E
Where D.Dno=E.Dno AND E.salary > 40000
Group By Dname
Having count (*) > 5 ;

```

 (A) Selects only departments that have more than 5 employees who earn more than \$ 40,000  
 (B) Selects all Department employees who earn more than \$40,000  
 (C) Selects all Employees who earn \$40,000.  
 (D) None of these
6. An operator on relations is called monotone whenever we add a tuple to one of its arguments. The result contains all the tuples that it contained before adding the tuple, plus perhaps more tuples. Which of the following operators are monotone?  
 (A)  $\times$ ,  $\sigma$ ,  $\bowtie$

- (B)  $X, \cap, -$   
 (C)  $\sigma, -, \bowtie$   
 (D) None of these

7. Consider a relation R (A,B,C,D,E) with  $F = \{A \rightarrow B, BC \rightarrow E, ED \rightarrow A\}$ . Given R is in which highest normal forms?

- (A) 1NF (B) 2NF (C) 3NF (D) BCNF

8. Consider the functional dependency set:

$F = \{ABC \Rightarrow D, B \rightarrow E, E \rightarrow A\}$ . Identify the correct statement.

- (A) A can be dropped from F (B) B can be dropped from F  
 (C) D can be dropped from F (D) None of these

9. What will be the output of T-I / T-II?

|         | T-I     | T-II    |         |
|---------|---------|---------|---------|
| SSN     | NAME    | NAME    |         |
| 412     | MK      | MK      |         |
| 412     | SK      | SK      |         |
| 412     | RK      |         |         |
| 413     | MK      |         |         |
| 413     | SK      |         |         |
| 532     | MK      |         |         |
| 676     | SK      |         |         |
| (A) SSN | (B) SSN | (C) SSN | (D) SSN |
| 412     | 412     | 412     | 412     |
| 413     | 412     | 532     | 676     |

10. Consider the following relation schema Books (Bid, Bauthor, Btitle) and Reserve (Bid, Date) then what does the following relational algebra query retrieve?

$\Pi_{Bauthor, Btitle} (BOOK \bowtie (Book\_Bid = Reserve\_Bid) \text{ AND } (Reserve\_Date = '23feb-2003') Reserve)$

- (A) Retrieves the author and title of books reserved on 23-feb-2003  
 (B) Retrieves the book author and file author who reserved the book on 23-feb-2003  
 (C) Retrieves the all book authors and titles  
 (D) None of these

**Q. No. 11 – 30 Carry Two Marks Each**

11. Find the candidate keys for the relation: R (C, S, Z) with FD,  $F = \{CS \rightarrow Z, Z \rightarrow C\}$ .  
 (A) CS and ZS (B) CZ (C) Z (D) All of these
12. Consider the following FD  
 $SSN \rightarrow EName$   
 $Pno \rightarrow Pname, Plocation$   
 $(SSN, Pno) \rightarrow Hours$   
 What is closure of  $(SSN, PNo)^t$ ?  
 (A) SSN, Pno, Hours  
 (B) SSN, Pno, Hours, Pname, Plocation  
 (C) SSN, Pno, Hours, Pname, Plocation, Ename  
 (D) SSN, Pno, Hours, Ename
13. Find the equivalent SQL query for the following relation Algebra query  
 $\Pi_{A,B}(\sigma_{C=D}(X,Y))$   
 (A) Select A, B from X, Y where C = D  
 (B) Select distinct A, B from X, Y where C = D  
 (C) Select \* from X, Y where C = D (D) None of these
14. Consider the following relation schema students S (name, age, city) Identify the TRC statement which displays all the student names whose age is at least 16 and who are from Hyderabad.  
 (A)  $\{t / \exists S \in \text{students}(s[age] \geq 16 \wedge S[city] = 'Hyderabad') \wedge t[name] = S[name] \wedge t[age] = S[age] \wedge t[city] = S[city]\}$   
 (B)  $\{t / \exists S \in \text{students}(s[age] \geq 16 \wedge S[city] = 'Hyderabad') \wedge t[age] = S[age] \wedge t[city] = S[city]\}$   
 (C)  $\{t / \exists S \in \text{students}(s[age] \geq 16) \wedge t[name] = S[name] \wedge t[age] = S[age] \wedge t[city] = S[city]\}$   
 (D) None of these
15. Consider the relation schema R(X, Y, Z), then which of the following is true with regard to multivalued dependency?  
 (A) If  $X \twoheadrightarrow Y$ , then  $X \twoheadrightarrow (R - Y)$   
 (B) If  $X \twoheadrightarrow Y$ , then  $Y \twoheadrightarrow Z$ , then  $X \twoheadrightarrow (Z - Y)$   
 (C) Both A and B (D) None of these

16. Following SQL query deals with  
 SELECT table1.column, table2.column  
 FROM table t1, table t2  
 Where t1.column=t2.column;  
 (A) Right outer join (B) Left outer join  
 (C) Join with equality (D) Natural join
17. Let X & Y be two relations with the following schema.  
 X (P, Q, R, S, T)  
 Y (P, Q, u, v)  
 Which of the following queries are equivalent?  
 (i)  $\Pi p(X \bowtie Y)$   
 (ii)  $\Pi p(X) \bowtie \Pi p(Y)$   
 (iii)  $\Pi p(\Pi pq(X) - (\Pi pq(X) - \Pi pq(Y)))$   
 (iv)  $\Pi p(X) - \Pi p(y)$   
 (A) Only I and III (B) Only II and III  
 (C) I, II & III (D) None of these
18. Let R(A,B,C,D,E,F,G,H,I,J) be a relation with dependency set  $F=\{AB \rightarrow C, A \rightarrow DE, B \rightarrow F, F \rightarrow GH, D \rightarrow IJ\}$  and decomposition of R is given as  





















































  
 Then the decomposed relation satisfies  
 (A) Dependency preserving & Lossless join property  
 (B) No dependency preserving & lossless joins property  
 (C) Dependency preserving & lossy join property  
 (D) No Dependency preserving & lossy join property
19. Consider a relation R(A,B,C,D,E) with FD  
 $A \rightarrow BCDE$   
 $BC \rightarrow ADE$   
 $D \rightarrow E$   
 The highest normal form achieved by R is  
 (A) 1NF (B) 2NF (C) 3NF (D) BCNF
20. The following SQL command deals with  
 SELECT Ename, Dname  
 FROM Employee, Department  
 Where Employee.Depart No = Department.Depart No;  
 (A) Equijoin (B) Natural join (C) Theta join (D) Self join

21. Member (Mid, Name, Desig, Age)

Books ( Bid, Btitle, Bauther, Bprice)

Reserves (Mid, Bid, Date)

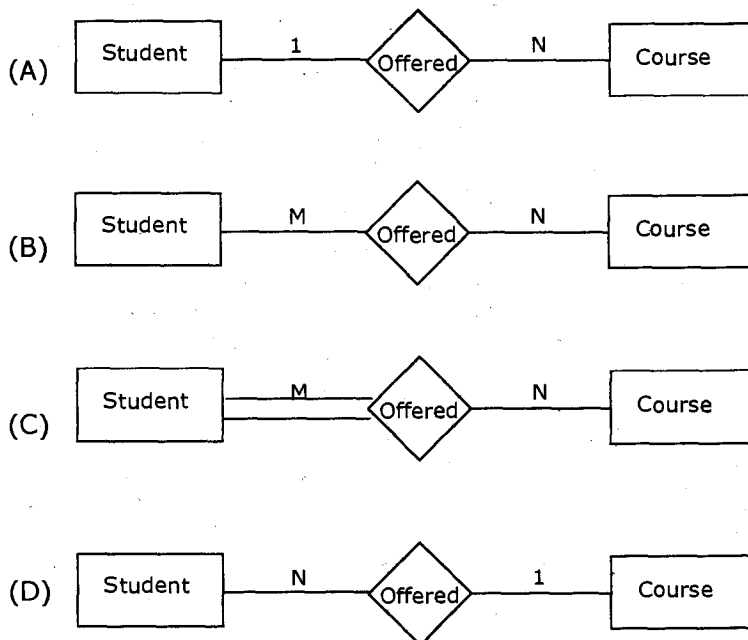
Which of the following option will retrieve the titles of books reserved by lecturers?

- (A)  $\Pi_{Name, BTitle}((Member \bowtie (Member.Mid=reserve.Mid) \text{ AND } (Desig='Lecturer') \text{ Reserve}) \bowtie_{res.bid=Book.Bid} Books)$
- (B)  $\Pi_{Name, BTitle}((Member (Member.Mid=reserve.Mid) \text{ AND } (Desig='Lecturer') \text{ Reserve}) \bowtie_{res.lect.bid=Book.Bid} Books)$
- (C)  $\Pi_{Name, BTitle}((Member \bowtie (Member.Mid=reserve.Mid) \text{ AND } (Desig='Lecturer') ) \bowtie_{res.lect.bid=Book.Bid} Books)$
- (D) None of these

22. Which of the following is true?

- (A)  $A \div B \equiv \Pi_x(A) - \Pi_x((\Pi_x(A) \times B)) - A$
- (B)  $0 \leq \text{degree}(A-B) \leq \text{degree}(B)$
- (C)  $0 \leq \text{degree}(A \times B) \leq \text{degree}(A) \times \text{degree}(B)$
- (D) All of these

23. A student can take one or more courses & course can be offered to any number of students. Which of the following represents given scenario in E.R model?





24. Consider the statements:

S1:- "Delete" is used to delete the table from data base.

S2:- "Truncate table" is used to delete all the data but not table.

S3:- "Drop table" is used to delete the data as well as table.

Which of the above statement(s) is/are true?

- (A) S1 & S2                      (B) S2 & S3                      (C) S1 & S3                      (D) S1, S2 & S3

25. Consider the following Relation.

Vehicle (vehicle#, sold-date, salesman #, commission%, discount-amt)

Assume that a vehicle may be sold by multiple salesman and

Vehicle {vehicle #, salesman #} is P.K. additional dependencies are

Sold-date  $\rightarrow$  discount-amt and salesman #  $\rightarrow$  commission%

Given relation is in which normal form

- (A) 1NF                      (B) 2NF                      (C) 3NF                      (D) None of these

26. Consider a relation R (A,B,C,D,E) with FD:

$A \rightarrow BCDE$

$BC \rightarrow ADE$

$D \rightarrow E$

The decomposition of R in 3NF will be

- (A) R1(ABCE) R2(DE)                      (B) R1(ADE) R2(BC)  
(C) R1(ABDE) R2(BDE)                      (D) R1(ABCD) R2(DE)

### Common Data Questions: 27 & 28

Consider a relation R(city, street, zipcode) or R(C,S,Z) and

$F = \{CS \rightarrow Z, Z \rightarrow C\}$ .

27. Find the candidate keys for given FD.

- (A) CS and ZS                      (B) Z and S                      (C) C and S                      (D) CS and C

28. What is the highest normal form of R?

- (A) 1NF                      (B) 2NF                      (C) 3NF                      (D) BCNF

**Statement for Linked Answer Questions: 29 & 30**

Consider the relation scheme  $R(A, B, C)$  with functional dependencies

$AB \rightarrow C, C \rightarrow A$

29. What are the minimal keys of relation  $R$ ?
- (A)  $AC, BC$                       (B)  $AB, CB$                       (C)  $A, B$                       (D)  $AC, CB$
30. What is the highest normal form of  $R$ ?
- (A) 1NF                      (B) 2NF                      (C) 3NF                      (D) BCNF

**Answer Keys:**

|    |   |    |   |    |   |    |   |    |   |    |   |    |   |
|----|---|----|---|----|---|----|---|----|---|----|---|----|---|
| 1  | D | 2  | B | 3  | D | 4  | D | 5  | A | 6  | A | 7  | C |
| 8  | A | 9  | A | 10 | A | 11 | A | 12 | C | 13 | B | 14 | A |
| 15 | C | 16 | D | 17 | C | 18 | A | 19 | B | 20 | B | 21 | A |
| 22 | D | 23 | C | 24 | B | 25 | D | 26 | D | 27 | A | 28 | C |
| 29 | B | 30 | C |    |   |    |   |    |   |    |   |    |   |

**Explanations:-**

4. BCNF R(A,B) If A is key  $A \rightarrow B$ . If B is key  $B \rightarrow A$  is both A,B are key  
 $A \rightarrow B$   $B \rightarrow A$  is  $AB \rightarrow AB$
7. Since it is not having any transitive dependence, it is in 3NF  
 $(SSN, Pno) \rightarrow Hours$
12.  $Pno \rightarrow Pname, Plocation$   
 $SSN \rightarrow Ename$
18. Since it gives lossless join
19. 2NF as A and BC is key  $D \rightarrow E$  violates 3NF condition.
21.  $\pi$  retrieves all titles of books reserved by lecturers
25. Because salesman # has multiple attribute so it is n't in 1NF.
26. A and BC are key. So  $D \rightarrow E$  3NF violation

# Database Management Systems-II

## Computer Science Engineering

Test ID: 

|   |   |   |   |
|---|---|---|---|
| 2 | 1 | 3 | 8 |
|---|---|---|---|

Duration: 90 minutes

Maximum Marks: 50

---

### Read the following instructions carefully:

1. Write your roll number, your name and name of the examination center at the specified locations of the ORS.
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6. Un-attempted questions will carry zero marks.
7. The question pair (27, 28) is common data questions.
8. The questions pair (29, 30) is questions with linked answers. The answer to the second question of the above pair will depend on the answer to the first question of the pair. If the first question in the linked pair is wrongly answered or is un-attempted, then the answer to the second question in the pair will not be evaluated.
9. **NEGATIVE MARKING:** For Q. 1 to Q. 10, 1/3<sup>rd</sup> mark will be deducted for each wrong answer. For Q. 11 to Q. 30, 2/3<sup>rd</sup> mark will be deducted for each wrong answer. For the pair of questions with linked answers, there will be negative marks only for wrong answer to the first question, i.e. for Q. 29, 2/3<sup>rd</sup> mark will be deducted for wrong answer. There is no negative marking for Q. 30.
10. Calculator without data connectivity is allowed in the examination hall. Charts, graph sheets or tables are NOT allowed in the examination hall.
11. Rough work can be done on the question paper itself.

**Q. No. 1 – 10 Carry One Mark Each**

1. If a file consists of 5 attributes, then the number of secondary indices that can be constructed on that file is  
 (A) 1 (B) 5 (C) 32 (D) 31

2. Which of the following is false?  
 (A) Ensuring durability is the responsibility of recovery management component  
 (B) Ensuring isolation is the responsibility of concurrency management  
 (C) Ensuring atomicity or consistency is the responsibility of recovery management Component  
 (D) None of these

3. Identify the problem(s) associated with the schedule given below.

| T <sub>1</sub> | T <sub>2</sub> |
|----------------|----------------|
| R(x)           |                |
|                | R(x)           |
|                | R(y)           |
|                | X=x+y          |
|                | W(x)           |
|                | Commit         |
| R(x)           |                |

- (A) Unrepeatable read (B) Dirty read  
 (C) Both (A) & (B) (D) None of these
4. Consider the following scenario:  
 T<sub>1</sub> Consists of 5 operations and T<sub>2</sub> consists of 4 operations, then the number of concurrent schedules possible is  
 (A) 9! (B) 126 (C) 5!\*4! (D) None of these

5. Which of the following operations can be reordered to improve concurrency?  
 (A) R<sub>1</sub>(A), W<sub>2</sub>(A) (B) W<sub>2</sub>(B), W<sub>1</sub>(C) (C) W<sub>1</sub>(B), R<sub>2</sub>(B) (D) None of these

6. Let 'm' be the number of primary indices on a file and 'n' be the number of clustering indices on other file, then which of the following is true?  
 (A)  $m \leq 1$  &  $n \leq 1$  (B)  $m \leq 1$  &  $n \geq 1$  (C)  $m \geq 1$  &  $n \leq 1$  (D)  $m \geq 1$  &  $n \geq 1$

7. Consider the given statements:  
 S<sub>1</sub> : All cascades less schedules are recoverable  
 S<sub>2</sub> : All the strict schedules are both cascade less and recoverable

- Which of the following is true?
- (A) Only  $S_1$  (B) only  $S_2$   
 (C) Both  $S_1$  &  $S_2$  are true (D) Both  $S_1$  &  $S_2$  are false
8. Shadow copy mechanism is used to implement  
 (A) Atomicity and durability (B) Only atomicity  
 (C) Only durability (D) None of these
9. Which of the following is true?  
 (A) Both sparse and dense indices consume same space  
 (B) Sparse index consumes more space than dense index  
 (C) Dense index consumes more space than sparse index  
 (D) Can't say
10. Problem of testing for view serializability is  
 (A) P problem (B) NP problem (C) NP hard (D) NP complete

**Q. No. 11 – 30 Carry Two Marks Each**

11. Consider the given schedule:

| $T_1$  | $T_2$                           |
|--------|---------------------------------|
| R(x)   |                                 |
|        | R(x)<br>R(y)<br>$X=x+y$<br>W(x) |
| R(x)   |                                 |
|        | Commit                          |
| commit |                                 |

The given schedule is

- (A) Recoverable and cascadeless (B) Recoverable but not cascadeless  
 (C) Not recoverable (D) Recoverable, cascadeless and strict
12. Consider the given schedule:

| $T_1$                           | $T_2$                   |
|---------------------------------|-------------------------|
| R(x)<br>R(y)<br>$x=x+y$<br>W(x) |                         |
|                                 | R(x)<br>$X=x+5$<br>W(x) |
| Abort                           |                         |

The problem associated with the above schedule is

- (A) Unrepeatable read (B) Lost update  
(C) Dirty Read (D) None of these

13. Identify the true statement

- (A) B<sup>+</sup> tree is useful for solving range queries  
(B) B<sup>+</sup> tree uses overflow pages  
(C) The order of leaf and internal node is different for B trees  
(D) All of these

14. Consider the following schedule:

| T <sub>1</sub>                             | T <sub>2</sub>                     |
|--------------------------------------------|------------------------------------|
| lock-x(A)<br>Read(A)<br>A=A+3<br>Write (A) |                                    |
|                                            | Lock S(B)<br>Read (B)<br>Lock S(A) |
| Lock x(B)                                  |                                    |

The above schedule is (select the most suitable answer)

- (A) Allowed under basic 2phase locking protocol  
(B) Not allowed under basic 2phase locking protocol  
(C) Allowed under basic 2phase locking protocol but there is a deadlock  
(D) Allowed under basic 2phase locking protocol and there is no dead lock

15. Consider the following statements and identity the true statement(s) with regard to time stamp based protocols.

- (1) Deadlocks are possible (2) They may allow irrecoverable schedules  
(A) Only 1 (B) Only 2  
(C) Both 1 & 2 are false (D) Both 1 & 2 are true

16. Let us assume that transaction T<sub>1</sub> has arrived before the transaction T<sub>2</sub>.

Consider the schedule

$S = r_1(A); r_2(B); w_2(A); w_1(B)$

Which of the following is true?

- (A) Allowed under basic timestamp protocols

- (B) Not allowed under basic timestamp protocols because  $T_1$  is rolled back  
 (C) Not allowed under basic timestamp protocols because  $T_2$  is rolled back  
 (D) None of these

17. The schedule shown below is (select the most suitable answer)

| $T_1$                           | $T_2$                                          |
|---------------------------------|------------------------------------------------|
| $R(x)$<br>$x = x + 1$<br>$W(x)$ | $R(x)$<br>$R(y)$<br>$X = x * y + 10$<br>$W(x)$ |
| Commit                          |                                                |
|                                 | Commit                                         |

- (A) Recoverable (B) Not recoverable  
 (C) Recoverable and also strict schedule (D) Recoverable but not strict
18. In multiple granularity protocol transaction  $T_1$  is holding intension shared lock on the some data item,  $T_2$  is not allowed to request  
 (A) Shared intension exclusive lock on that data item  
 (B) Exclusive lock on that data item  
 (C) Both 'A' and 'B'  
 (D) It can request both the above locks
19. Consider the statement with regards to time stamp ordering protocols.  
 (1) Starvation to a particular transaction is possible.  
 (2) It ensures recoverable schedule.  
 (3) It ensures conflict serializable schedule.  
 (4) Will not allow dead locks  
 Which of the above statements are true?  
 (A) 1 & 2 (B) 1 2 & 4 (C) 1, 3 & 4 (D) All of these
20. Consider the schedule  
 $S = \{R_1(A), R_2(B), W_2(A), W_1(A)\}$   
 Assume that transaction  $T_1$  has started execution before the Transaction  $T_2$  then the schedule is  
 (A) Allowed under Basic timestamp protocol but not under Thomas write rule  
 (B) Not allowed under Basic timestamp protocol but allowed under Thomas write rule  
 (C) Allowed under both Basic timestamp protocol and Thomas write rule  
 (D) Not allowed under both Basic timestamp protocol and Thomas write rule



21. Which of the following is true?
- (A) Schedules which are allowed under Thomas write rule are also allowed under Basic timestamp protocol
- (B) All the schedules which are allowed under Basic timestamp are also allowed under Multiversion timestamp protocol.
- (C) All the schedules which are allowed under Multiversion timestamp protocol are also allowed under Thomas write rule
- (D) All of these
22. Suppose that the time stamp of  $T_1$  is less than the time stamp of  $T_2$  and, if transaction  $T_1$  requests the data item locked by transaction  $T_2$ , then consider the statements
- $S_1$  :  $T_1$  is allowed to wait according to the wait die mechanism of deadlock prevention.
- $S_2$  :  $T_1$  is rolled back according to wound wait mechanism.
- Select the correct option.
- (A) Both  $S_1$  &  $S_2$  are true (B) Only  $S_1$  is true
- (C) Only  $S_2$  is true (D) Both  $S_1$  &  $S_2$  are false
23. In rigorous 2 phase locking protocol,
- (A) All the read locks are released only after commit
- (B) All the write locks are released only after commit
- (C) All the read & write locks are acquired before the execution starts
- (D) All the read and write locks are released only after commit
24. Consider a sorted file ordered on a key field consisting of 1024 blocks. The number of block accesses required to insert a record is
- (A) 20 (B) 15 (C) 12 (D) 10
25. The record pointer, key field and block pointer of a 'B' tree are 8B, 10B, & 6B respectively. Calculate the order of the tree if the block size is 1kB.
- (A) 44 (B) 43 (C) 24 (D) None of these
26. Consider the Relation  $R = \{A, B, C, D, E, F, G, H, I\}$  and F.D. set  $AB \rightarrow C; A \rightarrow DE; B \rightarrow F; F \rightarrow GH; D \rightarrow IJ$ . What is the key for R?
- (A) AC (B) AD (C) AB (D) A

### Common Data Questions: 27 & 28

Consider the schedule given below

| $T_1$                  | $T_2$                          | $T_3$                |
|------------------------|--------------------------------|----------------------|
| R(A)                   |                                |                      |
|                        | R(B)                           |                      |
| R(B)<br>W(A)<br>Commit |                                |                      |
|                        |                                | R(C)<br>R(B)<br>W(C) |
|                        | W(B)<br>R(A)<br>R(C)<br>Commit |                      |
|                        |                                | commit               |

27. The above schedule is
- (A) Conflict serializable (B) Cascade less
- (C) Recoverable (D) All of these
28. The above schedule is conflict equivalent to which of the following serial schedules?
- (A)  $T_1 \rightarrow T_3 \rightarrow T_2$  (B)  $T_1 \rightarrow T_2 \rightarrow T_3$
- (C)  $T_2 \rightarrow T_1 \rightarrow T_3$  (D) Not conflict serializable

### Statement for Linked Answer Questions: 29 & 30

Consider a B tree of degree 'n' with height 'h'.

29. Calculate maximum number of records that can be indexed by the above tree [assume root is at level '0']
- (A)  $n^h - 1$  (B)  $n^h$  (C)  $n^{h+1} - 1$  (D) None of these
30. The maximum number of records that can be indexed by a B tree of degree 3 and height 3 is
- (A) 80 (B) 27 (C) 26 (D) None of these

**Answer Keys**

|    |   |    |   |    |   |    |   |    |   |    |   |    |   |
|----|---|----|---|----|---|----|---|----|---|----|---|----|---|
| 1  | D | 2  | C | 3  | A | 4  | B | 5  | B | 6  | A | 7  | C |
| 8  | A | 9  | C | 10 | D | 11 | B | 12 | C | 13 | A | 14 | C |
| 15 | B | 16 | B | 17 | D | 18 | B | 19 | C | 20 | B | 21 | B |
| 22 | A | 23 | D | 24 | D | 25 | B | 26 | C | 27 | A | 28 | A |
| 29 | C | 30 | A |    |   |    |   |    |   |    |   |    |   |

**Explanations:**

- Secondary index is built on non ordering field. Hence if a file consists of 'n' attributes, then the number of secondary indices =  $2^n - 1$
- Recovery management component of database system takes care of Atomicity and durability but not consistency. Application programmer should take care of consistency.
- When read operations are executed by  $T_1$ , it will get different values. This is unrepeatable read problem.
- Number of concurrent schedules possible is  $\frac{9!}{5!4!} = 126$
- $W_2(B), W_1(C)$  are non conflicting operations. Hence they can be reordered.  
**Note:** Reads and writes on different data items from different transactions are non conflicting.
- Recoverable but not cascadeless. For cascadeless,  $T_1$  should read the value of X only after commit operation of  $T_2$
- $T_2$  reads the uncommitted data written by  $T_1$
- Here  $T_1$  holding exclusive lock on A, and  $T_2$  is requesting shared lock on A,  $T_2$  is waiting for  $T_1$  to unlock A, similarly  $T_2$  is holding shared lock on B, and  $T_1$  is requesting exclusive lock on B,  $T_1$  is waiting for  $T_2$  to unlock B. Hence there is a deadlock
- There will not be any locks in time stamp ordering protocols, hence deadlocks are not possible
- The schedule given, is recoverable but not strict because, for strict schedules, transaction should perform read or write operation of particular data item only after the commit operation of the transaction which has written that value
- The number of block accesses required to insert, search or delete a record in a sorted file of n blocks =  $\log_2 n = \log_2 1024 = \log_2 2^{10} = 10$

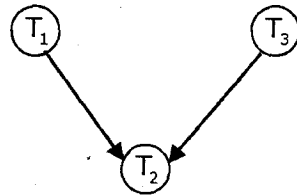
25.  $n(6) + (n-1)18 \leq 1024 \Rightarrow 6n + 18n - 18 \leq 1024$

$$24n \leq 1042 \Rightarrow n \leq \frac{1042}{24} \Rightarrow n \leq 43.41$$

26.  $AB \rightarrow C \quad \{A, B, C\}$   
 $A \rightarrow DE \quad \{A, B, C, D, E\}$   
 $B \rightarrow F \quad \{A, B, C, D, E, F\}$   
 $F \rightarrow GH \quad \{A, B, C, D, E, F, G, H\}$   
 $D \rightarrow IJ \quad \{A, B, C, D, E, F, G, H, I, J\}$

27. The schedule given, is not recoverable because  $T_2$  reads data item (C), written by  $T_3$  but commits before committing of  $T_3$ . If it is not recoverable it is also not cascadeless.  
Hence it is a conflict serializable

28. Precedence graph would be by



$$T_1 \rightarrow T_3 \rightarrow T_2 \text{ or } T_3 \rightarrow T_1 \rightarrow T_2$$

29. If the order is  $n$ , then  
Number of records at level '0' =  $n-1$   
Number of records at level '1' =  $n(n-1)$   
Number of records at level  $h$  =  $h^h(n-1)$

$$\text{Total} = (n-1)(1 + n + \dots + n^{h-1} + n^h) = (n-1) \frac{(n^{h+1} - 1)}{n - 1} = n^{h+1} - 1$$

# Compiler Design-I

## Computer Science Engineering

Test ID: 

|   |   |   |   |
|---|---|---|---|
| 2 | 1 | 3 | 9 |
|---|---|---|---|

Duration: 90 minutes

Maximum Marks: 50

**Read the following instructions carefully:**

1. Write your roll number, your name and name of the examination center at the specified locations of the ORS.
2. Using HB pencil, darken the appropriate bubble under each digit of your registration number and the letters corresponding to your paper code.
3. All the questions in this question paper are of objective type.
4. Questions must be answered on Objective Response Sheet (ORS) by darkening the appropriate bubble (marked A, B, C, D) using HB pencil against the question number on the left hand side of the ORS. **Each question has only one correct answer.** In case you wish to change an answer, erase the old answer completely. More than one answer bubbled against a question will be treated as a wrong answer.
5. This question paper contains 30 objective type questions. Q.1 to Q.10 carry **one** mark each and Q.11 to Q.30 carry **two** marks each.
6. Un-attempted questions will carry zero marks.
7. The question pair (27, 28) is common data questions.
8. The questions pair (29, 30) is questions with linked answers. The answer to the second question of the above pair will depend on the answer to the first question of the pair. If the first question in the linked pair is wrongly answered or is un-attempted, then the answer to the second question in the pair will not be evaluated.
9. **NEGATIVE MARKING:** For Q.1 to Q.10, 1/3<sup>rd</sup> mark will be deducted for each wrong answer. For Q. 11 to Q.30, 2/3<sup>rd</sup> mark will be deducted for each wrong answer. For the pair of questions with linked answers, there will be negative marks only for wrong answer to the first question, i.e. for Q.29, 2/3<sup>rd</sup> mark will be deducted for wrong answer. There is no negative marking for Q.30.
10. Calculator without data connectivity is allowed in the examination hall. Charts, graph sheets or tables are NOT allowed in the examination hall.
11. Rough work can be done on the question paper itself.

**Q. No. 1 – 10 Carry One Mark Each.**

1. What kind of conflict can exist in a LALR (1) parser that may not be present in a LR (1) parser for a given grammar?  
(A) Shift-reduce conflict (B) Shift-Shift conflict  
(C) Reduce-reduce conflict (D) None of these
2. For a string of length 'n' how many prefixes are possible?  
(A)  $n+1$  (B)  $n(n-1)/2$  (C)  $n(n+1)/2$  (D)  $2^n$
3. Consider the grammar  
 $E \rightarrow E+E / E^*E/id$   
The grammar is  
(A) Operator grammar (B) Ambiguous  
(C) Both A and B (D) None
4. What is the regular expression for the following language?  
 $\{w \mid w \in (a+b)^* : w \text{ contains no more than 3 a's}\}$ .  
( $\epsilon$  denotes epsilon)  
(A)  $ab^*ab^*ab^*$  (B)  $b^*(\epsilon+a)b^*(\epsilon+a)b^*(\epsilon+a)b^*$   
(C)  $b^*(\epsilon+a)^*b^*$  (D) None of these
5. Consider the following grammar  
 $S \rightarrow Sd \mid cAe$   
 $A \rightarrow Sa \mid S \mid a$   
Identify the class to which this grammar belongs to.  
(A) LR (0) (B) LALR (1) (C) SLR (1) (D) LR (1)
6. Consider the following grammar:  
 $M \rightarrow Mx$   
 $P \rightarrow xMz$   
 $P \rightarrow x$   
 $S \rightarrow uMP$   
 $M \rightarrow \epsilon$   
 $P \rightarrow Pw$   
Identify the class to which this grammar belongs to.  
(A) LR (0) (B) LR (1) (C) SLR (1) (D) None of these
7. Consider the following context free grammar:  
 $S \rightarrow pAB$

$A \rightarrow qA \mid \epsilon$

$B \rightarrow SAw \mid tB \mid s \mid \epsilon$

Compute the follow set for A

(A) { w,p,s,t,\$ } (B) { w,q } (C) { p,q,s,t,w,\$ } (D) { w,t }

8. Which of the following grammar is an operator precedence grammar?

(A)  $S \rightarrow SAS \mid (S) \mid -S \mid id, A \rightarrow + \mid - \mid * \mid / \mid ^$

(B)  $S \rightarrow S+S \mid S*S \mid A, A \rightarrow A-A \mid a \mid b$

(C)  $S \rightarrow S+S \mid S*S \mid A \mid \epsilon, A \rightarrow A-A \mid a \mid b$

(D) None of these

9. Which of the following is not necessary for a grammar to be LL (1)?

(A) The grammar should not be left-recursive

(B) The grammar should not be ambiguous

(C) The grammar must be in CNF

(D) If  $A \rightarrow B|C$ , and B derives  $\epsilon$ , C does not derive any string beginning with a terminal in FOLLOW (A)

10. Which of the following statements is false?

(A) If there is a conflict in the LALR (1) parsing table, it must be present in the LR (1) parsing table.

(B) If there is a conflict in the LALR (1) parsing table, it must be present in the SLR (1) parsing table.

(C) All LL (1) grammars are also LR (1) grammar

(D) None of these

### Q. No. 11 – 30 Carry Two Marks Each

11. A dangling-else grammar is an ambiguous grammar having shift-reduce conflict. In whose favor should this conflict be resolved to correctly parse this kind of grammar?

(A) Shift operation

(B) Reduce operation

(C) Either shift or reduce

(D) This kind of conflict cannot be resolved

12. Let number of states in SLR parser is n and canonical LR is m for Grammar G then

(A)  $n < m$

(B)  $n \leq m$

(C)  $m \leq n$

(D)  $m < n$

13. For syntax directed translation arrange the following items according to their precedence

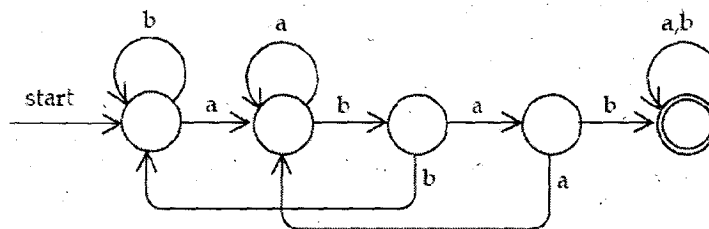
1. Dependency graph

2. Input string

3. Evaluation order for semantic rules

4. Parse tree

- (A)  $2 \rightarrow 1 \rightarrow 3 \rightarrow 4$  (B)  $2 \rightarrow 4 \rightarrow 1 \rightarrow 3$   
(C)  $2 \rightarrow 4 \rightarrow 3 \rightarrow 1$  (D)  $4 \rightarrow 2 \rightarrow 3 \rightarrow 1$
14. Which of the following statements is false?  
(A) All LL(1) grammars are also SLR(1) grammars  
(B) All LL(1) grammars are also LR(1) grammars  
(C) All LALR(1) grammars are also LR(1) grammars  
(D) All SLR(1) grammars are also LR(1) grammars
15. What is the default conflict resolution rule for the Yacc parser generator?  
(A) It will resolve in favor of shift  
(B) It will resolve in favor of reduce  
(C) Either shift or reduce depending on the situation  
(D) None of these
16. Which kind of conflict cannot be tackled to the Yacc parser generator?  
(A) Shift-reduce conflict (B) Reduce-reduce conflict  
(C) Both A and B (D) None of these
17. What is the regular expression for the set of strings  
 $\{w \in (a+b)^*: w \text{ contains exactly one occurrence of the substring } bbb\}$   
(A)  $(a+b)^*bbb(a+b)^*$   
(B)  $(a+ba+bba)^*bbb(a+ab+abb)^*$   
(C)  $(a+b)^*a^*bbba^*(a+b)^*$   
(D)  $(a+b+bbb)^*$
18. Describe the language represented by the following DFA.



- (A) Set of all strings with 'ab' as substring  
(B) Set of all strings with 'abab' as substring  
(C) Set of all strings over  $\{a,b\}$   
(D) None of these



19. Which of the following parsing methods can parse an ambiguous grammar without any conflict?  
(A) LL (1) (B) LR (1) (C) SLR (1) (D) None of these
20. Match the following:  
a. Canonical parser 1. No adjacent non-terminals  
b. SLR (1) parser 2. FOLLOW sets must be disjoint  
c. LL (1) parser 3. Most powerful parser  
d. Operator precedence grammar 4. Top down parser  
(A) a2 b3 c1 d4 (B) a3 b4 c2 d1 (C) a3 b2 c4 d1 (D) a2 b1 c4 d3
21. How does the Yacc parser generator handle reduce-reduce error by default?  
(A) It resolves in favor of the first reduce operation  
(B) It resolves in favor of the second reduce operation  
(C) It treats the entry as an error entry  
(D) Either first or second reduce operation depending on the type of the grammar
22. Which of the following cannot be a function of lexical analyzer?  
(A) Generating a sequence of tokens (B) Generating the syntax tree  
(C) Removing whitespace and comments (D) None of these
23. Consider the following grammar  
S  $\rightarrow$  0P0 | 1P1  
P  $\rightarrow$  1 | 0 |  $\epsilon$   
What is FIRST (1)?  
(A) {1} (B) { $\epsilon$ , 1} (C) {0, P, 1} (D) { $\epsilon$ , 0, 1, P}
24. What is the use of a DAG (directed acyclic graph) for an expression?  
(A) To identify common sub-expressions within an expression  
(B) To evaluate the order of semantic rules  
(C) To find out errors in the expression (D) None of these
25. Match the following:  
1. Input buffering a. Syntax directed translation  
2. Left-factoring b. Regular expression to DFA  
3. Followpos c. Sententials  
4. Syntax tree d. LL (1) grammar  
(A) 1a 2b 3c 4d (B) 1b 2d 3a 4c (C) 1c 2d 3b 4a (D) 1a 2c 3d 4b

26. Assertion (A) : LR (1) parsers cannot handle ambiguous grammars  
Reason (R) : It gives rise to conflicts.
- (A) Both A and R are true, but R is not the correct reason for 'A'  
(B) 'A' is true, but R is false.  
(C) Both 'A' and 'R' are true, and R is the correct reason for 'A'  
(D) Both 'A' and 'R' are false

**Common Data Questions: 27 & 28**

Consider the following grammar:

- 0)  $E' \rightarrow E$
- 1)  $E \rightarrow E++$
- 2)  $E \rightarrow *E$
- 3)  $E \rightarrow E()$
- 4)  $E \rightarrow E.E$
- 5)  $E \rightarrow id$

Here is the LR (0) configuring sets:

10.  $E' \rightarrow \bullet E$   
 $E \rightarrow \bullet E++$   
 $E \rightarrow \bullet *E$   
 $E \rightarrow \bullet E()$   
 $E \rightarrow \bullet E.E$   
 $E \rightarrow \bullet id$

11.  $E' \rightarrow E \bullet$   
 $E \rightarrow E \bullet ++$   
 $E \rightarrow E \bullet ()$   
 $E \rightarrow E \bullet .E$

12.  $E \rightarrow id \bullet$

13.  $E \rightarrow E++ \bullet$

14.  $E \rightarrow * \bullet E$   
 $E \rightarrow \bullet E++$   
 $E \rightarrow \bullet *E$   
 $E \rightarrow \bullet E()$   
 $E \rightarrow \bullet E.E$   
 $E \rightarrow \bullet id$

15.  $E \rightarrow *E \bullet$   
 $E \rightarrow E \bullet ++$   
 $E \rightarrow E \bullet . E$   
 $E \rightarrow E \bullet ( )$
16.  $E \rightarrow E ( \bullet )$
17.  $E \rightarrow E ( ) \bullet$
18.  $E \rightarrow E \bullet . E$   
 $E \rightarrow \bullet E ++$   
 $E \rightarrow \bullet * E$   
 $E \rightarrow \bullet E ( )$   
 $E \rightarrow \bullet E . E$   
 $E \rightarrow \bullet id$
19.  $E \rightarrow E . E \bullet$   
 $E \rightarrow E \bullet ++$   
 $E \rightarrow E \bullet ( )$   
 $E \rightarrow E \bullet . E$
27. What kind of conflicts exist in the given LR(0) parser?  
(A) Shift-shift (B) Shift-reduce (C) Reduce-reduce (D) No conflicts
28. If there are conflicts which of the configuring set have the conflicts?  
(A) 5 & 9 (B) 3 & 5 (C) 4 & 9 (D) None of these

**Statement for Linked Answer Questions: 29 & 30**

Consider the following grammar:

$S \rightarrow (B)$

$B \rightarrow CB$

$B \rightarrow \epsilon$

$C \rightarrow S$

$C \rightarrow D$

$D \rightarrow a$

29. What is FIRST (B)?  
(A)  $\{a, (, \epsilon\}$  (B)  $\{a, ( \}$  (C)  $\{ \}$  (D)  $\{a, ( \}$
30. What is FOLLOW (C)?  
(A)  $\{\epsilon, a\}$  (B)  $\{a, (, )\}$  (C)  $\{(, )\}$  (D)  $\{a, (, ), \$\}$

**Answer Keys**

|    |   |    |   |    |   |    |   |    |   |    |   |    |   |
|----|---|----|---|----|---|----|---|----|---|----|---|----|---|
| 1  | C | 2  | A | 3  | C | 4  | B | 5  | C | 6  | D | 7  | C |
| 8  | B | 9  | C | 10 | A | 11 | A | 12 | B | 13 | B | 14 | A |
| 15 | A | 16 | D | 17 | B | 18 | B | 19 | D | 20 | C | 21 | A |
| 22 | B | 23 | A | 24 | A | 25 | C | 26 | C | 27 | B | 28 | A |
| 29 | A | 30 | B |    |   |    |   |    |   |    |   |    |   |

**Explanations:-**

1. Reduce-reduce errors occur due to merging of states of a LR(1) parser to create new configuring states of the LALR(1) parser.
2. Consider the string 'abc', the possible prefixes are  $\epsilon$ , a, ab, abc  
For n length string there will be n+1 prefixes.  
**Note:** Among all the prefixes except  $\epsilon$  and the string itself, remaining prefixes are called as proper prefixes.  
Number of proper prefixes =  $n+1-2 = n-1$
3. The given grammar is operator grammar, since each production doesn't contain  $\epsilon$  productions and two adjacent non terminals on right hand side. It is also ambiguous, since the string id+id\*id  
Contains more than one parse tree
4. The string can contain 1 or 2 or 3 a's between any number of b's in between.
5. There is a shift-reduce conflict for the LR(0) parser which is not present in the SLR(1) parser.
6. The grammar is ambiguous leading to a reduce-reduce conflict for LR(1) parser.  
Consider the string "uxxz"
7. Anything in first of B can follow A as B is after A in the production  $S \rightarrow pAB$ .  
Since first (B) contains ' $\epsilon$ ' follow (A) = follow(S) from the production  $S \rightarrow pAB$ .
8. An operator precedence grammar should not have consecutive non-terminals or epsilon productions.
9. Except C, all the rest are essential.
10. LALR(1) can have reduce-reduce conflicts which are not present in LR(1) parser.  
These conflicts occur due to merging of states in LR(1) parser.
11. Shift is the correct option as this action will take care of the dangling else part.
12.  $n \leq m$
13. The input string is parsed by a parser to output the parse tree. The parse tree is used to derive dependency of attributes and from there the evaluation order of attributes is determined. This is the general flow of a compiler.

14. LL(1) grammars are not necessarily SLR(1).  
For example  
 $S \rightarrow AaAb \mid BbBa$ ,  $A \rightarrow \epsilon$ ,  $B \rightarrow \epsilon$
15. Yacc follows this rule by default as it is the correct way of resolving conflict of dangling-else grammar; which are very common in programming constructs.
16. Both kinds of errors can be tackled automatically. Shift-reduce errors are resolved in favor of shift and reduce-reduce errors are resolved in favor of the first reduce operation.
17. 'b' can occur once or twice consecutively any number of times in any position. But bbb will occur only once and it must be preceded and followed by an 'a.'
18. Two consecutive "ab"s will only lead to the final state.
19. Ambiguous grammar cannot be parsed without conflicts by any of the given parsing methods.
20. For any 2 common items the follow sets must be disjoint to avoid conflict in SLR(1) parsing.
21. This is the general rule for Yacc parser.
22. Syntax tree is created during syntax directed translation. Since the Lexical analyzer reads the source code, it can perform secondary tasks like removing whitespaces and comments.
23. If X is a terminal,  $FIRST(X) = \{X\}$ . Here 1 is a terminal.
24. Directed acyclic graph is used to eliminate common sub expressions. This improves the efficiency of the code.
25. Sententials are special characters to mark the end of a buffer half in input buffering. Followpos is calculated to convert a regular expression to a DFA. Left factoring is essential for making a grammar LL(1).
26. No parser can handle ambiguous grammars as they give rise to conflicts.
- 27& 28.  
State 5 has a complete item  $E \rightarrow *E\bullet$  and other incomplete items. An upcoming or (or ++ creates a problem of whether to reduce or to shift.  
State 9 has a complete item  $E \rightarrow E.E\bullet$  and other incomplete items which gives rise to shift-reduce conflict.
29. From the production  $S \rightarrow (B)$ , ( is in  $FIRST(B)$ .  
a is in  $FIRST(C)$  and from the production  $B \rightarrow CB$  everything in  $FIRST(C)$  is in  $FIRST(B)$ .  
Since B is null able,  $\epsilon$  is also in  $FIRST(B)$ .
30. From the production  $B \rightarrow CB$  everything in  $FIRST(B)$  except  $\epsilon$  is in  $FOLLOW(C)$ .  
Since B is  
null able everything in  $FOLLOW(B)$  is in  $FOLLOW(C)$  and  $FOLLOW(B)$  contains)

# Compiler Design-II

## Computer Science Engineering

Test ID: 

|   |   |   |   |
|---|---|---|---|
| 2 | 1 | 4 | 0 |
|---|---|---|---|

Duration: 90 minutes

Maximum Marks: 50

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### Read the following instructions carefully:

1. Write your roll number, your name and name of the examination center at the specified locations of the ORS.
2. Using HB pencil, darken the appropriate bubble under each digit of your registration number and the letters corresponding to your paper code.
3. All the questions in this question paper are of objective type.
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11. Rough work can be done on the question paper itself.

**Q. No.1-10 Carry One Mark Each**

1. Intermediate code cannot be represented with  
(A) Syntax tree (B) Three address code  
(C) Prefix notation (D) Postfix notation
2. Redundancy elimination can be done using  
(A) Syntax tree (B) Parse tree (C) DAG (D) Postfix notation
3. Which of the following is not machine independent optimization?  
(A) Loop optimization (B) Register Allocation  
(C) Folding (D) Redundancy Elimination
4. Memory can be allocated and de-allocated dynamically with \_\_\_\_\_ storage.  
(A) Heap (B) Stack (C) Static (D) None of these
5. Recursion is not possible in which of the following storage allocation?  
(A) Static (B) Stack (C) Heap (D) None of these
6. During compilation process, Symbol table is not used in  
(A) Lexical Analysis (B) Semantic Analysis  
(C) Code generation (D) None of these
7. Calculate First(S) for the following grammar:  
 $S \rightarrow ABb$   
 $A \rightarrow c/\epsilon$   
 $B \rightarrow d/\epsilon$   
(A) {b} (B) {b,c} (C) { b,c,d, $\epsilon$  } (D) {b,c,d}
8. The output form code generator is in the form of  
(A) Machine language (B) Assembly language  
(C) High-level language (D) None of these
9. Consider the grammar  
 $S \rightarrow abc/abd/ae/f$   
Left factor for the above grammar is  
(A)  $S \rightarrow abS'/ae/f$  (B)  $S \rightarrow aS''/f$   
 $S' \rightarrow c/d$   $S'' \rightarrow bS''/e$   
 $S'' \rightarrow c/d$

(C)  $S \rightarrow abS'/aS''/f$   
 $S' \rightarrow c/d$   
 $S'' \rightarrow e/\epsilon$

(D)  $S \rightarrow aS'/abS''/f$   
 $S' \rightarrow bs''/e$

10. Which of the following grammar is not ambiguous?

(A)  $S \rightarrow aSbS/bSaS/\epsilon$

(B)  $S \rightarrow S+S/SS/S^*/a/b$

(C)  $S \rightarrow (S)/[S]/SS/\epsilon/a/b$

(D)  $S \rightarrow aSb/SS/S/\epsilon$

**Q. No.11–30 Carry Two Marks Each**

11. With the static storage allocation strategy, the numbers of activation records existing for a single procedure are

(A) One

(B) Two

(C) Three

(D) None of these

12. Frequency reduction is used to

(A) Combine the bodies of loops

(B) Move loop invariant code outside

(C) Eliminate dead code

(D) Eliminate common sub expression

13. Match the following

|    |                                   |    |                                             |
|----|-----------------------------------|----|---------------------------------------------|
| P. | Common sub expression elimination | 1. | Folding                                     |
| Q. | Frequency Reduction               | 2. | Combining bodies of loop                    |
| R. | Loop jamming                      | 3. | Moving loop invariant code outside the loop |
| S. | Register allocation               | 4. | DAG                                         |
|    |                                   | 5. | M/C dependent -optimization                 |

(A) P-1,Q-2,R-3,S-5 (B) P-4,Q-2,R-3,S-5 (C) P-4,Q-3,R-2,S-1 (D) P-4,Q-3,R-2,S-5

14. Which of the following technique is efficient in terms of storage?

(A) Call by value

(B) Call by reference

(C) Call by value refill

(D) Call by value restore

15. Consider the following program:

Program P

Var n: integer;

Procedure Q( )

Var n = char

begin

n = 'A';

R ( );



```
end;
Procedure R()
begin
 Print (n);
end;
begin {main}
 n = 42;
 R ();
 Q ();
end;
```

Calculate output of above program if the scopes of variables are static.

(A) 42, A                      (B) A, 42                      (C) 42, 42                      (D) A, A

16. Find the output of program in above question if the scopes of variables are dynamic.

(A) 42, A                      (B) A, 42                      (C) 42, 42                      (D) A, A

17. Program p

```
Var a, b;
Procedure Q(x,y)
{
 x = x+a;
 y = x+b;
 print (x,y);
}
Procedure R (Z)
Var a;
{
 a = 5;
 z = z+2;
 Q (a, z);
 Print (a,z);
}
Begin {main}
 a = 3;
 b = 4;
 Q (a, b);
 R (b);
 Print (a, b);
end;
```

In the above program, scopes of the variables are static and procedures use call by reference technique to call parameters. Find the output after execution of the program.

- (A) 6, 10, 6, 23, 11, 23, 11, 23      (B) 6, 10, 6, 23, 11, 23, 6, 23  
(C) 6, 10, 11, 23, 6, 23, 6, 23      (D) 6, 10, 11, 23, 11, 23, 6, 23

18. Which of the following is true?

- (A) Scope of variable is a spatial concept  
(B) Extent of variable is a temporal concept  
(C) Call by value and call by reference are both supported in C & C++  
(D) All of these

19. Consider the following program:

```
Begin
Integer x;
X=3
Procedure P(y);
Integer x;
X=4
Print (y)
End p
P(x)
End
```

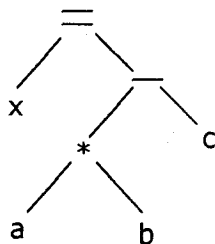
What will the output when we pass the parameters by call by name & call by test respectively?

- (A) 3, 4      (B) 3, 3      (C) 4, 4      (D) 4, 3

20. The quadruple form of  $x+y/z-w$  is

- (1)  $(+, x, y, t_1)$       (1)  $(/, y, z, t_1)$       (1)  $(+, x, y)$   
(A) (2)  $(/, t, z, t_2)$       (B) (2)  $(+, x, t_1, t_2)$       (C) (2)  $(/, (1), z)$       (D) None of these  
(3)  $(-, t_2, w, t_3)$       (3)  $(-, t_2, w, t_3)$       (3)  $(-, (2), d)$

21.



Three address code for the above syntax tree is

- |                                                                  |                                                                  |                                                   |                                                   |
|------------------------------------------------------------------|------------------------------------------------------------------|---------------------------------------------------|---------------------------------------------------|
| (A) $t_1 = a * b$<br>$t_2 = C$<br>$t_3 = t_2 - t_1$<br>$x = t_3$ | (B) $t_1 = a * b$<br>$t_2 = C$<br>$t_3 = t_2 - t_1$<br>$x = t_3$ | (C) $t_1 = a * b$<br>$t_2 = C - t_1$<br>$x = t_2$ | (D) $t_1 = a * b$<br>$t_2 = t_1 - C$<br>$x = t_2$ |
|------------------------------------------------------------------|------------------------------------------------------------------|---------------------------------------------------|---------------------------------------------------|

22.  $a = b;$   
 $c = a * b;$   
 $d = c;$   
 $e = c * a;$   
 $x = e + d;$

Optimization form of above statements using copy – propagation will be

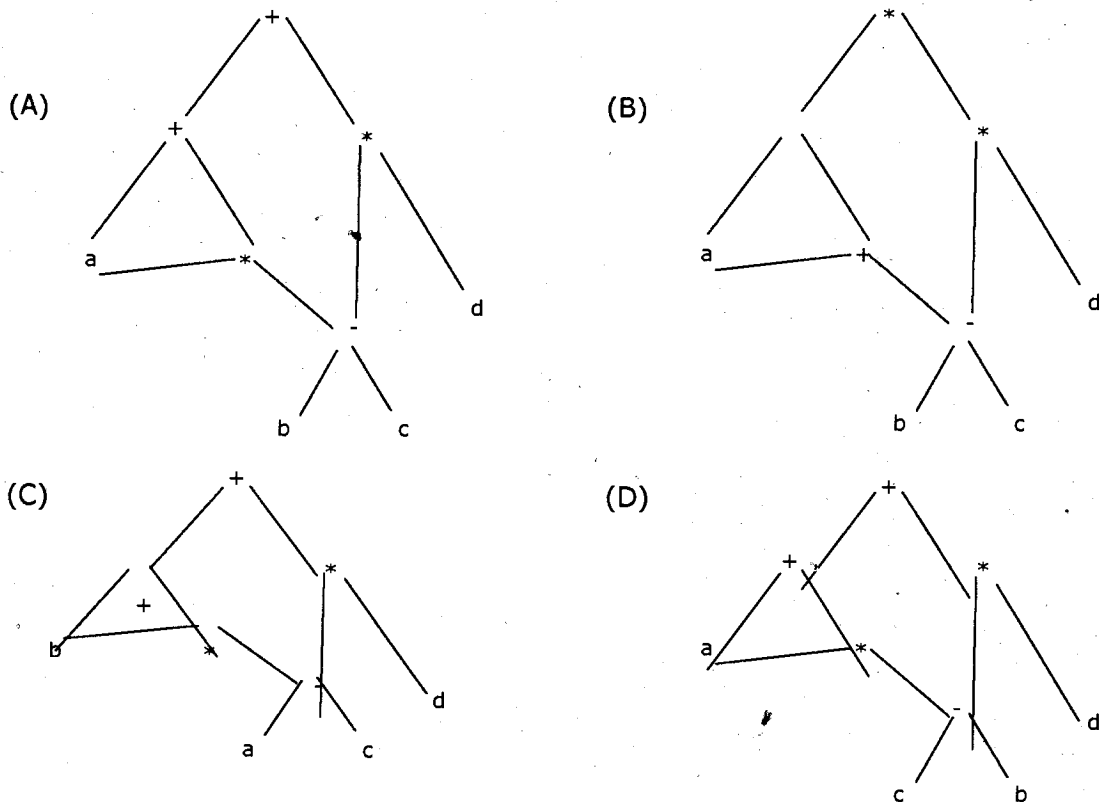
- |                                                  |                                                  |                                                  |                                                  |
|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|
| (A) $c = a * a;$<br>$e = c * a;$<br>$x = e + c;$ | (B) $c = b * b;$<br>$e = d * b;$<br>$x = e + c;$ | (C) $c = a * a;$<br>$e = d * a;$<br>$x = e + c;$ | (D) $c = b * b;$<br>$e = c * b;$<br>$x = e + c;$ |
|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|

23. **Assertion [A]:** Three address statements when stored as triples do not waste space for temporaries.

**Reason[R]:** Triples are useful in optimization.

- (A) Both A & R are true and R is the correct reason for A  
(B) Both A & R are true but R is not the correct reason for A  
(C) Both A & R are false  
(D) A is true but R is false

24. DAG representation for the expression  $a + a * (b - c) + (b - c) * d$  is



25. Consider the grammar  
 $E \rightarrow bEa/aEb/ba$   
The number of conflicts or errors occurred during the SLR (1) Construction is  
(A) 2 Shift-Reduce conflicts  
(B) 2 Reduce-Reduce conflicts  
(C) 1 Shift-Reduce and 1 Reduce-Reduce conflict  
(D) None of these
26. Activation record does not contain the \_\_\_\_\_ information.  
(A) Access link      (B) Symbol link      (C) Control link      (D) None of these

**Common Data Questions: 27 & 28**

```
Program P
Var Z: integer
Procedure Q(x)
{
 If $x \leq 40$ then
 {
 $x = x + z$;
 Q (x);
 $Z = Z + 10$;
 }
}
begin {main}
 $Z = 10$;
 Q (Z);
 Print (Z);
end;
```

27. Find the output of above program, if the procedure Q uses call by reference.  
(A) 200      (B) 110      (C) 60      (D) 50
28. Find the output, if the procedure Q uses "call by value result".  
(A) 200      (B) 110      (C) 60      (D) 50

**Statement for Linked Answer Questions: 29 & 30**

Consider the following expression

$$(a+b) - (e-(c+d))$$

29. Construct three address codes for the above expression.

|                 |                   |                 |                 |
|-----------------|-------------------|-----------------|-----------------|
| (A) $t_1 = a+b$ | (B) $t_1 = c+d$   | (C) $t_1 = a+b$ | (D) $t_1 = c+d$ |
| $t_2 = e-(c+d)$ | $t_2 = e-t_1$     | $t_2 = c+d$     | $t_2 = e-t_1$   |
| $t_3 = t_1-t_2$ | $t_3 = (a+b)-t_2$ | $t_3 = e-t_2$   | $t_3 = a+b$     |
| $t_4 = t_3$     | $t_4 = t_3$       | $t_4 = t_1-t_3$ | $t_4 = t_2-t_3$ |

30. For the above three - address code, generate the instruction code with the use of only two registers  $R_0$  and  $R_1$

|                  |                  |                  |                  |
|------------------|------------------|------------------|------------------|
| (A) MOV a, $R_0$ | (B) MOV a, $R_0$ | (C) MOV c, $R_0$ | (D) MOV c, $R_0$ |
| ADD b, $R_0$     | ADD b, $R_0$     | ADD d, $R_0$     | ADD b, $R_0$     |
| MOV c, $R_1$     | MOV c, $R_1$     | MOV e, $R_1$     | MOV e, $R_1$     |
| ADD d, $R_1$     | ADD d, $R_1$     | SUB $R_0, R_1$   | SUB $R_0, R_1$   |
| MOV $R_0, t_1$   | MOV $R_0, t_1$   | MOV a, $R_0$     | MOV a, $R_0$     |
| MOV e, $R_0$     | MOV e, $R_0$     | ADD b, $R_1$     | ADD d, $R_1$     |
| SUB $R_1, R_0$   | SUB $R_1, R_0$   | SUB $R_1, R_0$   | SUB $R_1, R_0$   |
| MOV $t_1, R_1$   | MOV $t_1, R_1$   | MOV $R_0, t_4$   | MOV $R_1, t_4$   |
| SUB $R_0, R_1$   | SUB $R_1, R_0$   |                  |                  |
| MOV $R_1, t_4$   | MOV $R_0, t_4$   |                  |                  |

**Answer Keys**

|    |   |    |   |    |   |    |   |    |   |    |   |    |   |
|----|---|----|---|----|---|----|---|----|---|----|---|----|---|
| 1  | C | 2  | C | 3  | B | 4  | A | 5  | A | 6  | D | 7  | D |
| 8  | B | 9  | B | 10 | A | 11 | A | 12 | B | 13 | D | 14 | B |
| 15 | C | 16 | A | 17 | D | 18 | D | 19 | A | 20 | B | 21 | D |
| 22 | D | 23 | D | 24 | A | 25 | A | 26 | B | 27 | B | 28 | D |
| 29 | C | 30 | A |    |   |    |   |    |   |    |   |    |   |

**Explanations:-**

- Intermediate code can be represented with
  - Syntax tree
  - DAG
  - Postfix notation
  - Three address code
 So, prefix notation is not an intermediate code representation.
- DAG is used for redundancy Elimination
- Register allocation is machine dependent and remaining three optimizations are machine independent
- With heap storage, memory can be allocated and deallocated dynamically
- Symbol table is used in all phases of compiler

$$S \rightarrow ABb$$

$$A \rightarrow c \mid \epsilon$$

$$7. \quad B \rightarrow d \mid \epsilon$$

$$\begin{aligned} \text{First}(S) &= \text{First}(ABb) = \text{First}(cBb) \cup \text{First}(Bb) \\ &= \{c\} \cup \text{First}(db) \cup \text{First}(b) = \{c\} \cup \{d\} \cup \{b\} = \{b, c, d\} \end{aligned}$$

$$9. \quad S \rightarrow abc|abd|ae|f$$

First consider the common substring which has higher length

$$S \rightarrow abc|abd|ae|f$$

⇓

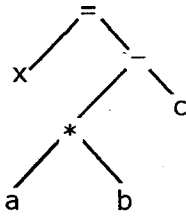
$$S \rightarrow abS'|ae|f$$

$$S' \rightarrow c/d$$

⇓ consider the next common substring



21.



Three address code for above syntax tree is:

$$t_1 = a * b$$

$$t_2 = t_1 - c$$

$$x = t_2$$

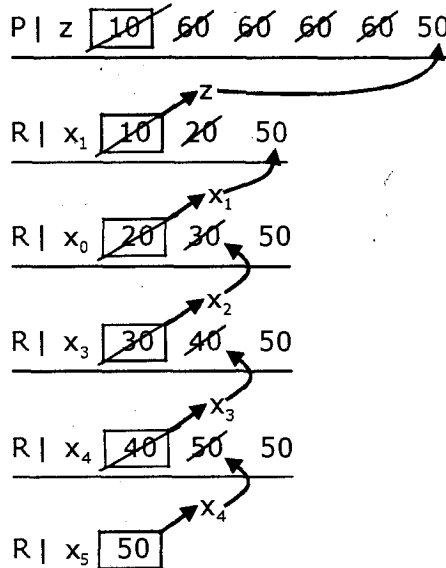
22.  $a = b ;$

$c = a * b;$   
 $d = c;$   
 $e = c * a;$   
 $x = e + d;$

optimization  $\Rightarrow$  copy propagation

$c = b * b;$   
 $e = c * b;$   
 $x = e + c;$

28.



29. Three address code:

$$t_1 = a + b$$

$$t_2 = c + d$$

$$t_3 = e - t_2$$

$$t_4 = t_1 - t_3$$



30. The required code generator is (using two registers)

```
MOV a, R0
ADD b, R0
MOV c, R1
ADD d, R1
MOV R0, t1
MOV e, R0
SUB R1, R0
MOV t1, R1
SUB R0, R1
MOV R1, t4
```

# Computer Networks-I

## Computer Science Engineering

Test ID: 

|   |   |   |   |
|---|---|---|---|
| 2 | 1 | 4 | 1 |
|---|---|---|---|

Duration: 90 minutes

Maximum Marks: 50

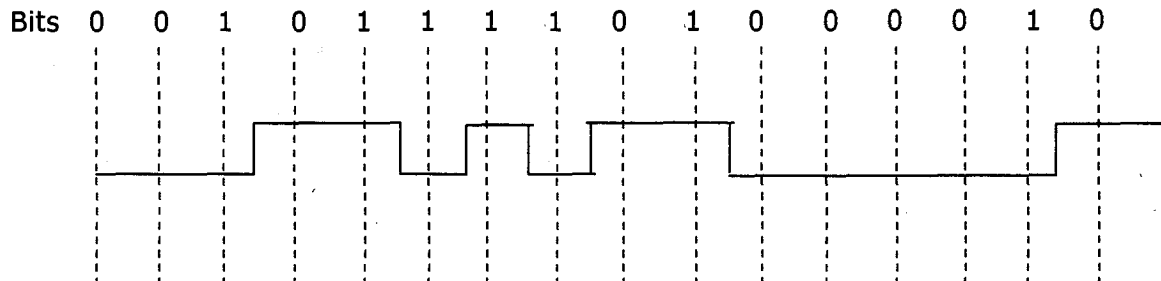
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### Read the following instructions carefully:

1. Write your roll number, your name and name of the examination center at the specified locations of the ORS.
2. Using HB pencil, darken the appropriate bubble under each digit of your registration number and the letters corresponding to your paper code.
3. All the questions in this question paper are of objective type.
4. Questions must be answered on Objective Response Sheet (ORS) by darkening the appropriate bubble (marked A, B, C, D) using HB pencil against the question number on the left hand side of the ORS. **Each question has only one correct answer.** In case you wish to change an answer, erase the old answer completely. More than one answer bubbled against a question will be treated as a wrong answer.
5. This question paper contains 30 objective type questions. Q.1 to Q.10 carry **one** mark each and Q.11 to Q.30 carry **two** marks each.
6. Un-attempted questions will carry zero marks.
7. The question pair (27, 28) is common data questions.
8. The questions pair (29, 30) is questions with linked answers. The answer to the second question of the above pair will depend on the answer to the first question of the pair. If the first question in the linked pair is wrongly answered or is un-attempted, then the answer to the second question in the pair will not be evaluated.
9. **NEGATIVE MARKING:** For Q.1 to Q.10, 1/3<sup>rd</sup> mark will be deducted for each wrong answer. For Q. 11 to Q.30, 2/3<sup>rd</sup> mark will be deducted for each wrong answer. For the pair of questions with linked answers, there will be negative marks only for wrong answer to the first question, i.e. for Q.29, 2/3<sup>rd</sup> mark will be deducted for wrong answer. There is no negative marking for Q.30.
10. Calculator without data connectivity is allowed in the examination hall. Charts, graph sheets or tables are NOT allowed in the examination hall.
11. Rough work can be done on the question paper itself.

**Q. No.1-10 Carry One Mark Each**

1. Look at the following encoding of binary data into signals



What is the above encoding technique?

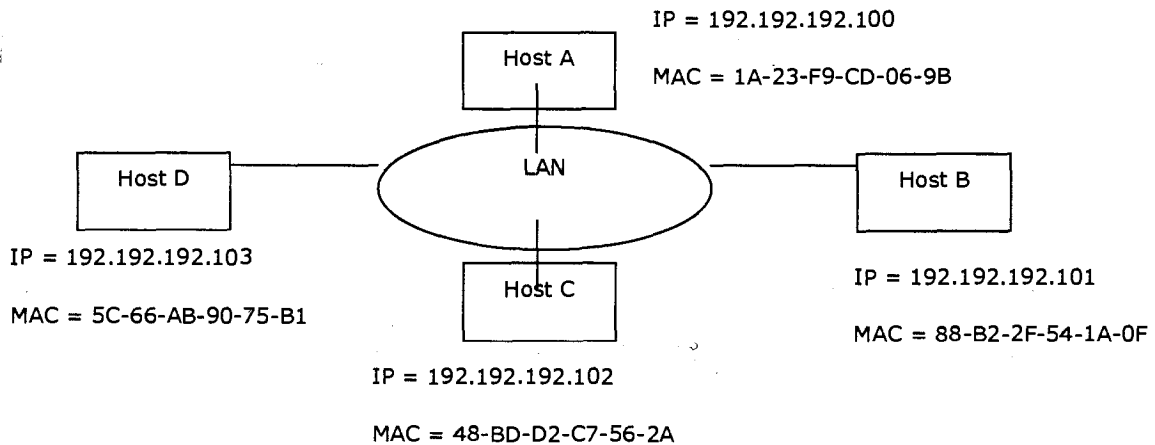
- (A) Manchester encoding  
(B) Non-return to Zero Inverted encoding  
(C) Clock Synchronization encoding (D) Non-return to Zero encoding
2. Which of the following protocol(s) are not data link protocols?
- |           |            |           |              |
|-----------|------------|-----------|--------------|
| 1. RIP    | 2. BGP     | 3. PPP    | 4. OSPF      |
| (A) 1 & 3 | (B) Only 3 | (C) 3 & 4 | (D) 1, 2 & 4 |
3. In OSI model, which layer provides the flow control between sender and receiver?
- (A) Application Layer (B) Network Layer (C) Data Link Layer (D) Physical Layer
4. Which of the following statement is true about data link layer?
- |                                                     |                                                           |                                        |                                       |
|-----------------------------------------------------|-----------------------------------------------------------|----------------------------------------|---------------------------------------|
| 1. The transmission of frames is always full duplex | 2. It retransmits the frames which were damaged by errors | 3. It assures that no frames were lost | 4. It detects the transmission errors |
| (A) 3 & 4                                           | (B) 2 & 4                                                 | (C) 2, 3 & 4                           | (D) All of these                      |
5. What is the size of ARP request and reply packet?
- (A) 12bytes (B) 20bytes (C) 28bytes (D) 128bytes
6. You need to retrieve a file from the file server for your word processing application. Which layer of the OSI model is responsible for this function?
- (A) Presentation Layer (B) Session Layer  
(C) Transport Layer (D) None of these

7. Routers can be configured using several sources. Which of the following cannot be used for Routers configuration?  
 (A) Removable Media (B) Console Port  
 (C) Virtual Terminals (D) TFTP server
8. In a Data link protocol, the frame delimiter flag is given by 01111110. Assuming that bit stuffing is employed, the transmitter sends data sequence "011101111101101" as  
 (A) 0111011111001101 (B) 011101111101101  
 (C) 011101111101001101 (D) None of these
9. In a Ring network, the transmission speed is  $10^9$  bps and the propagation speed is 1000 meters /  $\mu$ s. The 1-bit delay in this network is equivalent to  
 (A) 10meters (B) 100meters (C) 1000meters (D) 1meter
10. The Message "11011011" should be transmitted using CRC polynomial  $x^3 + x + 1$ . In order to protect it from errors, it will be transmitted as  
 (A) 11011011001 (B) 11011011100 (C) 11011011110 (D) none of these
11. Which of the following statement is true?  
 1. RIP is a Distance Vector routing protocol.  
 2. BGP is not a Distance Vector routing protocol.  
 3. OSPF is a Link-State routing protocol.  
 4. RIP and BGP both are Distance Vector routing protocols.  
 (A) Option 1 only (B) Options 1, 2 and 3  
 (C) Options 1, 3 and 4 (D) Option 4 only
12. Match the following two lists

| List 1             | List 2                     |
|--------------------|----------------------------|
| (A) 193.4.5.6      | (1) Class - A IP Address   |
| (B) 150. 75. 9. 28 | (2) Class - B IP Address   |
| (C) 182.73.4.10    | (3) Class - C IP - Address |
| (D) 75. 71. 3.2    |                            |

- (A) A - 1, B - 2, C - 2, D - 1 (B) A - 3, B - 2, C - 3, D - 1  
 (C) A - 3, B - 2, C - 2, D - 1 (D) A - 1, B - 1, C - 2, D - 3

13. Assume the following hosts are presented in the local network.



Suppose host A send the ARP request to find the MAC address of host C and host C sends back the ARP reply. What is destination MAC address in ARP request packet and reply packets?

- (A) Destination MAC in ARP request = 48-BD-D2-C7-56-2A and in ARP reply = 1A-23-F9-CD-06-9B
- (B) Destination MAC in ARP request = FF-FF-FF-FF-FF-FF and in ARP reply = 1A-23-F9-CD-06-9B
- (C) Destination MAC in ARP request = FF-FF-FF-FF-FF-FF and in ARP reply = FF-FF-FF-FF-FF-FF
- (D) Destination MAC in ARP request = 48-BD-D2-C7-56-2A and in ARP reply = FF-FF-FF-FF-FF-FF
14. Suppose that humans cannot hear audio tones higher than 20 kHz, then what is a reasonable maximum value for  $f$ ?
- (A)  $f \leq 80$  kHz      (B)  $f \leq 120$  kHz      (C)  $f \leq 40$  kHz      (D)  $f \leq 60$  kHz
15. Data Rate is a function of
- (A) Bandwidth      (B) Signal/noise ratio
- (C) Encoding technique      (D) All of these
16. Which of the following statement is true about ARP?
1. All ARP request packets are transmitted with the Ethernet broadcast address
  2. ARP reply packet is directed to the host, which transmitted the ARP request packet
  3. ARP reply packet is transmitted with the Ethernet broadcast address
  4. All ARP request packets are transmitted to the router in the local network
- (A) Options 3 and 4      (B) Options 1 and 3
- (C) Options 1 and 2      (D) Option 2 and 4

17. Is it possible to release a connection such that both parties always agree?  
(A) YES (B) NO (C) Can't Say (D) None of these
18. Suppose, the source has sent four TCP segments to Destination with the sequence numbers 50, 74, 97, 120 (first, second, third and fourth segments respectively). If the first and fourth segments arrive at destination successfully, then what is the Negative Acknowledgement that destination sends to source?  
(A) 120 (B) 97 (C) 74 (D) 75
19. A sender uses Selective Repeat ARQ and uses the window size of 8-frames. Then what is the sequence number after sending 200 frames.  
(A) 15 (B) 8 (C) 0 (D) 6
20. Suppose a host A in a LAN transmitting the IP packet to some other host B in the same network. Host A sends the ARP request packet to resolve the IP address of B to its MAC address. What happens, if the IP address of destination host cannot be resolved to MAC address?  
(A) Host A sends the IP packet to the ARP server  
(B) Host A broadcasts the IP packet in the local network  
(C) Host A simply drops the IP packet  
(D) Host A sends the IP packet to the DNS server if any in the local network
21. A local Area Network operates Ethernet with CSMA/CD mechanism runs at a transmission rate of 8 Mbps and one way signal propagation time is  $25\mu\text{s}$ . What is the minimum transmitted frame length? (In bits)  
(A) 300 (B) 200 (C) 500 (D) 400
22. If the number of bits used to represent the frame sequence number is  $x$ , then what is the total number of frames in the sliding window using selective repeat ARQ, Go Back-n ARQ respectively.  
(A)  $2^x, 2^{x-1}$  (B)  $2^{x-1}, 2^x - 1$  (C)  $2^x - 1, 2^{x-1}$  (D)  $2^{x+1}, 2^{x-1}$
23. The Bandwidth in a CSMA/CD network is 10 Mbps. What is the maximum frame size required in this network with a round trip time of 384 micro sec?  
(A) 380bytes (B) 3840bytes (C) 4860bytes (D) None of these
24. The bandwidth in a Stop and Wait ARQ is 1Gbps and 1-bit delay to make round trip is 30micro sec. If the system data frames are 2000 bits in length, then what is the percentage of the utilization of the link?  
(A) 6.6% (B) 3.3% (C) 4% (D) 5.2%

25. A 20kbps satellite link has a propagation delay of 300ms. The transmitter employs the 'go back-n ARQ' scheme with n set to 10. Assume each frame is 50 bytes long. What is the maximum data rate possible?

(A) 6.4kbps (B) 5.2kbps (C) 9.6kbps (D) 6kbps

26. A CRC code has 10 message bits and uses the generator polynomial  $x^6 + x^4 + x + 1$ . What would be the redundant check bits appended to the following message at the sender side 1011001011?

(A) 000001 (B) 000011 (C) 000000 (D) 110000

### Common Data Questions: 27 & 28

Consider a sliding window protocol using selective Repeat. The sender sliding window size is 32.

27. What is the sequence number of the frame to be sent after successfully sending 200 frames?

(A) 6 (B) 7 (C) 63 (D) 8

28. What is the Acknowledgement number that is piggybacked by the Receiver along with data frame after receiving the first 100 frames?

(A) 35 (B) 36 (C) 38 (D) 37

### Statement for Linked Answer Questions: 29 & 30

Consider a message bit stream "1011011" which is to be transmitted using CRC method using a generator polynomial  $x^2 + 1$

29. Which of the following is the bits pattern transmitted to the destination?

(A) 101101110 (B) 101101100 (C) 101101101 (D) 011011011

30. How the correct the bit pattern which is transmitted using the bit stuffing with a flag bit of 0111?

(A) 10110011001 (B) 101101101011

(C) 10010100101001 (D) 101101101

**Answer Keys**

|    |   |    |   |    |   |    |   |    |   |    |   |    |   |
|----|---|----|---|----|---|----|---|----|---|----|---|----|---|
| 1  | B | 2  | D | 3  | C | 4  | C | 5  | C | 6  | B | 7  | C |
| 8  | A | 9  | D | 10 | C | 11 | C | 12 | B | 13 | B | 14 | C |
| 15 | D | 16 | C | 17 | B | 18 | C | 19 | B | 20 | D | 21 | D |
| 22 | B | 23 | D | 24 | A | 25 | A | 26 | C | 27 | D | 28 | A |
| 29 | C | 30 | A |    |   |    |   |    |   |    |   |    |   |

**Explanations:-**

- NRZI: Make a transition from current signal to encode 1 and stay at current signal to encode a zero.
- RIP, BGP and OSPF all are network layer protocols  
PPP is a data link protocol
- In data link layer the transmission may be half duplex or full duplex

9. 1 sec -  $10^9$ bits

$$1\text{bit} = \frac{1}{10^9} \text{sec} = \frac{1}{10^9} \times 10^6 \mu\text{s} = \frac{1}{10^3} \mu\text{s}$$

$$1\mu\text{s} = 1000\text{meters} \Rightarrow \frac{1}{10^3} \mu\text{s} = 1\text{meter}$$

- 10.

$$\begin{array}{r}
 1011 \overline{) 11011011000} \quad 11111010 \quad X^3 + X + 1 = 1011 \\
 \underline{1101} \phantom{000000000} \\
 1101 \phantom{000000000} \\
 \underline{1011} \phantom{000000000} \\
 1100 \phantom{000000000} \\
 \underline{1011} \phantom{000000000} \\
 1111 \phantom{000000000} \\
 \underline{1011} \phantom{000000000} \\
 0100 \phantom{000000000} \\
 \underline{0000} \phantom{000000000} \\
 1000 \phantom{000000000} \\
 \underline{1011} \phantom{000000000} \\
 0110 \phantom{000000000} \\
 \underline{0000} \phantom{000000000} \\
 110
 \end{array}$$

So it will be 11011011110

- All ARP request packets are transmitted with the Ethernet broadcast address, so that all hosts in the network will receive the request.  
ARP reply packet is directed to the host, which transmitted the ARP request packet



14. Consider an audio signal that is sampled at a frequency of 'f' Hz with a sample size of b bits.  
 As per Nyquist theory,  $f > 40$  kHz is useless
18. In TCP, Every byte will be numbered. So, the last byte received in the first segment is 73, so it sends a NAK for byte-74.
19. Window size = 8 Frames  
 Number of bits used for frame sequence  

$$= \frac{2^x}{2} = 8; \text{ where } x=4, [0,1,2... 15, 0, 1,2 .... 15.....]$$
 After 192, the sequence number is '0' and after 200, it will be 8
20. It sends to nearest DNS server
21.  $1\text{sec} \rightarrow 8 \times 10^6 \text{bits}; 1\text{bit} \rightarrow \frac{1}{8 \times 10^6} \times 10^6 \mu\text{s}$   
 $1\text{bit} \rightarrow \frac{1}{8} \mu\text{sec}; 1\mu\text{sec} = 8\text{bit}$   
 $25\mu\text{s} \rightarrow 25 \times 8 = 400\text{bits}.$   
 RIT =  $50\mu\text{s}$ ; So for  $50\mu\text{s}$ ,  $2 \times 25 \times 8\text{bits} = 400\text{bits}$
23.  $1\text{sec} \rightarrow 10 \times 10^6 \text{bits}; 1\text{bit} \rightarrow \frac{1}{10 \times 10^6} \text{sec} \rightarrow \frac{1}{10} \mu\text{sec}$   
 Let x is the number of Bytes of frame, then for 8x bits  
 It is  $\frac{8x}{10\mu\text{sec}}$ ;  $x = \frac{3840}{8} = 480$  bytes  $\left( \because \frac{8x}{10} = 384 \right)$
24.  $1\text{sec}, \text{Bandwidth is } 10^9 \text{bits}; 1\text{bit} = \frac{1}{10^9} \text{sec} = \frac{1}{10^3} \mu\text{s}$   
 RIT = 30 sec  
 $\frac{1}{10^3} \mu\text{s} \rightarrow 1\text{bit}; 1\mu\text{s} \rightarrow 10^3 \text{bit}$   
 $30\mu\text{s} \rightarrow 30,000\text{bit}; \text{Data frame size} = 2000\text{bit}$   
 Link utilization =  $\frac{2000}{30,000} \times 100 = \frac{20}{3} = 6.6\%$
25. Time required for transmitting 50 bytes frame =  $\frac{50 \times 8}{20 \times 10^3} = \frac{400}{20 \times 10^3} = \frac{1}{50} \text{sec} = 20\text{ms}$   
 RIT =  $2 \times 300 = 600\text{ms}$ , Total time =  $600 + 20 = 620\text{ms}$   
 $\frac{20}{620} \times 20 = \frac{400}{620} = 0.64; n=10; 0.64 \times 10 = 6.4\text{kbps}$

26. 1010011 | 1011001011000000 | 10010

```

101001
000000

0101001
0000000

1010011
1010011

0000000
0000000

0000000

```

27.  $\frac{2^n}{2} = 32$

$2^n = 64, n = 6$

Sequence numbers are 0, 1, 2.....,63, 0,1....63 after sending 200 frames

$64 + 64 + 64 = 192$ , next eight frames are to 7 so the next frame is 8

28. After receiving the first 100 frames

0,1,2,.....63,0,1,2-----34,35  
100 frames

Ack-35 is piggybacked with the Data frame

29. 101 | 101101100 | 1001001

```

 101↓

 001
 000↓

 101
 101↓

 001
 000↓

 010
 000↓

 100
 101↓

 01

```

Message: 101101101

30. Since flag is 0111, bit (0 – bit) will be stuffed after every two consecutive 0 is occurred in data

101101101 will be stuffed as follows

10110011001 Stuffed bits

# Computer Networks-II

## Computer Science Engineering

Test ID: 

|   |   |   |   |
|---|---|---|---|
| 2 | 1 | 4 | 2 |
|---|---|---|---|

Duration: 90 minutes

Maximum Marks: 50

---

**Read the following instructions carefully:**

1. Write your roll number, your name and name of the examination center at the specified locations of the ORS.
2. Using HB pencil, darken the appropriate bubble under each digit of your registration number and the letters corresponding to your paper code.
3. All the questions in this question paper are of objective type.
4. Questions must be answered on Objective Response Sheet (ORS) by darkening the appropriate bubble (marked A, B, C, D) using HB pencil against the question number on the left hand side of the ORS. **Each question has only one correct answer.** In case you wish to change an answer, erase the old answer completely. More than one answer bubbled against a question will be treated as a wrong answer.
5. This question paper contains 30 objective type questions. Q. 1 to Q.10 carry **one** mark each and Q. 11 to Q.30 carry **two** marks each.
6. Un-attempted questions will carry zero marks.
7. The question pair (27, 28) is common data questions.
8. The questions pair (29, 30) is questions with linked answers. The answer to the second question of the above pair will depend on the answer to the first question of the pair. If the first question in the linked pair is wrongly answered or is un-attempted, then the answer to the second question in the pair will not be evaluated.
9. **NEGATIVE MARKING:** For Q.1 to Q.10,  $1/3^{\text{rd}}$  mark will be deducted for each wrong answer. For Q. 11 to Q.30,  $2/3^{\text{rd}}$  mark will be deducted for each wrong answer. For the pair of questions with linked answers, there will be negative marks only for wrong answer to the first question, i.e. for Q.29,  $2/3^{\text{rd}}$  mark will be deducted for wrong answer. There is no negative marking for Q.30.
10. Calculator without data connectivity is allowed in the examination hall. Charts, graph sheets or tables are NOT allowed in the examination hall.
11. Rough work can be done on the question paper itself.

**Q. No. 1 – 10 Carry One Mark Each**

1. Assume that a host uses DHCP protocol to obtain its IP address. At the beginning of DHCP processing, host broadcasts the "DHCP discover" messages. Which of the following is the valid reply message from a DHCP server?  
(A) DHCP request      (B) DHCP offer      (C) DHCP ack      (D) None of these
2. Which of the following is a common services provided by both TCP and UDP?  
1. Multiplexing/demultiplexing      2. Flow control  
3. Error detection      4. Reliable data transfer  
(A) Only 1      (B) 1 & 2      (C) 1 & 3      (D) 2, 3 & 4
3. Which of the following services are not offered by TCP?  
(A) Delay guarantees  
(B) Bandwidth guarantees  
(C) Both "delay guarantees" and "bandwidth guarantees"  
(D) None of these
4. What is reliable data transfer?  
(A) "guaranteed arrival of data" and "in order delivery of data"  
(B) "guaranteed arrival of data" and "no error in the data"  
(C) "guaranteed arrival of data", "in order delivery of data" and "no error in the data"  
(D) "no error in the data"
5. In TCP, when the receiver receives the out-of-order segments, it buffers the segments and sends which of the following to the sender?  
(A) Send the ACK of the last in-order data segment  
(B) Send the ACK of the last segment  
(C) Send the NACK of the last segment  
(D) None of these
6. "The service required in a public key cryptosystem is Authentication", then which of the following is correct?  
(A) Sender encrypts the data using receiver's public key  
(B) Sender encrypts the data using its public key  
(C) Sender encrypts the data using its private key  
(D) None of these

7. In a class B network on the Internet has a subnet mask of 255.255.224.0. What is the maximum number of hosts per subnet?  
(A) 8 (B) 6 (C) 30 (D) 8190
8. Internet Addresses must always have at least  
i. A country name or organization type ii. Internet service provider's name  
iii. Name of organization iv. Name of individual  
v. Type of organization  
(A) i, ii, iii (B) ii, iii, iv (C) i, iii (D) ii, iii, iv, v
9. Which of the following parameters can be used by a firewall to decide whether to forward/drop packets?  
(A) Source IP address and destination IP address  
(B) TCP/UDP source and destination port numbers  
(C) TCP SYN and ACK bits  
(D) All of these
10. Which of the following is a symmetric key cryptographic algorithm?  
1. DES (Data Encryption Standard) 2. 3-DES  
3. AES (Advanced Encryption Standard) 4. RSA  
(A) 1 & 2 (B) 1, 2 & 3 (C) 1, 2 & 4 (D) Only 4

**Q. No. 11 – 30 Carry Two Marks Each**

11. The class-C Address is to be sub-divided into subnets with 3-bit subnet number. What is the maximum number of sub-networks and the maximum number of hosts in each sub-network?  
(A) 8 subnets, 32 hosts (B) 6 subnets, 32 hosts  
(C) 8 subnets, 30 hosts (D) 6 subnets, 30 hosts
12. What fields in IP header are involved in packet fragmentation?  
(A) Flags (B) Fragment offset (C) Identification (D) All of these
13. What happens to congestion window at the sender side when it receives 3 duplicate ACKs?  
(A) Congestion window is cut to half, it then grows linearly  
(B) Congestion window is set to 1 MSS, fall back to slow start  
(C) Congestion window is set to threshold, it then grows linearly  
(D) None of these

14. Which of the following IP address is an example of a multicast address?  
(A) 201.65.121.128 (B) 224.18.241.1  
(C) 242.17.123.12 (D) None of these
15. Which of the following is not a valid IP address?  
(A) 192.168.1.0 (B) 111.222.12.256  
(C) 241.1.1.254 (D) All of these
16. IP address of a particular class-B host is 152.45.32.14. What is the broadcast address of the subnet, if the subnet mask is 255.255.240.0?  
(A) 152.45.47.255 (B) 152.45.255.255 (C) 152.45.53.14 (D) None of these
17. Which of the following is an example of ICMP Queries?  
(A) Echo Request (B) Router Advertisement  
(C) Timestamp Request (D) All of these
18. Consider the following statements:  
S1: A computer crime is any threat to computer or data security  
S2: Encryption of message with source private key forms the digital signature  
Which of the above statement(s) is / are true?  
(A) Only S1 (B) S1 & S2 (C) Only S2 (D) neither S1 nor S2
19. Suppose there are 12 intermediate routers between the source and destination of an IP packet. If the sender enables the "Record Route" option in the IP header, how many intermediate routers can place their IP addresses in the IP header?  
(A) 12 (B) 11 (C) 10 (D) 9
20. Two hosts, each located in a different network, exchange their e-mails via the internet and make use of a pair of email gateways. Such gateways are necessary because  
(A) Each host is on a separate network  
(B) Each host is using a different email application  
(C) Each host is using a different email message format  
(D) Both (A) and (B)
21. A class-C address has the following subnet mask 255.255.255.192. Which of the following are valid IP-addresses under this network?  
i. 194.25.64.68 ii. 194.43.75.128 iii. 194.65.73.64 iv. 194.75.74.131  
(A) i & ii (B) i, ii & iv (C) i & iv (D) ii & iv

22. Which of the following application runs on UDP?  
1. SNMP                      2. DNS                      3. HTTP  
(A) Only 1                      (B) Only 2                      (C) 1 & 2                      (D) 2 & 3
23. How many subnets can be formed by using the following subnet mask in a class B network?  
Subnet mask = 255.255.248.0  
(A) 28                      (B) 30                      (C) 31                      (D) 32
24. The mechanism in which we send the data along with the acknowledgement in TCP is  
(A) Flow control                      (B) Piggy backing  
(C) Nagle's Algorithm                      (D) Karn's Algorithm
25. A class B address has the subnet mask of 255.255.224.0. What is the IP address of the second host in the second sub-network of the main network address 132.55.0.0?  
(A) 132.55.0.1                      (B) 132.55.32.2                      (C) 132.55.64.1                      (D) 132.55.64.2
26. Assume that one TCP packet has been transmitted from sender to receiver. What happens when TCP timeout happens at the sender side before receiving the ACK?  
(A) It is required for the sender to retransmit the identical packet (same as before) again even though it has a bigger packet.  
(B) The sender can perform repacketization and send a bigger packet  
(C) The sender first retransmits the first byte of the packet and then retransmits the remaining packets after getting the ACK for the first byte  
(D) None of these

**Common Data Questions: 27 & 28**

In a network that has maximum TPDU size of 128 bytes, a maximum TPDU life time of 20 sec and an 8-bit sequence number is used.

27. What is the maximum data rate per connection?  
(A) 12.75kbps                      (B) 8kbps                      (C) 50kbps                      (D) 255kbps
28. What is the percentage of reduction in the data rate per the connection, if the TPDU maximum life time is 30 sec?  
(A) 38%                      (B) 32%                      (C) 33.33%                      (D) 40%

**Statement for Linked Answer Questions: 29 & 30**

Consider an organization with a class-C IP network address of 195.37.5.0, they wish to divide the network into different sub networks. The subnet mask is 255.255.255.192

29. Which one of the following is not a broadcast address in any of the sub network?  
(A) 195.37.5.127 (B) 195.37.5.191 (C) 195.37.5.31 (D) 195.37.5.255
30. The correct IP address belongs to  
(A) The first sub network (B) The second sub network  
(C) Third sub network (D) Fourth sub network



**Answer Keys**

|    |   |    |   |    |   |    |   |    |   |    |   |    |   |
|----|---|----|---|----|---|----|---|----|---|----|---|----|---|
| 1  | B | 2  | C | 3  | C | 4  | C | 5  | A | 6  | C | 7  | C |
| 8  | C | 9  | D | 10 | B | 11 | C | 12 | D | 13 | C | 14 | B |
| 15 | D | 16 | A | 17 | D | 18 | C | 19 | D | 20 | D | 21 | C |
| 22 | C | 23 | D | 24 | B | 25 | B | 26 | A | 27 | A | 28 | C |
| 29 | C | 30 | A |    |   |    |   |    |   |    |   |    |   |

**Explanations:-**

1. The following are the sequence of messages being exchanged between host and the DHCP server  
 Host broadcasts "DHCP discover" msg  
 DHCP server responds with "DHCP offer" msg  
 Host requests IP address: "DHCP request" msg  
 DHCP server sends address: "DHCP ack" msg
2. Flow control and Reliable data transfer are not provided by UDP
3. TCP does not guarantee both "delay" and "bandwidth".
7.  $224 = 11100000$ , using 5-bits,  $2^5 - 2 = 32 - 2 = 30$
10. RSA is a public key cryptographic algorithm and all others are symmetric key algorithms
11. Subnet id = 255.255.255.11100000  
 Using 3-bits, we can provide  $2^3$  subnets using 5 bits. We can provide,  $2^5 - 2$  hosts. So 8,30
14. Multicast address is a class 'D' address.
15. 192.168.1.0 – This is a class 'C' address and hence the hostid=0 is not valid.  
 111.222.12.256 – Here 256 is not a valid octet.  
 241.1.1.254 – This is a class 'E' address, which is reserved.
16. 152.45.00100000.0001110  
 255.255.11110000.00000000  
 152.45. 0010 0000.00000000  

↓  
Subnet id

↓  
Host id

Broadcast Address is 152.45.00101111.11111111

↓  
Broadcast

So it is 152.45.47.255

18. Computer Crime is an illegal action in which the preparatory uses special knowledge of computer technology.
19. The minimum IP packet header size = 20 bytes  
The maximum IP packet header size = 60 bytes  
Number of bytes remaining for options = 40 bytes  
The no. of bytes required for the record route option header = 3 bytes  
Number of bytes remaining for IP addresses = 37 bytes  
Since each IP address requires 4 bytes, we can store maximum of 9 IP addresses in the optional part of IP header
21. 194.43.75.128, 194.65.73.64 are subnetwork Addresses, since the host part (last 6 bits) are all 0's
22. Both SNMP and DNS run on UDP. HTTP runs on TCP.
23.  $2^5=32$   
Number of sub networks=32  
We need to subtract 2 only when we need to find the number of hosts
25. subnet mask 255.255.11100000.0  
first subnetwork Address is 132.55.0.0  
first host in first subnetwork is 132.55.0.1  
second subnetwork address is 132.55.32.0  
second subnet and second host is 132.55.32.2
26. When timeout occurs, it retransmits
27. Sender cannot send more than 255 TPDU'S.  
i.e.,  $255 \times 128 \times 8$  bits per 20 sec  
 $1 \text{ sec} = \frac{255 \times 128 \times 8}{20} = 12.75 \text{ kbps}$   
255 is the maximum since we use 8 bits for sequence number

28.  $255 \times 128 \times 8$  bits per 30 sec

$$1\text{sec} = \frac{255 \times 128 \times 8}{30} = 8.5 \text{ kbps}$$

$$\text{Difference } 12.75 - 8.5 = 4.25$$

$$\text{Percentage of Reduction} = \frac{4.25}{12.75} \times 100 = 33.33\%$$

29. Options A, B & D are broadcast Addresses

Since the host part 2 bit are taken for sub network

$$01 - 11 \ 11 \ 11 = 127$$

$$10 - 11 \ 11 \ 11 = 191$$

$$11 - 11 \ 11 \ 11 = 255$$

$$00 - 01 \ 11 \ 11 = 31$$

This is not Broadcast Address since the last 6 bits are not ones

30. The above host belonging to the first sub network

00 – first sub network

01 – Second sub network

10 – Third sub network

11 – Fourth sub network

# Software Engineering and Web Technology

## Computer Science Engineering

Test ID: 

|   |   |   |   |
|---|---|---|---|
| 2 | 1 | 4 | 3 |
|---|---|---|---|

Duration: 90 minutes

Maximum Marks: 50

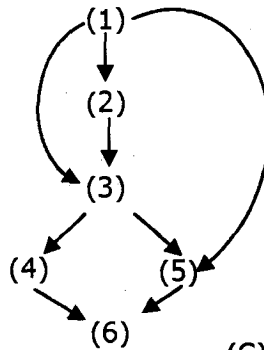
---

### Read the following instructions carefully:

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4. Questions must be answered on Objective Response Sheet (ORS) by darkening the appropriate bubble (marked A, B, C, D) using HB pencil against the question number on the left hand side of the ORS. **Each question has only one correct answer.** In case you wish to change an answer, erase the old answer completely. More than one answer bubbled against a question will be treated as a wrong answer.
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10. Calculator without data connectivity is allowed in the examination hall. Charts, graph sheets or tables are NOT allowed in the examination hall.
11. Rough work can be done on the question paper itself.

**Q. No. 1 – 10 Carry One Mark Each**

1. Suppose, flow graph contains 14 nodes and its cyclometric complexity is 5, then the number of edges of that flow graph is  
(A) 12 (B) 14 (C) 17 (D) 8
2. A 20 KDSI embedded programs for teleprocessing is to be developed. Find the time required for the project using basic COCOMO model.  
(A) 24 months (B) 18 months (C) 12 months (D) None of these
3. Functional testing is also known as  
(A) Black box testing (B) White box testing  
(C) Unit testing (D) None of these
4. A project takes 20days to be completed with the help of 15 engineers. Now the number of engineers gets doubled; can you assure that now the project will be completed quickly?  
(A) Always (B) Never (C) Cannot say (D) No Change
5. Which parameter is not necessary for calculation of UFP?  
(A) Number of inquiries (B) Number of interfaces  
(C) Number of lines of code (D) Number of files
6. Compute the below cyclometric complexity.



- (A) 4 (B) 3 (C) 2 (D) 1
7. Let us assume software tested by error sending technique. Let the number of seeded error are 400, seeded errors found are 200. The same test suit defected 100non seeded errors. So find the remaining defects.  
(A) 60 (B) 100 (C) 120 (D) None of these
  8. In client Server computing how user can send request to the server?  
(A) Through browser (B) Through Notepad  
(C) Through web server (D) None of these

9. Who will process the client request?  
(A) Client (B) Server programs  
(C) Both server and client (D) None of these
10. What is the availability of software with the following reliabilities?  
Mean time between failure (MTBF) = 25days  
Mean Time to repair (MTTR) = 6hour  
(A) 1% (B) 24% (C) 99% (D) None of these

**Q. No. 11 – 30 Carry Two Marks Each**

11. Consider the execution of the following commands in a shell on a Linux operating system.  
Bash \$ cat alpha  
History  
Bash\$ in alphabeta  
Bash\$ rm alpha  
Bash\$ cat >> beta << same  
Computer Science  
Same  
Bash \$ cat beta  
The output of the last command is  
(A) History Computer Science Same (B) History Computer Science  
(C) Computer Science (D) Computer Science Same
12. Which one is not features of XML?  
i) Its simultaneously human and machine-read able format  
ii) It has support for Unicode  
iii) The strict syntax and passing requirements that allow the necessary passing algorithms to remain simple, efficient and consistent  
(A) Only (i) (B) Only (i) & (ii) (C) All three (D) None of these
13. Which of the following is true?  
(A) Every XML document does not have any root element  
(B) Every XML document must have only non root element  
(C) Every XML document must have two root elements  
(D) Every XML document must have three root elements

14. In a certain software company, software development cost is \$20,000. During a financial year 2009-2010, there are 1000 kilo lines of code added during maintenance and during maintenance 50 kilo lines of codes were deleted. If original

code consisted of 4000 kilo lines of code in year 2009, then find the total maintenance cost of the software during 2009-2010.

- (A) \$5250                      (B) \$5000                      (C) \$2500                      (D) None of these

15. DA Let us assume a software tested by error seeding technique; Let  $N$  be the total number of defects in the system and let  $n$  of these defects be found by testing. Let  $S$  be the total number of seeded defects, and let  $s$  of these defects be found during testing.

Which of the following denotes defects still remaining after testing?

- (A)  $n \times (S - s) / s$                       (B)  $n \times S - s$                       (C)  $(N \times S) / s$                       (D)  $(N - n) / s$

16. Which is not the server side technology?

- (A) ASP                      (B) JSP                      (C) JavaScript                      (D) PHP

17. Data validation at the client is done by using

- (A) JSP                      (B) ASP                      (C) JavaScript                      (D) Servlets

18. Reading from file - A and write it into file B is

- (A) logical                      (B) temporal                      (C) procedural                      (D) functional

19. Which of the following module is created to convert a bit map file to Jpeg format?

- (A) Temporal                      (B) Functional                      (C) Procedural                      (D) Logical

20. Which one is correct?

(1) `<NAME>Write name here</NAME>`

(2) `<name>Write name here</name>`

- (A) Only 2                      (B) Only 1                      (C) Both 1 & 2                      (D) None of these

21. Choose correct syntax for making a submit button

(1) `<form action=""> <input type="submit" name="s1" value=" Press " /> </form>`

(2) `<input type="submit" name="s1" value=" submit " />`

(3) `<form action=""> </form>`

(4) `<form action=""> <input type="button" name="s1" value=" Submit " /> </form>`

- (A) Only 2                      (B) Only 1                      (C) Both 1 & 2                      (D) None of these

22. How do you link an image to something?

(1) `<a href=""></a>`

(2) `<a href=""><img src=""></a>`

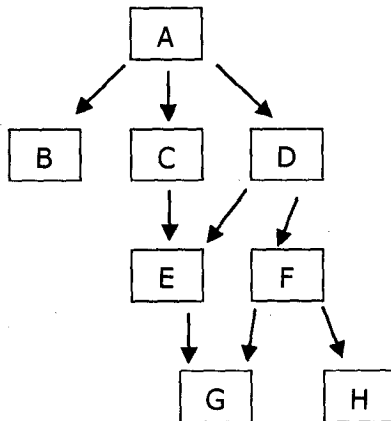
(3) `<a src=""></a>`

- (A) Only 2                      (B) Only 1                      (C) Both 1 & 2                      (D) None of these

23. The client's responsibility is usually to  
(A) Listen for a client's query  
(B) Process that query  
(C) Return the results back to the client  
(D) Translate the user's request into the desired protocol
24. What is the correct HTML for adding a background color?  
(A) <background>yellow</background>  
(B) <body style="background-color: yellow">  
(C) <body bgcolor="yellow">  
(D) <body background="s.gif">
25. Which of the following is correct?  
(A) <?xml version="1.0"?> (B) <xml version="1.0">  
(C) <?xml version="1.0"/> (D) <xml version="1.0">
26. In GET method data is  
(A) Not appended to url (B) Not secret  
(C) Not faster for transmission (D) None of these

**Common Data Questions: 27 & 28**

Consider the following:



27. Span of control for A is  
(A) 0 (B) 3 (C) 2 (D) 1
28. Fan-in of E is  
(A) 0 (B) 1 (C) 2 (D) 3



**Statement for Linked Answer Questions: 29 & 30**

To release the mark sheet the necessary thing is calculating total marks and identify the grade from the total marks.

29. The release of mark sheet is a
- |                         |                         |
|-------------------------|-------------------------|
| (A) Temporal cohesion   | (B) Procedural cohesion |
| (C) Sequential cohesion | (D) Functional cohesion |
30. All the actions on the file is
- |                     |                |
|---------------------|----------------|
| (A) Communicational | (B) Procedural |
| (C) Temporal        | (D) Logical    |

**Answer Keys**

|    |   |    |   |    |   |    |   |    |   |    |   |    |   |
|----|---|----|---|----|---|----|---|----|---|----|---|----|---|
| 1  | C | 2  | C | 3  | C | 4  | C | 5  | C | 6  | A | 7  | B |
| 8  | A | 9  | B | 10 | C | 11 | B | 12 | C | 13 | B | 14 | A |
| 15 | A | 16 | C | 17 | C | 18 | C | 19 | B | 20 | A | 21 | B |
| 22 | A | 23 | D | 24 | C | 25 | A | 26 | B | 27 | B | 28 | C |
| 29 | C | 30 | A |    |   |    |   |    |   |    |   |    |   |

**Explanations:-**

1. Complexity =  $\begin{matrix} \text{E} \\ \downarrow \\ \text{Number of edges} \end{matrix} - \begin{matrix} \text{N} \\ \downarrow \\ \text{Number of nodes} \end{matrix} + 2$

$$5 = E - 14 + 2$$

$$E = 12 + 5 = 17$$

2. Person month =  $3.6 \times (20)^{1.2} = 131\text{PM}$

$$T_{\text{DEV}} (\text{Time for development}) = 2.5 \times (131)^{0.32} = 11.89 = 12 \text{ months}$$

4. Sometimes we can't predict

6. Number of cycle=1

$$\therefore \text{Total cycles} = 3$$

$$\therefore \text{Cyclometric complexity} = 3 + 1 = 4$$

7.  $S = 400$

$$s = 200$$

$$n = 100$$

$$\text{Remaining error} = \frac{n(S-s)}{s} = \frac{100(400-200)}{200}$$

10.  $\text{MTBF} = \text{MTTF} + \text{MTTR}$

$$\text{Availability} = (\text{MTTF}/\text{MTBF}) \times 100\%$$

$$25 \text{ days} = 600\text{Hrs} \quad \therefore \text{Availability} = \frac{600-6}{600} \times 100 = 99\%$$

14. Estimation of maintenance cost

Annual change traffic (ACT)

$$ACT = \frac{KLOC_{added} + KLOC_{deleted}}{KLOC_{total}}$$

KLOC added → kilo lines of code added during maintenance

KLOC deleted – total KLOC deleted during maintenance

$$\text{Total cost} = (ACT_{cost}) = \frac{(1000 + 50)}{4000} \times 20,000 = \$5250.$$

15.  $n/N = s/S$  or  $N = S \times n/s$

Defects still remaining after testing =  $N - n = n \times (S - s)/s$

27. Span of control means number of intermediate subordinates.
28. Fan in means number of modules that call a particular module.

# Verbal Ability

## Computer Science Engineering

Test ID: 

|   |   |   |   |
|---|---|---|---|
| 3 | 1 | 4 | 4 |
|---|---|---|---|

Duration: 90 minutes

Maximum Marks: 50

---

### Read the following instructions carefully:

1. Write your roll number, your name and name of the examination center at the specified locations of the ORS.
2. Using HB pencil, darken the appropriate bubble under each digit of your registration number and the letters corresponding to your paper code.
3. All the questions in this question paper are of objective type.
4. Questions must be answered on Objective Response Sheet (ORS) by darkening the appropriate bubble (marked A, B, C, D) using HB pencil against the question number on the left hand side of the ORS. **Each question has only one correct answer.** In case you wish to change an answer, erase the old answer completely. More than one answer bubbled against a question will be treated as a wrong answer.
5. This question paper contains 30 objective type questions. Q.1 to Q.10 carry **one** mark each and Q.11 to Q.30 carry **two** marks each.
6. Un-attempted questions will carry zero marks.
7. **NEGATIVE MARKING:** For Q.1 to Q.10, 1/3<sup>rd</sup> mark will be deducted for each wrong answer. For Q. 11 to Q.30, 2/3<sup>rd</sup> mark will be deducted for each wrong answer.
8. Calculator without data connectivity is allowed in the examination hall. Charts, graph sheets or tables are NOT allowed in the examination hall.
9. Rough work can be done on the question paper itself.

**Q. No.1–10 Carry One Mark Each**

**DIRECTIONS:** Choose the answer key corresponding to the word with a meaning most nearly similar to the meaning of word in capital letters.

1. INCARCERATION  
(A) imprisonment (B) degeneration (C) poverty (D) assault
2. RETRIBUTION  
(A) allotment (B) repayment (C) revenge (D) homage
3. LUDICROUS  
(A) jealous (B) handsome (C) absurd (D) circular
4. REGALE  
(A) restore (B) fly (C) revitalize (D) amuse
5. VILIFY  
(A) soothe (B) defame (C) rectify (D) magnify

**DIRECTIONS:** Choose the answer key corresponding to the word with a meaning most nearly opposite to the meaning of word in capital letters.

6. PRECIPITOUS  
(A) gentle (B) steep (C) consolidated (D) porous
7. LURID  
(A) sensational (B) bland (C) torrid (D) complicated
8. Exacerbate  
(A) exasperate (B) instigate (C) improve (D) intimate
9. BRUSQUE  
(A) civil (B) invoke (C) repent (D) involve
10. VAPID  
(A) tranquil (B) insipid (C) stimulating (D) lethargic

**Q. No.11-30 Carry Two Marks Each**

**Directions:** In each of the sample questions, a related pair of words is followed by four lettered pairs of words. Click on the lettered pair that best expresses a relationship similar to that expressed in the original pair.

**11. MENDACITY : HONESTY ::**

- |                                      |                           |
|--------------------------------------|---------------------------|
| (A) courage : cravenness             | (B) courage : fortitude   |
| (C) unsophistication : ingenuousness | (D) turpitude : depravity |

**12. MEANDERING : DIRECTNESS ::**

- |                              |                              |
|------------------------------|------------------------------|
| (A) menacing : ambition      | (B) affable : permissiveness |
| (C) digressive : conciseness | (D) circuitous : rotation    |

**13. PERJURY : OATH ::**

- |                            |                          |
|----------------------------|--------------------------|
| (A) plagiarism : authority | (B) embezzlement : trust |
| (C) disrespect : age       | (D) testimony : court    |

**14. SNICKER : DISRESPECT ::**

- |                          |                        |
|--------------------------|------------------------|
| (A) whimper : impatience | (B) chortle : glee     |
| (C) frown : indifference | (D) sneer : detachment |

**15. DRUDGERY : IRKSOME ::**

- |                              |                         |
|------------------------------|-------------------------|
| (A) encumbrance : burdensome | (B) journey : wearisome |
| (C) ambivalence : suspicious | (D) compliance : forced |

**Directions:** Each question has a set of four words. Choose the word that does not belong to the group.

**16. LAUGHTER**

- |             |           |             |            |
|-------------|-----------|-------------|------------|
| (A) chuckle | (B) snort | (C) snigger | (D) cackle |
|-------------|-----------|-------------|------------|

**17. GOLD**

- |          |           |            |           |
|----------|-----------|------------|-----------|
| (A) rose | (B) green | (C) orange | (D) white |
|----------|-----------|------------|-----------|

**18. COW**

- |            |            |           |              |
|------------|------------|-----------|--------------|
| (A) bovine | (B) bellow | (C) force | (D) contract |
|------------|------------|-----------|--------------|

**19. CALCULUS**

- |                |            |                 |                 |
|----------------|------------|-----------------|-----------------|
| (A) limitation | (B) tartar | (C) integration | (D) distinction |
|----------------|------------|-----------------|-----------------|

20. PLANE  
(A) simplicity (B) aircraft (C) level (D) tool

**DIRECTIONS:** Each sentence below has two blanks; each blank indicates that something has been omitted. Beneath the sentence are four lettered words. Choose the word for each blank that best fits the meaning of the sentence as a whole.

21. The proposal, which resembles one developed through a similar partnership in New haven, does away with the \_\_\_\_\_ evaluation system under which teachers are observed briefly in the classroom and even the most ineffective ones regularly receive \_\_\_\_\_ ratings.  
(A) contemporary - infallible (B) dubious - punctual  
(C) shoddy - glowing (D) plausible - jeopardizing
22. Like all other living things found on this planet, Swans too have \_\_\_\_\_ ancestors, and some of the fossils are found to be bigger than \_\_\_\_\_ local dwarf elephants.  
(A) enigmatic - majestic (B) pre-historic - contemporary  
(C) untraceable - ubiquitous (D) myriad - vulnerable
23. Foreign adventures and the colonial wealth it brings with it enriches a merchant class to display its might with opulent new homes outside the city's inner core.  
(A) It brings with it enriches a merchant class to display its might with  
(B) They brought with them enriched a merchant class eager to display its might with  
(C) Brought with themselves enriched merchant class eager to display their might of  
(D) Bringing with them enriched merchant class eagerly displaying their might with
24. Since open Arctic waters can be a boon for ships, fishing and oil exploration, an annual seesawing between ice and no ice could be a particularly harsh jolt to polar bears.  
(A) Since open Arctic waters can be a boon for ships  
(B) Because open Arctic waters could be a boon for shipping  
(C) While open Arctic waters could be a boon for shipping  
(D) As open Arctic waters could be boon for shipping
25. Delirium can cause not only aggressive but also disruptive patients or incoherent, it can also manifest itself in much less obvious ways, making a patient seem withdrawn or disconnected.  
(A) Delirium can cause not only aggressive but also disruptive patients  
(B) When patients become aggressive and disruptive due to delirium  
(C) While delirium causes aggressiveness and disruption to patients  
(D) While delirium can cause patients to become aggressive, disruptive

**Directions: Each of the following questions is based on a short argument, a set of statements, or a plan of action. For each question, select the best answer of the choices given.**

26. On investigation, the traffic police department concluded that motor cycles of Durgapur are, on average, slightly less likely to be involved in a collision than in Samanthpur. However, for similar motor cycles and drivers with comparable skills and age groups, automobile insurance for collision damage always costs more in Durgapur than in Samanthpur. Hence it is obvious that the insurers of collision damage in Durgapur are at a fairly big disadvantage vis-a-vis their counterparts in Samanthpur.

In evaluating the given argument, it would be more useful to compare

- (A) The condition of Samanthpur's roads and streets with that of Durgapur's roads and streets.
  - (B) The cost of repairing collision damages in Samanthpur with the corresponding cost in Durgapur.
  - (C) The cost of collision-damage insurance in Durgapur and Samanthpur with that in other cities.
  - (D) The level of traffic congestion in of Durgapur and Samanthpur.
27. Ever since Lloyd's automobile division amalgamated with the electronics division in 2007, the company has been performing consistently well; in each of the last three years, the automobile division has accounted for 25 per cent of rupee sales and 45 per cent of the electronics division for the remaining.
- Which of the can properly be inferred regarding the past three years from the statement above?
- (A) The electronics division has realized lower profits per rupee of sale than has the automobile division.
  - (B) The product mix offered by each of the company's divisions has not changed.
  - (C) Total rupee sales for each of the company's divisions have roughly remained constant.
  - (D) The automobile division has faced stiffer competition than has the electronics division.
28. Pilotless aircraft before being deployed into real-time conditions are tested with the help of a robot. However, since the experiment involves huge expenditure, it is sometimes essential to send a pilot to monitor any contingent maintenance job during the flight rather than post landing. Without this measure, the aircraft faces a high risk of air collapse and consequently enormous amounts of public funds are wasted. Therefore, even the pilotless aircraft should be manned by a pilot.
- Which of the following if true would most seriously weaken the argument above?
- (A) Repair of aircraft requires heavy equipment, which adds to the amount of fuel needed to lift an aircraft carrying pilot
  - (B) Technical obsolescence of robot aircraft makes repairing them more costly and less practical than sending new, improved aircraft
  - (C) Aircraft falling from air because of malfunctions burn up in the atmosphere
  - (D) The government responding to public pressures has decided to cut the budget for such flights and put more money into social welfare programs



29. Lidah Buaya is considered panacea in curing most infections as well as in nature-cure treatment. However, the extract from the plant is so vital that to make one hundred gram ointment from the plant, it requires cutting at least two thousand plants. Proponents of environmental safety thus apprehend that further production of ointment inevitably leads to extinction of Lidah Buaya.
- Which of the following if true, most seriously weakens the argument above?
- (A) The Lidah Buaya can be propagated from cuttings and grown under cultivation
  - (B) The drug made from Lidah Buaya is very popular among women since it serves as a cosmetic as well
  - (C) The roots of the Lidah Buaya are used in a number of medical products
  - (D) The ointment made from Lidah Buaya is fragrant but expensive to produce
30. In an attempt to reconcile the governors of two states, the mediator has expounded a theory from economics, according to which, states closed out any of another state's markets should close some of their own markets to the other state in order to pressure the other state to reopen its markets.
- The mediator's argument relies on which of the following assumptions?
- (A) Inter- state disputes can be easily settled through an arbitrator
  - (B) No state should block any of its markets to its neighboring state
  - (C) For any two states, at least one has some market closed to the other
  - (D) It is highly unlikely to find any state adopting such a policy

**Answer Keys**

|    |   |    |   |    |   |    |   |    |   |    |   |    |   |
|----|---|----|---|----|---|----|---|----|---|----|---|----|---|
| 1  | A | 2  | C | 3  | C | 4  | D | 5  | B | 6  | A | 7  | B |
| 8  | C | 9  | A | 10 | C | 11 | A | 12 | C | 13 | B | 14 | B |
| 15 | A | 16 | A | 17 | C | 18 | D | 19 | B | 20 | A | 21 | C |
| 22 | B | 23 | B | 24 | C | 25 | D | 26 | B | 27 | A | 28 | B |
| 29 | A | 30 | C |    |   |    |   |    |   |    |   |    |   |

**Explanations:**

11. Mendacity (deliberate untruthfulness) means not to have honesty and courage means not to have cravenness (lacking in courage as to be worthy of contempt).
12. To be meandering (to follow an indirect route or course, especially one with a series of twists and turns) is not to have directness.
13. Perjury (the telling of a lie after having taken an oath to tell the truth, usually in a court of law) leads to breach of oath as embezzlement (to take for personal use money or property that has been given on trust by others, without their knowledge or permission) leads to breach of trust.
14. To snicker is to laugh disrespectfully and to chortle is to laugh gleefully.
15. Drudgery (unpleasant work) is characterized by irksome nature as encumbrance (burden) is characterized by burdensome nature.
16. The other words refer to laughter in a negative way. Chuckle means to laugh in a kind and thoughtful manner.  
 Snort: a snob expressing disapproval.  
 Snigger: insensitive, unsympathetic and immature.  
 Cackle: loud, ape-like shrieks, enjoying the misfortune of others.  
 Chuckle: kind and thoughtful.
17. Gold used in jewellery can be in any of the given colors except in orange.
18. Cow refers to all of the given choices except contract.
19. Calculus refers to tartar in dentistry and others in mathematics but not distinction.
20. A plane is not similar to plain.  
 A plane can be a carpenter's tool or airplane or a level.
21. Is the best option. There is a sharp contrast between present and the new proposal and the problem is - ineffective ones are getting good grades.
22. Is the best option. The clue is fossils which correctly matches with pre-historic. The other choices are far from logical.

23. Is the best option. The pronoun **they** refers to foreign adventures and **it** to class. Subject –verb agreement is correctly maintained in (B).
24. Is the best choice since it correctly maintains the parallelism with shipping – fishing as well as **could be** in the second part. Also it shows the correct contrast using **while**. Other choices incorrectly use causatives like as, since etc.
25. The best choice is (D).The sentence involves two important testing points. First, parallelism with the words **can** as well as **incoherent**-so the other two words should be **can** and **adjectives**. Second, to show a contrast with the flip side of effects of delirium, **while** is required.
26. The best choice is (B).The profitability of the insurers depends on the cost of repairing the collision damages, in the two given places.
27. Is the best option. If the information in the given passage is true, then this must also be true.
28. Is the best choice .This is precisely the information that challenges the assumption in the argument that there is no good alternative to repairing the aircraft.
29. The best choice is (A).This is the statement that most weakens the given argument.
30. The best choice is (C). This statement properly identifies the assumption required for the given argument.

# Numerical Ability

## Computer Science Engineering

Test ID: 

|   |   |   |   |
|---|---|---|---|
| 3 | 1 | 4 | 5 |
|---|---|---|---|

Duration: 90 minutes

Maximum Marks: 50

---

### Read the following instructions carefully:

1. Write your roll number, your name and name of the examination center at the specified locations of the ORS.
2. Using HB pencil, darken the appropriate bubble under each digit of your registration number and the letters corresponding to your paper code.
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6. Un-attempted questions will carry zero marks.
7. **NEGATIVE MARKING:** For Q. 1 to Q. 10,  $1/3^{\text{rd}}$  mark will be deducted for each wrong answer. For Q. 11 to Q. 30,  $2/3^{\text{rd}}$  mark will be deducted for each wrong answer.
8. Calculator without data connectivity is allowed in the examination hall. Charts, graph sheets or tables are NOT allowed in the examination hall.
9. Rough work can be done on the question paper itself.

**Q. No.1–10 Carry One Mark Each**

1. If x is 50% larger than z and y is 25% larger than z, then x is what percent larger than y?  
(A) 10% (B) 20% (C) 15% (D) 25%
2. If A is 30% of B, B is 20% of C and D is 50% of C, then the ratio of A to D is  
(A) 3:10 (B) 4:45 (C) 2:17 (D) 3:25
3. Henry lent a sum of money to Joseph at the rate of 5.75% per annum. Henry cleared the debt by paying Rs. 8932.5 at the end of 8 years and 6 months. If Henry borrows the same sum of money from Joseph at the rate of 8.5% per annum, then how much would Henry need to return at the end of 5 years and 9 months?  
(A) Rs. 9548.50 (B) Rs. 8535.50 (C) Rs. 9150 (D) None of these
4. If 1 is added to the denominator and subtracted from the numerator, the fraction becomes  $\frac{1}{2}$ . If 1 is added to the numerator and subtracted from the denominator, then it becomes 1. Find the fraction.  
(A)  $\frac{5}{7}$  (B)  $\frac{3}{5}$  (C)  $\frac{5}{8}$  (D)  $\frac{4}{7}$
5. The product of n positive real numbers is 1. What can we tell about the sum of those positive real numbers?  
(A) 1 (B) multiple of n  
(C) Never less than n (D) always greater than n
6. A fair die is tossed thrice. Given that the sum of the numbers on the first two tosses are equal to the number on the third toss. Find the probability that at least one 3 is tossed.  
(A)  $\frac{3}{8}$  (B)  $\frac{2}{5}$  (C)  $\frac{7}{15}$  (D) None of these
7. If a, b and c are real numbers such that  $(a-2)^2 + (b+5)^2 + (c-3)^2 = 0$ , then find the value of a+b+c.  
(A) 10 (B) 1 (C) 0 (D) 3
8. Find the average of the first 150 terms of the sequence 1, -2, 3, -4, 5,.....  
(A) 50 (B) -75 (C) -50 (D) -100
9. How many two digit numbers when reversed and added to the original number results in a perfect square?  
(A) 8 (B) 20 (C) 15 (D) 12
10. Which one of the following numbers can be expressed as the sum of 100 consecutive positive integers?  
(A) 2345678910 (B) 4692587550 (C) 3579111300 (D) 5815849275

**Q. No.11-30 Carry Two Marks Each**

11. Ram, Rahim and Robert can do a piece of work in 20 days, 30 days and 60 days respectively. If Rahim and Robert help Ram on every 3<sup>rd</sup> day, then how long will it take for them to complete the work?  
(A) 10 (B) 20 (C) 15 (D) 18
12. Let x, y and z are three real numbers satisfying the relations  $1001z - 2002x = 4004$  and  $1001y + 3003x = 2005$ . Find the average of the numbers x, y and z.  
(A) 9 (B) 4 (C) 3 (D) None
13. If  $p+1 = q+2 = r+3 = s+4 = p+q+r+s+5$ , then find the value of  $p+q+r+s$ .  
(A)  $7/2$  (B)  $5/3$  (C)  $11/3$  (D)  $4/3$
14. A sum of money lent at compound interest triples in eight years. In how many years will it become 3 times at the same rate of interest?  
(A) 300 (B) 400 (C) 800 (D) 1000
15. For which of the following value of k, does the equation  $\frac{x-2}{x-1} = \frac{x-k}{x-6}$  have no solution for x?  
(A) 4 (B) 5 (C) 8 (D) 2
16. Two shopkeepers, Aaya Ram and Gaya Ram, sell each a similar article for Rs. 600. Aaya Ram computes his profit on selling price while Gaya Ram computes his profit on cost price. If each of them computes their profit percentages as 20%, then by how much is the profit made by Aaya Ram greater than that of Gaya Ram(in Rs.)?  
(A) 10 (B) 20 (C) 15 (D) 25
17. If chocolates are bought at the rate of 6 for Rs.10, then how many chocolates must be sold for Rs. 9 so as to gain 35%?  
(A) 2 (B) 3 (C) 4 (D) 5
18. Find the least number, which when divided by 2,3,4,5 and 6 leaves remainder 1 in each case, but when divided by 7 leaves no remainder.  
(A) 347 (B)  $240\frac{1}{2}$  (C) 343 (D) 301
19. Which term of the sequence 20, 17, 14,..... is the first negative term?  
(A) 18 (B) 25 (C) 30 (D) 22
20. Two costumers Pooja and Seema are visiting a particular shop in the same week (Tuesday-Saturday). Each is equally likely to visit the shop on any day. What is the probability that both will visit the shop on consecutive days?  
(A)  $4/11$  (B)  $1/3$  (C)  $8/25$  (D)  $3/8$

21. Two cars race around a circular track at constant speeds starting at the same point. If they travel in same direction, then they meet in 5 minutes and if they travel in opposite direction, then they meet every 60 seconds. If the length of the track is 3000m, then find the speed of the fastest car (in m/sec).  
(A) 30 (B) 20 (C) 25 (D) 40
22. Working alone, Anand and Bhupal can build a wall in 12 hours and 8 hours respectively. If they work together, they can build the wall in 6 hours. Since, they sometimes get in each other's way, they build 15 bricks less per hour than they would if they did not get in each other's way. Find the number of bricks in the wall.  
(A) 280 (B) 480 (C) 240 (D) 360
23. In a colony, it is observed that 51 people watch movie on Monday, 60 on Tuesday and 73 on Wednesday. Of those who watch movie on only one of the days, 25 chose Monday, 32 chose Tuesday and 43 chose Wednesday. If each person watches at least one of the days and 12 watches on all the three days, then find the number of people residing in the colony.  
(A) 125 (B) 180 (C) 136 (D) 200
24. The letters of the word TUESDAY are arranged in a row at random. Find the probability that there are exactly two letters between U and D.  
(A)  $\frac{1}{8}$  (B)  $\frac{4}{21}$  (C)  $\frac{1}{5}$  (D)  $\frac{3}{22}$
25. Simplify  $(1 \times 1!) + (2 \times 2!) + (3 \times 3!) + \dots + (99 \times 99!)$ .  
(A)  $100! - 1$  (B)  $99!$  (C)  $100! - 100$  (D)  $99! - 99$
26. From a container of milk containing 50 liters, 10 liters are drawn out and the container is filled up with water. The same process is repeated for three times. What will be the quantity of milk left after the 3<sup>rd</sup> operation (in liters)?  
(A) 22.5 (B) 28.5 (C) 34.8 (D) 25.6

**Directions for Questions: 27 & 28**

**Directions:** Each question is followed by two statements, i and ii. Answer each question using the following instructions:

**Choose A;** if the question can be answered by using one of the statements alone, but cannot be answered using the other statement alone.

**Choose B;** if the question can be answered by using either of the statements alone

**Choose C;** if the question can be answered by using both the statements together, but cannot be answered using either of the statements alone.

**Choose D;** if the question cannot be answered even by using both the statements together

27. If  $p$  and  $q$  are real numbers, then find the value of  $p^3 - q^3$ ?
- i.  $p^2 + q^2 = 0$       ii.  $p - q = 6$
28. The price of which of the articles A and B is increased more?
- i. The price of A is increased by 20%
- ii. The price of B is increased by 25%

**Directions for Questions: 29 & 30**

Following table shows the unit sales of the XYZ motorcycle in six countries over a six month period. These motorcycles are imported into each country by a third party dealer.

| Country/month | January | February | March | April | May | June |
|---------------|---------|----------|-------|-------|-----|------|
| France        | 22      | 24       | 24    | 26    | 25  | 23   |
| Italy         | 29      | 29       | 28    | 31    | 29  | 31   |
| New Zealand   | 14      | 14       | 14    | 16    | 17  | 14   |
| Canada        | 37      | 32       | 32    | 32    | 34  | 33   |
| Australia     | 40      | 44       | 36    | 47    | 47  | 46   |
| Germany       | 34      | 47       | 45    | 54    | 56  | 60   |
| Spain         | 176     | 190      | 179   | 206   | 208 | 207  |

29. What percent of the overall total was sold to the Italian importer?
- (A) 15%      (B) 12%      (C) 8%      (D) 18%
30. Which month showed biggest increase in total sales from the previous month?
- (A) February      (B) March      (C) April      (D) May



**Answer Keys**

|    |   |    |   |    |   |    |   |    |   |    |   |    |   |
|----|---|----|---|----|---|----|---|----|---|----|---|----|---|
| 1  | B | 2  | D | 3  | D | 4  | A | 5  | C | 6  | C | 7  | C |
| 8  | B | 9  | A | 10 | B | 11 | C | 12 | C | 13 | B | 14 | B |
| 15 | B | 16 | B | 17 | C | 18 | D | 19 | D | 20 | C | 21 | A |
| 22 | D | 23 | C | 24 | B | 25 | A | 26 | D | 27 | A | 28 | D |
| 29 | A | 30 | C |    |   |    |   |    |   |    |   |    |   |

**Explanations:**

1. Let  $z = 100$

Hence,  $x = 150\%$  of  $z$

$$\Rightarrow x = 150$$

$$y = 125\% \text{ of } z \Rightarrow y = 125$$

$$\text{Required Percentage} = \frac{x-y}{y} \times 100 = \frac{150-125}{125} \times 100 = \frac{25}{125} \times 100 = 20\%$$

2. Let  $C = 100$

Hence,  $B = 20$  and  $D = 50$

Also,  $A = 30\%$  of  $20 = 6$

We have,

$$\frac{A}{D} = \frac{A}{B} \times \frac{B}{C} \times \frac{C}{D} = \frac{6}{20} \times \frac{20}{100} \times \frac{100}{50} = \frac{3}{25}$$

Hence, required ratio is  $3 : 25$

3. Case (i)

Given,  $P = P$ ,  $R = 5.75\%$ ,  $T = 8\frac{1}{2}$  years and  $A = \text{Rs. } 8932.5$

Case (ii)

Given,  $P = P$ ,  $R = 8.5\%$ ,  $T = 5\frac{3}{4}$  years

Note that

(a) Principal is same in both the cases

(b) Numerical values of rate of interest in case (i) and time period in case (ii) are equal.

(c) Numerical values of time period in case (i) and rate of interest in case (ii) are equal.

In such cases, amount in case (i) must be equal to the amount in case (ii)

Hence, the required amount is Rs. 8932.5

4. Let the required fraction be  $\frac{x}{y}$

$$\text{Given, } \frac{x-1}{y+1} = \frac{1}{2}$$

$$\Rightarrow 2(x-1) = y+1$$

$$\Rightarrow 2x - y = 3 \text{ -----(1)}$$

Also, given that  $\frac{x+1}{y-1} = 1 \Rightarrow x - y = -2$  ----- (2)

Solving equations (1) and (2), we get

$x = 5$  and  $y = 7$

Hence, the required fraction is  $\frac{5}{7}$ .

5. We know that,

For any number of positive real numbers,

Arithmetic Mean  $\geq$  Geometric Mean

$\frac{\text{Sum of } n \text{ numbers}}{n} \geq \sqrt[n]{\text{Product of } n \text{ numbers}}$

$\Rightarrow \frac{\text{Sum of } n \text{ numbers}}{n} \geq \sqrt[n]{1}$

$\Rightarrow \text{Sum of } n \text{ numbers} \geq n$

Hence, choice (C) follows.

6. Given, A fair die is tossed thrice.

Also, Given that the sum of the numbers on the first two tosses is equal to the number on the third toss.

Then Sample Space,

$S = \left\{ (1,1,2), (1,2,3), (1,3,4), (1,4,5), (1,5,6), (2,1,3), (2,2,4), \right. \\ \left. (2,3,5), (2,4,6), (3,1,4), (3,2,5), (3,3,6), (4,1,5), (4,2,6), (5,1,6) \right\}$

$n(S) = 15$

Set of favourable cases be E

$E = \{(1,2,3), (1,3,4), (2,1,3), (2,3,5), (3,1,4), (3,2,5), (3,3,6)\}$

$n(E) = 7$

Required Probability =  $\frac{n(E)}{n(S)} = \frac{7}{15}$

7. Given equation is  $(a-2)^2 + (b+5)^2 + (c-3)^2 = 0$

If the sum of the squares of n numbers is equal to zero, then each of the numbers n must be zero.

Hence,  $a-2 = 0$ ,  $b+5 = 0$ , and  $c-3 = 0$

$a=2$ ,  $b=-5$  and  $c=3$

Required sum =  $a+b+c = 2-5+3=0$

8. Given sequence of numbers is 1, -2, 3, -4, 5, .....

Sum of the numbers is  $1+(-2)+3+(-4)+5+(-6)+ \dots$

$= (1+3+5+ \dots +149) - (2+4+6+ \dots +150)$

$= (\text{sum of first 75 odd numbers}) - (\text{sum of first 75 even numbers})$

$= 75^2 - (75^2+75) = -75$

9. Let the two digit number be  $10x + y$ , where  $x$  is the tens digit and  $y$  is the units digit.  
If reversed, then the number will be  $x + 10y$ , where  $y$  is the tens digit and  $x$  is the units digit.  
Now,  $(10x + y) + (x + 10y)$  has to be a perfect square.  
i.e.,  $11(x+y)$  is a perfect square.  
 $x+y$  must be 11.  
The ordered pairs  $(x, y)$  are  $(2,9), (3,8), (4,7), (5,6), (6,5), (7,4), (8,3)$  and  $(9,2)$   
Hence, the required number of two digit numbers is 8.
10. Let the numbers be  $a, a+1, a+2, a+3, \dots, a+99$   
Sum of these 100 numbers  $= \frac{100}{2}(a + a+99) = 50(2a+99)$   
 $= 50(2a+100-1) = 100(a+50) - 50$   
The last two digits of the number in the result of above expression are 50  
The number with its last two digits as 50 is in option (B)  
It can be the possible answer  
Hence, choice (B) follows
11. As Ram is helped by Rahim and Robert every third day, Ram works for 3 days while Rahim and Robert work for 1 day each in every 3 days.  
Therefore, the amount of work done in 3 days by Ram, Rahim and Robert  
 $= \frac{3}{20} + \frac{2}{30} + \frac{2}{60} = \frac{9+2+1}{60} = \frac{12}{60} = \frac{1}{5}$  of the work  
Hence, it will take them five times the amount of time  $= 3 \times 5 = 15$  days.
12. Given,  $1001z - 2002x = 4004$   
 $1001y + 3003x = 5005$   
Rewriting the given equations we have,  
 $Z-2x = 4$  -----(1)  
 $Y+3x = 5$  -----(2)  
Adding (1) and (2), we have,  $x+y+z = 9$   
Required Average  $= \frac{x+y+z}{3} = \frac{9}{3} = 3$
13. Let,  $p+1=q+2=r+3=s+4=p+q+r+s+5=k$   
 $\rightarrow p = k-1, q=k-2, r=k-3, s=k-4$   
Substituting in  $p+q+r+s+5 = k$   
We have,  $k-1+k-2+k-3+k-4+5 = k \Rightarrow 4k-5=k \Rightarrow K = 5/3$
14. Let the sum be Rs. 100  
It becomes 300 in eight years  
It becomes 900 in another eight years.  
It becomes 2700 in another eight years.  
And so on.  
Hence, it becomes  $3^{30}$  times in  $50 \times 8$  i.e., 400 years

15. Given equation is  $\frac{x-2}{x-1} = \frac{x-k}{x-6}$   
 $\Rightarrow (x-1)(x-6) = (x-2)(x-k)$   
 $\Rightarrow x^2 - 7x + 6 = x^2 - x(k+2) + 2k \Rightarrow kx - 5x = 2k - 6$   
 $x(k-5) = 2k-6 \Rightarrow x = \frac{2k-6}{k-5}$   
 The above equation yields real values if only if  $k \neq 5$   
 Hence, the required value of  $k$  is 5.
16. Aaya Ram computes his profit on selling price of Rs. 600.  
 Profit made by him = 20% of 600 = 120  
 Gaya Ram computes his profit on Cost price.  
 When he makes a profit of 20% i.e.,  $\frac{1}{5}$  of cost price, then it is equivalent to the  
 profit of  $\frac{1}{1+5} = \frac{1}{6}$  or  $16\frac{2}{3}\%$  of the selling price.  
 Profit made by him =  $16\frac{2}{3}\%$  of 600 = 100  
 Hence, the required difference is  $120 - 100 = \text{Rs. } 20$
17. The shopkeeper makes a profit of 35%.  
 This means the shopkeeper sells 6 chocolates for Rs. 135% of 10 i.e., Rs. 13.50  
 Hence, the selling price of one chocolate =  $\frac{13.5}{6} = \text{Rs. } 2.25$   
 Hence, the number of chocolates that can be sold for Rs. 9 =  $\frac{9}{2.25} = 4$
18. Required number is the multiple of 7.  
 Also, the required number is the  $k$  [LCM (2, 3, 4, 5, 6)] + 1 =  $60k + 1$   
 Required number belongs to the set  
 $\{60 \times 1 + 1, 60 \times 2 + 1, 60 \times 3 + 1, 60 \times 4 + 1, \dots\}$   
 i.e.,  $\{61, 121, 181, 241, 301, 361, \dots\}$   
 The least multiple of 7 from the above set is 301  
 Hence, the required least number is 301
19. Given Arithmetic Progression is 60, 57, 54, 51.....  
 Here,  $a = 60$   
 $d = t_2 - t_1 = 17 - 20 = -3$   
 Since, the required term is negative, we have  
 $t_n < 0$   
 $\Rightarrow 60 + (n-1)(-3) < 0 \Rightarrow 63 < 3n \Rightarrow n > \frac{63}{3}$   
 The least integer greater than  $\frac{63}{3} = 21$  is 22  
 Hence, the 22<sup>nd</sup> term is the first negative term of the given Arithmetic Progression.
20. Let P(A) be the event of visiting the shop by Pooja on a day of the week.  
 Let P(B) be the event of visiting the shop by Seema on a day of the week.

Given days of visits are Tuesday, Wednesday, Thursday, Friday and Saturday.  
Since, the probability of each of them to visit the shop on any day is equally likely,

We have,

$$P(A) = \frac{1}{5} \text{ and } P(B) = \frac{1}{5}$$

Sample space of the possibilities in which Pooja and Seema visits the shop is as follows.

$$s = \left\{ \begin{array}{l} (T, T), (T, W), (T, Th), (T, F), (T, S) \\ (W, W), (W, Th), (W, F), (W, S), (W, T) \\ (Th, Th), (Th, F), (Th, S), (Th, T), (Th, W) \\ (F, S), (F, S), (F, T), (F, W), (F, Th) \\ (S, S), (S, T), (S, W), (S, Th), (S, F) \end{array} \right\}$$

Here, abbreviations are used for Tuesday, Wednesday, Thursday, Friday and Saturday as T, W, Th, F and S respectively.

Probability that both will visit the shop on consecutive days

i.e, probability that Pooja visits shop on day X (can be any given day) and

Probability that Seema visits shop on day after X (or day before X).

The outcomes which satisfy this condition are (T, W), (W, Th), (W, T), (Th, F), (Th, W), (F, S), (F, Th), (S, F)

$$\text{Required Probability} = \frac{\text{Number of favourable outcomes}}{\text{Total number of outcomes in sample space}} = \frac{8}{25}$$

21. Let the speeds of the two cars be x m/sec and y m/sec.

When travelled in same direction, then

Relative speeds = Difference of their speeds =  $x - y$

$$\text{Time taken to meet} = \frac{\text{length of the track}}{\text{Relative Speed}}$$

$$\Rightarrow 5 \times 60 = \frac{3000}{x - y} \Rightarrow x - y = 10 \text{ ----- (1)}$$

When travelled in opposite direction, then

Relative speeds = Sum of their speeds =  $x + y$

$$\text{Time taken to meet} = \frac{\text{length of the track}}{\text{Relative Speed}}$$

$$\Rightarrow 60 = \frac{3000}{x + y} \Rightarrow x + y = 50 \text{ ----- (2)}$$

Solving (1) and (2), we have

$x = 30 \text{ m/sec}$  and  $y = 20 \text{ m/sec}$

Hence, the speed of the fastest car is 30 m/sec.

22. Let the number of bricks in the wall be x.

Hence, Anand builds  $\frac{x}{12}$  bricks per hour and Bhupal builds  $\frac{x}{8}$  bricks per hour.

Their combined speed, if they sometimes get into each other's way is  $\frac{x}{12} + \frac{x}{8} - 15$

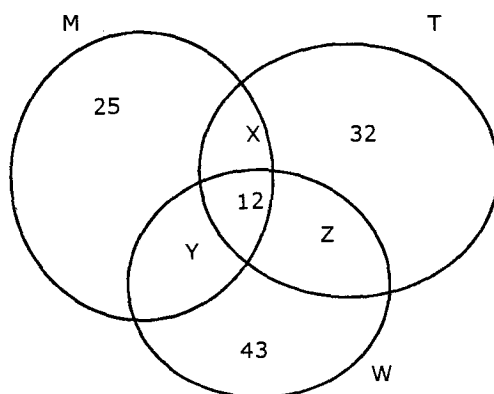
But, it is also equal to  $\frac{x}{6}$

$$\text{Hence, } \frac{x}{12} + \frac{x}{8} - 15 = \frac{x}{6} \Rightarrow x = 360$$

Therefore, the required number of bricks is 360.

23.

|                  | Total | Only one day | All three days |
|------------------|-------|--------------|----------------|
| <b>Monday</b>    | 51    | 25           | 12             |
| <b>Tuesday</b>   | 60    | 32           | 12             |
| <b>Wednesday</b> | 73    | 43           | 12             |



From the figure, we have

$$25 + x + y + 12 = 51 \Rightarrow x + y = 14$$

$$32 + x + z + 12 = 60 \Rightarrow x + z = 16$$

$$43 + 12 + x + y = 73 \Rightarrow x + y = 18$$

Adding above equations, we have  $x + y + z = 24$

Hence, the required number of people is  $25 + 43 + 32 + 12 + x + y + z = 136$

24. Let A be the event that there are exactly two letters between U and D when the letters of the word TUESDAY are arranged in a row and S be the sample space.

The seven letters of the given word can be arranged themselves in  $7!$  Ways.

Thus  $n(S) = 7!$

For the required arrangement, since there are exactly two letters between U and D, the two places between U and D can be filled with the other 5 letters first. It can be done in  $5P_2$  ways.

After filling these two places, consider the four letter arrangement from U to D as one entity and the remaining 3 letters as 3 different entities. These four entities can be arranged themselves in  $4!$  Ways. U and D can be interchanged in 2 ways.

Thus,  $n(A) = 2 \times {}^5P_2 \times 4!$

$$\text{Required probability} = \frac{n(A)}{n(S)} = \frac{2 \times {}^5P_2 \times 4!}{7!} = \frac{2 \times 5 \times 4}{7 \times 6 \times 5} = \frac{4}{21}$$

25. Consider  $1 \times 1! = (2-1) \times 1 = 2 \times 1! - 1 \times 1! = 2! - 2!$

Now,  $2 \times 2! = (3-1) \times 2! = 3 \times 2! - 1 \times 2! = 3! - 2!$

$3 \times 3! = (4-1) \times 3! = 4 \times 3! - 1 \times 3! = 4! - 3!$

.....

.....

$99 \times 99! = (100-1) \times 99! = 100 \times 99! - 1 \times 99! = 100! - 99!$

Adding all these, we have

$(1 \times 1!) + (2 \times 2!) + (3 \times 3!) + \dots + (99 \times 99!)$

$= 2! - 1! + 3! - 2! + 4! - 3! + \dots + 100! - 99! = 100! - 1! = 100! - 1$

26. The quantity of milk left after  $n$ th operation is given by  $\left(\frac{x-y}{x}\right)^n$

of the whole quantity.

Here,  $x$  is the quantity of milk present in the container initially,  $y$  is the quantity of milk withdrawn in each process and  $n$  is the number of processes.

Hence, the quantity of milk after the 3<sup>rd</sup> operation

$= \left(\frac{50-10}{50}\right)^3 \times 50 \text{ liters} = \left(\frac{4}{5}\right)^3 \times 50 = \frac{64}{125} \times 50 = 25.6 \text{ liters}$

27. Statement I

Given,  $p^2 + q^2 = 0$

This is true if  $p = 0$  and  $q = 0$

Hence,  $p^2 - q^2 = 0 - 0 = 0$

Clearly, Statement II alone is not sufficient.

Hence, choice (A) follows.

28. In each of the two statements I and II, the original prices of A and B are not given. Hence, data is not sufficient.

Hence, choice (D) follows.

29. Required percentage  $= \frac{177}{1166} \times 100 = 15\%$  (approximately)

30. Increase in total sales from January to February  $= 190 - 176 = 14$

Increase in total sales from February to March  $= 179 - 190 = -11$

Increase in total sales from March to April  $= 206 - 179 = 27$

Increase in total sales from April to May  $= 208 - 206 = 2$

Increase in total sales from May to June  $= 207 - 208 = -1$

Hence, month of April showed highest increase in sales.