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GATE 2016

Detailed Solutions For
Computer Science and Information Technology

Date: 06-02-2016
Forenoon Session

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General Aptitude

Q.1 – Q.5 carry one mark each

01. Out of the following four sentences, select the most suitable sentence with respect to grammar and usage.

(A) I will not leave the place until the minister does not meet me.

(B) I will not leave the place until the minister doesn't meet me.

(C) I will not leave the place until the minister meet me.

(D) I will not leave the place until the minister meets me.

01. Ans: (D)

Sol: 'until' itself is negative so it can't take one more negative i.e., 'does not'. Hence, Option (D) is the right answer

02. A rewording of something written or spoken is a _____

(A) paraphrase (B) paradox

(C) paradigm (D) paraffin

02. Ans: (A)

Sol: 'paraphrase' means a restatement of a text, passage or a rewording of something written or spoken.

03. Archimedes said, "Give me a lever long enough and a fulcrum on which to place it, and I will move the world."

The sentence above is an example of a _____ statement.

(A) figurative (B) collateral

(C) literal (D) figurine

03. Ans: (A)

Sol: 'figurative' means representing by a figure or resemblance or expressing one thing in terms normally denoting another with which it may be regarded as analogous.

04. If 'relftaga' means carefree, 'otaga' means careful and 'fertaga' means careless, which of the following could mean 'aftercare'?

(A) zentaga (B) tagafer

(C) tagazen (D) relffer

04. Ans: (C)

Sol: From given codes

relftaga ⇒ carefree

Otaga ⇒ careful

Fertaga ⇒ careless

From these codes, clearly known that "care" means "taga," from given alternatives, option 'C' is correct.

05. A cube is build using 64 cubic blocks of side one unit. After it is built, one cubic block is removed from every corner of the cube. The resulting surface area of the body (in square units) after the removal is _____.

(A) 56 (B) 64

(C) 72 (D) 96

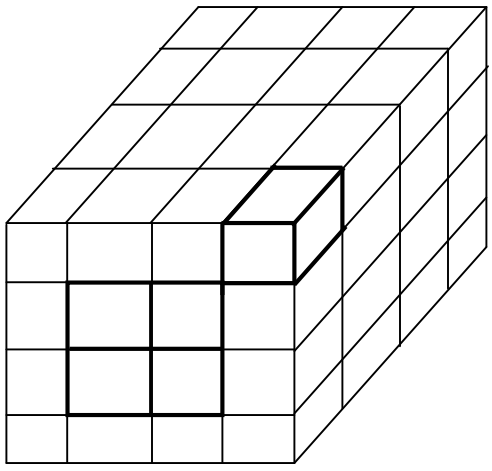
05. Ans: (D)

Sol: From given data, 64 cubic blocks of one unit Sizes are formed

No of faces of the Cube is '6'

No of corners of the Cube is '8'

After removing one Cubic block from Each corner,



The resulting surface area of the body = 6 × (4) = 96 sq. Units.

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06. A shaving set company sells 4 different types of razors, Elegance, Smooth, Soft and Executive. Elegance sells at Rs. 48, Smooth at Rs. 63, and Soft at Rs. 78 and Executive at Rs. 173 per piece. The table below shows the numbers of each razor sold in each quarter of a year.

Quarter/Product	Elegance	Smooth	Soft	Executive
Q1	27300	20009	17602	9999
Q2	25222	19392	18445	8942
Q3	28976	22429	19544	10234
Q4	21012	18229	16595	10109

Which product contributes the greatest fraction to the revenue of the company in that year?

(A) Elegance (B) Executive

(C) Smooth (D) Soft

06. Ans: (B)

Sol: Total No. of razors Elegance type from all four quarters = 27300 + 25222 + 28976 + 201012
= 10,2510

Total No. of razors of Smooth type from all four quarters = 20009 + 19392 + 22429 + 18229
= 8,0059

Total No. of razors of Soft type from all four Quarters = 17602 + 18445 + 19544 + 16595
= 7,2186

Total No. of razors of Executive type from all four Quarters = 9999 + 8942 + 10234 + 10109
= 3,9286

The revenue of the company in that year of 4 different types of razors

Elegance = 10,2510 × 48 = 49,20,480

Smooth = 8,0059 × 63 = 50,43,717

Soft = 7,2186 × 78 = 56,30,508

Executive = 3,9284 × 193 = 67,96,132

∴ The Executive of razors contributes the greatest revenue of the company in that year.

07. Indian currency notes show the denomination indicated in at least seventeen languages. If this is not an indication of the nation's diversity, nothing else is

Which of the following can be logically inferred from the above sentences?

(A) India is a country of exactly seventeen languages

(B) Linguistic pluralism is the only indicator of a nation's diversity

(C) Indian currency notes have sufficient space for all the Indian languages.

(D) Linguistic pluralism is strong evidence of India's diversity

07. Ans: (D)

Sol: If seventeen languages were not an indication of the nation's diversity, nothing else is. If nothing else is so the best inference is option 'D'.

08. Consider the following statements relating to the level of poker of four players P, Q, R and S.

I. P always beats Q

II. R always beats S

III. S loses to P only sometimes

IV. R always loses to Q

Which of the following can be logically inferred from the above statements?

(i) P is likely to beat all the three other players

(ii) S is the absolute worst player in the set

(A) (i) only (B) (ii) only

(C) (i) and (ii) (D) neither (i) nor (ii)

08. Ans: (A)

Sol: From the given data

Player P > Player Q

Player R > Player S

Player S < Player P (sometimes only)

Player R < Player Q

$\therefore$ Player 'P' > Player 'Q' > Player 'R' > Player 'S'

$\therefore$ Logically, the statement (i) is definitely true, but statement (ii) is not

$\therefore$ Option 'A' is true

09. If $f(x) = 2x^7 + 3x - 5$, which of the following is a factor of f(x)?

(A) (x^3+8) (B) $(x-1)$

(C) $(2x-5)$ (D) $(x+1)$

09. Ans: (B)

Sol: $f(x) = 2x^7 + 3x - 5$ for x = 1 the equation is satisfied. The factor is (x–1).

10. In a process, the number of cycles to failure decreases exponentially with an increase in load. At a load of 80 units, it takes 100 cycles for failure. When the load is halved, it takes 10000 cycles for failure. The load for which the failure will happen in 5000 cycles is _____.

(A) 40.00 (B) 46.02

(C) 60.01 (D) 92.02

10. Ans: (B)

Sol: ↓ load cycles for failure ↑ exponentially

Eg: load = x

Cycles for failure = y

$\frac{x}{2} = y^2$, $\frac{x}{3} = y^3$, $\frac{x}{4} = y^4$

By elimination procedure from options,

Option (A)

Load = 40units, it says that, the load is halved, it takes 10,000 cycles for failure.

$\frac{80}{2} = (100)^2$

40 units = 10,000 cycles, it is not

Option (D)

Load = 92.02 units means it is more than 80 units, so it is not.

Option (C)

Load = 60.01 units

$\frac{3}{4}$(80 units) = 60.01 units

From the given relation

$\frac{3}{4}$(80 units) = $(10)^{4/3} = (100)^1 \times (100)^{1/3} = 100 \times 4.64 = 464$

It is not

∴ Option (B) only possible

∴ At the load of 46.02 units, the failure will happen in 5000 cycles.

Q.1 – Q.25 carry one mark each

01 Let p, q, r, s represent the following propositions.

p: $x \in \{8,9,10,11,12\}$

q: x is a composite number

r: x is a perfect square

s: x is a prime number

The integer $x \geq 2$ which satisfies $\neg ((p \Rightarrow q) \wedge (\neg r \vee \neg s))$ is _____.

01. Ans: 11

Sol: $= \sim((p \rightarrow q) \wedge (\sim r \vee \sim s))$

$= (p \wedge \sim q) \vee (r \wedge s)$

For x = 11, we have $(p \wedge \sim q) \vee (r \wedge s)$ is TRUE.

02. Let a_n be the number of n-bit strings that do NOT contain two consecutive 1s. Which one of the following is the recurrence relation for a_n?

(A) $a_n = a_{n-1} + 2a_{n-2}$ (B) $a_n = a_{n-1} + a_{n-2}$

(C) $a_n = 2a_{n-1} + a_{n-2}$ (D) $a_n = 2a_{n-1} + 2a_{n-2}$

02. Ans: (B)

Sol: Let a_n denote the number of n-bit strings that do not contain two consecutive 1's

n	**Possible strings**	**a_n**
0	{ }	$1=a_0$
1	0 1	$2 = a_1$
2	00 01 10 11	$3 = a_2$

By observing above analysis, we can write $a_n = a_{n-1} + a_{n-2}$

(OR)

Case 1: If the first bit is zero, then the remaining bits we can choose in a_{n-1} ways.

Case 2: If the first bit is one, then the second bit is 0 and the remaining bits we can choose in a_{n-2} ways.

The recurrence relation is $a_n = a_{n-1} + a_{n-2}$

03. $\lim\limits_{x\to 4}\dfrac{\sin(x-4)}{x-4}$ = _____.

03. Ans: 1

Sol: $\lim\limits_{x\to 4}\dfrac{\sin(x-4)}{x-4}$

Let $x - 4 = t$

$$= \lim_{t\to 0}\frac{\sin t}{t} = 1$$

(OR)

The given limit is in 0/0 form. Applying L. Hospital's rule, we get
The limiting value = 1

04. A probability density function on the interval [a, 1] is given by $1/x^2$ and outside this interval the value of the function is zero. The value of a is _____.

04. Ans: 0.5

Sol: Given $f(x) = \begin{cases} \dfrac{1}{x^2} & \text{for } a \le x \le 1 \\ 0 & \text{otherwise} \end{cases}$

$$\int_{-\infty}^{\infty} f(x)dx = 1 \Rightarrow \int_{a}^{1}\frac{1}{x^2}dx = 1$$

$$\Rightarrow \left[\frac{-1}{x}\right]_a^1 = 1 \Rightarrow \frac{1}{a} - 1 = 1$$

$$\Rightarrow a = \frac{1}{2} = 0.5$$

05. Two eigen values of a 3×3 real matrix P are $\left(2+\sqrt{-1}\right)$ and 3. The determinant of P is _____.

05. Ans: 15

Sol: If $\lambda = 2+\sqrt{-1} = 2+\text{i}$ is an eigen value then 2 –i is also eigen value

$\therefore |\text{P}| = (2+\text{i})(2-\text{i})3 = (4+1)3 = 15$

(OR)

Complex roots of a polynomial equation always occur in pairs.

If (2 + i) is an eigen value then (2 – i) is also an eigen value of P.

Determinant of P = (2 + i) (2 – i) 3 = 15

06. Consider the Boolean operator # with the following properties:

$x \# 0 = x$, $x \# 1 = \overline{x}$, $x \# x = 0$ and $x \# \overline{x} = 1$. Then x # y is equivalent to

(A) $x\overline{y} + \overline{x}y$ (B) $x\overline{y} + \overline{x}\,\overline{y}$

(C) $\overline{x}\,\overline{y} + xy$ (D) $xy + \overline{x}\,\overline{y}$

06. Ans: (A)

Sol: From the given data, properties of XOR GATE hence # means XOR.

(OR)

is equivalent to XOR operation.

$\therefore\ x\#y = x.\overline{y} + \overline{x}.y$

07. The 16-bit 2's complement representation of an integer is 1111 1111 1111 0101; its decimal representation is _____.

07. Ans: –11

Sol: Integer size is 16 bit, already it is given in it's 2's complement notation; So, when it is 2's complemented once again it gives value. So answer is –11.

08. We want to design a synchronous counter that counts the sequence 0-1-0-2-0-3 and then repeats. The minimum number of J-K flip-flops required to implement this counter is _____.

08. Ans: 4

Sol: In the given first loop of states, zero has repeated 3 times. So, minimum 4 number of Flip-flops are needed.

09. A processor can support a maximum memory of 4GB, where the memory is word-addressable (a word consists of two bytes). The size of the address bus of the processor is at least _____bits.

09. Ans: 31

Sol: Word size = 16 bit,

so memory size = 2^{31} words.

$\therefore$ 31 address bits are needed.

10. A queue is implemented using an array such that ENQUEUE and DEQUEUE operations are performed efficiently. Which one of the following statements is **CORRECT** (n refers to the number of items in the queue)?

(A) Both operations can be performed in O(1) time

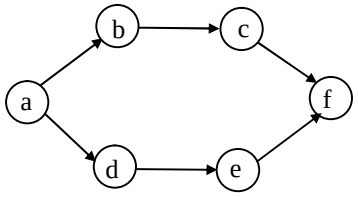
(B) At most one operation can be performed in O(1) time but the worst case time for the other operation will be $\Omega(n)$

(C) The worst case time complexity for both operations will be $\Omega(n)$

(D) Worst case time complexity for both operations will be $\Omega(\log n)$

10. Ans: (A)

11. Consider the following directed graph:



The number of different topological orderings of the vertices of the graph is _____.

11. Ans: 6

Sol:

1	a	b	c	d	e	f
2	a	b	d	c	e	f
3	a	b	d	e	c	f
4	a	d	e	b	c	f
5	a	d	b	e	c	f
6	a	d	b	c	e	f

12. Consider the following C program.

```
void f(int, short);
void main( )
{       int i = 100;
        short s = 12;
        short *p = &s;
        _____ ; // call to f( )
}
```

Which one of the following expressions, when placed in the blank above, will NOT result in a type checking error?

(A) f(s,*s) (B) i = f(i,s)

(C) f(i,*s) (D) f(i,*p)

12. Ans: (D)

Sol: Since function prototype is void f(int, short) i.e., f is accepting, arguments int, short and its return type is void. So f(i, *p) is correct answer.

13. The worst case running times of Insertion sort, Merge sort and Quick sort, respectively, are:

(A) $\Theta(n\log n)$, $\Theta(n\log n)$, and $\Theta(n^2)$ (B) $\Theta(n^2)$, $\Theta(n^2)$, and $\Theta(n\log n)$

(C) $\Theta(n^2)$, $\Theta(n\log n)$, and $\Theta(n\log n)$ (D) $\Theta(n^2)$, $\Theta(n\log n)$, and $\Theta(n^2)$

13. Ans: (D)

14. Let G be a weighted connected undirected graph with distinct positive edge weights. If every edge weight is increased by the same value, then which of the following statements is/are **TRUE**?

P: Minimum spanning tree of G does not change

Q: Shortest path between any pair of vertices does not change

(A) P only (B) Q only

(D) Neither P nor Q (D) Both P and Q

14. Ans: (D)

15. Consider the following C program.

```
#include<stdio.h>
void mystery(int *ptra, int *ptrb)
{
        int *temp;
        temp = ptrb;
         ptrb = ptra;
         ptra = temp;
}
int main( )
{
        int a = 2016, b = 0, c = 4, d = 42;
        mystery (&a, &b);
        if (a < c)
        mystery(&c, &a);
        mystery(&a, &d);
        printf("%d\n", a);
}
```

The output of the program is _____.

15. Ans: 2016

Sol: Whatever modifications are performed in mystery ( ) function, those modifications are not reflected in main ( ) function so it will print 2016.

16. Which of the following languages is generated by the given grammar?

$$S \rightarrow aS \mid bS \mid \varepsilon$$

(A) $\{a^n b^m \mid n,m \geq 0\}$

(B) $\{w \in \{a,b\}^* \mid w$ has equal number of a's and b's$\}$

(C) $\{a^n \mid n \geq 0\} \cup \{b^n \mid n \geq 0\} \cup \{a^n b^n \mid n \geq 0\}$

(D) $\{a, b\}^*$

16. Ans: (D)

Sol: $S \rightarrow aS \mid bS \mid \in$

$S \rightarrow (a + b)^*$

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

17. Which of the following decision problems are undecidable?

I. Given NFAs N_1 and N_2, is $L(N_1) \cap L(N_2) = \phi$?

II. Given a CFG G = (N, $\sum$, P, S) and a string $x \in \sum^*$, does $x \in L(G)$?

III. Given CFGs G_1 and G_2 is $L(G_1) = L(G_2)$?

IV. Given a TM M, is $L(M) = \phi$?

(A) I and IV only (B) II and III only

(C) III and IV only (D) II and IV only

17. Ans: (C)

Sol: III. Equality of CFG is undecidable

IV. Emptiness of TM is undecidable

18. Which one of the following regular expressions represents the language: the set of all binary strings having two consecutive 0s and two consecutive 1s?

(A) $(0+1)^* 0011(0+1)^* + (0+1)^* 1100(0+1)^*$ (B) $(0+1)^* (00(0+1)^* 11+11(0+1)^* 00)(0+1)^*$

(C) $(0+1)^* 00(0+1)^* + (0+1)^* 11(0+1)^*$ (D) $00(0+1)^* 11+11(0+1)^* 00$

18. Ans: (B)

19. Consider the following code segment.

```
x = u – t;
y = x * v;
x = y + w;
y = t – z;
y = x * y;
```

The minimum number of total variables required to convert the above code segment to static single assignment form is _____.

19. Ans: 7

20. Consider an arbitrary set of CPU-bound processes with unequal CPU burst lengths submitted at the same time to a computer system. Which one of the following process scheduling algorithms would minimize the average waiting time in the ready queue?

(A) Shortest remaining time first

(B) Round-robin with time quantum less than the shortest CPU burst

(C) Uniform random

(D) Highest priority first with priority proportional to CPU burst length

20. Ans: (A)

21. Which of the following is **NOT** a superkey in a relational schema with attributes V, W, X, Y, Z and primary key V Y?

(A) VXYZ (B) VWXZ

(C) VWXY (D) VWXYZ

21. Ans: (B)

Sol: A superkey is one which contains a candidate key.

22. Which one of the following is **NOT** a part of the ACID properties of database transactions?

(A) Atomicity (B) Consistency

(C) Isolation (D) Deadlock-freedom

22. Ans: (D)

Sol: A: Atomicity

C: Consistency

I: Isolation

D: Durability

23. A database of research articles in a journal uses the following schema.

(VOLUME, NUMBER, STARTPAGE, ENDPAGE, TITLE, YEAR, PRICE)

The primary key is (VOLUME, NUMBER, STARTPAGE, ENDPAGE) and the following functional dependencies exist in the schema.

(VOLUME, NUMBER, STARTPAGE, ENDPAGE) → TITLE

(VOLUME, NUMBER) → YEAR

(VOLUME, NUMBER, STARTPAGE, ENDPAGE) → PRICE

The database is redesigned to use the following schemas.

(VOLUME, NUMBER, STARTPAGE, ENDPAGE, TITLE, PRICE)

(VOLUME, NUMBER, YEAR)

Which is the weakest normal form that the new database satisfies, but the old one does not?

(A) 1NF (B) 2NF

(C) 3NF (D) BCNF

23. Ans: (B)

Sol: (Volume, Number) → Year is a partial functional dependency. So, the given relation is in 1 NF but not in 2 NF.

24. Which one of the following protocols is **NOT** used to resolve one form of address to another one?

(A) DNS (B) ARP (C) DHCP (D) RARP

24. Ans: (C)

Sol: DHCP is dynamic host configuration protocol: allocates one of the unused IP address

25. Which of the following is/are example(s) of stateful application layer protocols?

(i) HTTP (ii) FTP (iii) TCP (iv) POP3

(A) (i) and (ii) only (B) (ii) and (iii) only

(C) (ii) and (iv) only (D) (iv) only

25. Ans: (C)

Sol: POP 3 and FTP are stateful application layer protocols

Q.26 – Q.55 carry two marks each

26. The co-efficient of x^{12} in $(x^3 + x^4 + x^5 + x^6 + \cdots)^3$ is _____.

26. Ans: 10

Sol: $\left(x^3+x^4+x^5+x^6+....\right)^3 = x^9\left[1+x+x^2+x^3+.....\right]^3$

$= x^9\left[\left(1+x+x^2+x^3+....+\right)^2\left(1+x+x^2+...+..\right)\right]$

$= x^9\left[\left(1+2x+3x^2+4x^3+...\right)\left(1+x+x^2+x^3+...\right)\right] = x^9\left[1.x^3+2.x.x^2+3x^2.x+4x^3+....\right]$

$= x^9\left[10x^3\right] = 10x^{12}$

(OR)

$(x^3 + x^4 + x^5 + x^6 + ...)^3 = x^9\,(1 + x + x^2 + x^3 + \ldots)^3$

$= x^9\,\{(1-x)^{-1}\}^3 = x^9\,(1-x)^{-3} = x^9\sum_{n=0}^{\infty} C(n+2,2)x^n$

Coefficient of x^{12} = C(5, 2) = 10

27. Consider the recurrence relation $a_1 = 8$, $a_n = 6n^2 + 2n + a_{n-1}$. Let $a_{99} = K \times 10^4$. The value of K is ___.

27. Ans: 198

Sol: The recurrence relation is $a_n - a_{n-1} = 6n^2 + 2n$

Complementary function = C_1

Let particular solution = $(An^2 + Bn\ C)n$

Substituting in the recurrence relation, and solving we get A = 2, B = 4 and C = 2.

$\therefore$ The solution is $a_n = C_1 + 2n^3 + 4n^2 + 2^n$

$a_1 = 8 \Rightarrow 8 = C_1 + 8$

$\Rightarrow C_1 = 0$

$a_{99} = 2\{(99^3) + 2(99^2) + 99\}$

$= 2\{(100 - 1)^3 + 2(100 - 1)^2 + (100 - 1)\}$

$= 10^4\ (198)$

$\therefore k = 198$

28. A function $f : N^+ \to N^+$, defined on the set of positive integers N^+, satisfies the following properties:

$f(n) = f(n/2)$ if n is even

$f(n) = f(n+5)$ if n is odd

Let $R=\{i|\exists j: f(j)=i\}$ be the set of distinct values that f takes. The maximum possible size of R is _____.

28. Ans: 2

Sol: $f(n) = \begin{cases} f\left(\frac{n}{2}\right), & \text{if n is even} \\ f(n+5), & \text{if n is odd} \end{cases}$

Using the definition of the function we can show that

$f(1) = f(2) = f(3) = f(4) = f(6) = f(7) = f(8) = f(9) \ldots$

and $f(5) = f(10) = f(15) = f(20) = \ldots..$

$\therefore$ The range of f(n) contain two distinct elements.

29. Consider the following experiment.

Step1: Flip a fair coin twice.

Step2: If the outcomes are (TAILS, HEADS) then output Y and stop.

Step3: If the outcomes are either (HEADS, HEADS) or (HEADS, TAILS), then output N and stop.

Step4: If the outcomes are (TAILS, TAILS), then go to Step 1.

The probability that the output of the experiment is Y is (up to two decimal places) _____.

29. Ans: 0.33

Sol: The possibilities are

$$P(Y) = \frac{1}{4} + \frac{1}{4}\times\frac{1}{4} + \frac{1}{4}\times\frac{1}{4}\times\frac{1}{4} + \frac{1}{4}\times\frac{1}{4}\times\frac{1}{4} + ... = \frac{\frac{1}{4}}{1-\frac{1}{4}} = \frac{1}{3} = 0.33$$

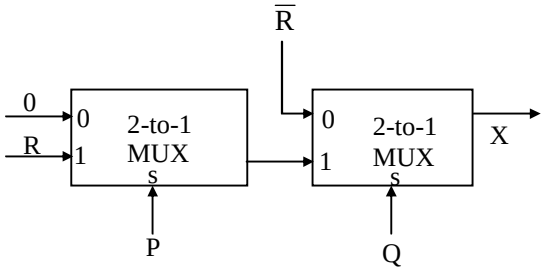
1st time	H	H	T	T
2nd time	H	T	H	T
		N		Y

(OR)

The probabilities for output Y are $\frac{1}{4}, \left(\frac{1}{4}\right)\frac{1}{4}, \left(\frac{1}{4}\right)^2\frac{1}{4}, ...$

Required probability = $\frac{1}{4}\left\{1 + \frac{1}{4} + \left(\frac{1}{4}\right)^2 + \left(\frac{1}{4}\right)^3 + ...\right\} = \frac{1}{4}\left(\frac{1}{1-\frac{1}{4}}\right) = \frac{1}{3} = 0.33$

30. Consider the two cascaded 2-to-1 multiplexers as shown in the figure.



The minimal sum of products form of the output X is

(A) $\overline{P}\,\overline{Q} + PQR$ (B) $\overline{P}Q + QR$

(C) $PQ + \overline{P}\,\overline{Q}R$ (D) $\overline{Q}\,\overline{R} + PQR$

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HEARTY CONGRATULATIONS TO OUR IES - 2015 TOPPERS

Total no.of selections in IES 2015 - EC : 52 EE : 36 CE : 24 ME : 28

24 SELECTIONS IN TOP 10

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30. Ans: (D)

Sol: Output of 1st multiplexer ($\overline{P}.0 + PR$) = PR

Output of 2nd multiplex (at X) = $\overline{Q}.\overline{R} + PRQ = \overline{Q}\,\overline{R} + PQR$

31. The size of the data count register of a DMA controller is 16 bits. The processor needs to transfer a file of 29,154 kilobytes from disk to main memory. The memory is byte addressable. The minimum number of times the DMA controller needs to get the control of the system bus from the processor to transfer the file from the disk to main memory is ____.

31. Ans: 456

Sol: Terminal Count Register size = 16 bit.

So, for one transfer operation of 64 KB, the register content will become zero, so, number of times the content of the register to be filled is

$$\frac{29154\,\text{KB}}{64\,\text{KB}} = 456$$

32. The stage delays in a 4-stage pipeline are 800,500,400 and 300 picoseconds. The first stage (with delay 800 picoseconds) is replaced with a functionally equivalent design involving two stages with respective delays 600 and 350 picoseconds. The throughput increase of the pipeline is ____ percent.

32. Ans: 33.33

Sol: Old pipeline maximum delay = 800 ns

New pipeline maximum delay = 600 ns

800 : 600 = 4:3

Increasing throughput $= \frac{4-3}{3} = 33.3\%$

33. Consider a carry look ahead adder for adding two n-bit integers, built using gates of fan-in at most two. The time to perform addition using this adder is

(A) $\Theta(1)$ (B) $\Theta(\log(n))$

(C) $\Theta(\sqrt{n})$ (D) $\Theta(n)$

33. Ans: (B)

Sol: Size of the integer = n bit and maximum number of inputs to the gate is two. So, time is depending on size.

34. The following function computes the maximum value contained in an integer array p[ ]of size n (n >= 1).

```
int max(int *p, int n) {
    int a = 0, b = n – 1;
    while (_____) {
        if (p[a] <= p[b]) { a = a+1; }
        else              { b = b-1; }
    }
    return p[a];
}
```

The missing loop condition is

(A) a != n (B) b != 0 (C) b > (a + 1) (D) b != a

34. Ans: (D)

Sol: If b! = a we get maximum element of an integer

35. What will be the output of the following C program?

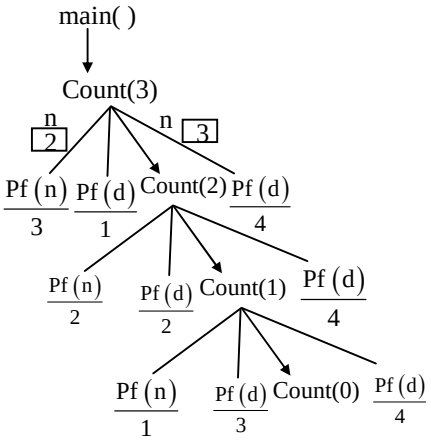
```
void count (int n)
{       static int d = 1;
        printf("%d" , n);
        printf("%d",d);
        d++;
        if (n >1) count(n –1);
        printf("%d", d);       }
void main ( ) {
        count (3);
}
```

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

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

35. Ans: (A)

Sol:



Output = 3, 1, 2, 2, 1, 3, 4, 4, 4

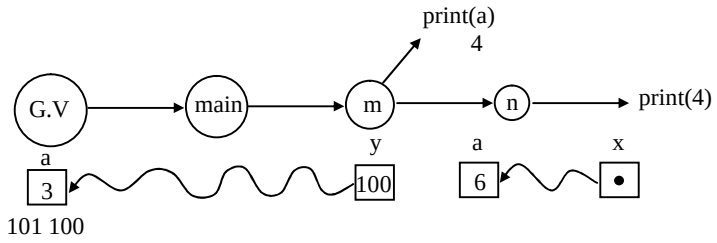
36. What will be the output of the following pseudo-code when parameters are passed by reference and dynamic scoping is assumed?

```
a = 3;
void n(x) {x = x * a; print(x);}
void m(y) {a = 1; a = y - a; n(a); print(a);}
void main() {m(a);}
```

(A) 6, 2 (B) 6, 6 (C) 4, 2 (D) 4, 4

36. Ans: (D)

Sol:



37. An operator delete(i) for a binary heap data structure is to be designed to delete the item in the i-th node. Assume that the heap is implemented in an array and i refers to the i-th index of the array. If the heap tree has depth d (number of edges on the path from the root to the farthest leaf), then what is the time complexity to re-fix the heap efficiently after the removal of the element?

(A) O(1) (B) O(d) but not O(1)

(C) $O(2^d)$ but not O(d) (D) $O(d2^d)$ but not $O(2^d)$

37. Ans: (B)

38. Consider the weighted undirected graph with 4 vertices, where the weight of edge {i,j} is given by the entry W_{ij} in the matrix W.

$$W = \begin{bmatrix} 0 & 2 & 8 & 5 \\ 2 & 0 & 5 & 8 \\ 8 & 5 & 0 & x \\ 5 & 8 & x & 0 \end{bmatrix}$$

The largest possible integer value of x, for which at least one shortest path between some pair of vertices will contain the edge with weight x is _____.

38. Ans: 12

39. Let G be a complete undirected graph on 4 vertices, having 6 edges with weights being 1, 2, 3, 4 ,5 and 6. The maximum possible weight that a minimum weight spanning tree of G can have is ___.

39. Ans: 7

40. G = (V,E) is an undirected simple graph in which each edge has a distinct weight, and e is a particular edge of G. Which of the following statements about the minimum spanning trees (MSTs) of G is/are **TRUE?**

I. If e is the lightest edge of some cycle in G, then every MST of G includes e

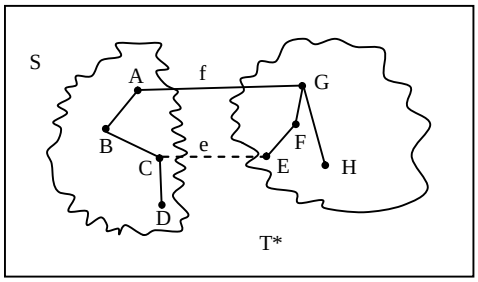
II. If e is the heaviest edge of some cycle in G, then every MST of G excludes e

(A) I only (B) II only

(C) both I and II (D) neither I nor II

40. Ans: (C)

Sol:



I. ***TRUE***

- Suppose 'f' belongs to T*
- Deleting 'f' from T* disconnects T* and let 's' be one side of cut.
- Some other edge in cycle 'C' say 'e' has exactly one end point in S
- $T = T^* \cup \{e\} - \{f\}$ is also a spanning Tree.

  Since $C_e < C_f$ so cost(T) < cost(T*)

  Which is contradictory to minimality of T*

II. ***TRUE***

Suppose 'e' does not belong to T*

Adding 'e' to T* creates a(unique) cycle 'C' in T*

Some other edge in cycle 'C', say 'f' has exactly one end point in 's'

$T = T^* \cup \{e\} - f$ is also spanning Tree and since $C_e < C_f$

So,cost(T) < cost(T*)

Which is contridicts minimality of T*.

41. Let Q denote a queue containing sixteen numbers and S be an empty stack. Head(Q) returns the element at the head of the queue Q without removing it from Q. Similarly Top(S) returns the element at the top of S without removing it from S. Consider the algorithm given below.

```
while Q is not Empty do
    if S is Empty OR Top(S) ≤ Head(Q) then
        x:= Dequeue(Q);
        Push(S,x);
    else
        x:= Pop(S);
        Enqueue(Q,x);
    end
end
```

The maximum possible number of iterations of the while loop in the algorithm is_____.

41. Ans: 256

Sol: Trying with queue elements, say n = 1, 2, 3, then maximum number of iterations are noticed as n^2. Here n = 16, So answer will be 256.

42. Consider the following context-free grammars:

G_1: $S \rightarrow aS|B$, $B \rightarrow b|bB$

G_2: $S \rightarrow aA|bB$, $A \rightarrow aA|B|\varepsilon$, $B \rightarrow bB|\varepsilon$

Which one of the following pairs of languages is generated by G_1 and G_2, respectively?

(A) $\{a^m b^n | m > 0 \text{ or } n > 0\}$ and $\{a^m b^n | m > 0 \text{ and } n > 0\}$

(B) $\{a^m b^n | m > 0 \text{ and } n > 0\}$ and $\{a^m b^n | m > 0 \text{ or } n \geq 0\}$

(C) $\{a^m b^n | m \geq 0 \text{ or } n > 0\}$ and $\{a^m b^n | m > 0 \text{ and } n > 0\}$

(D) $\{a^m b^n | m \geq 0 \text{ and } n > 0\}$ and $\{a^m b^n | m > 0 \text{ or } n > 0\}$

42. Ans: (D)

Sol: **G_1:** $S \rightarrow aS \mid B$

$B \rightarrow b \mid b\,B$

$\Rightarrow B \rightarrow b^+$

$S \rightarrow aS \mid b^+$

$S \rightarrow a^* b^+ = \{a^m b^n \mid m \geq 0, n \geq 0\}$

G_2: $S \rightarrow aA \mid bB$

$A \rightarrow aA \mid B \mid \in$

$B \rightarrow bB \mid \in \quad B \rightarrow b^*$

$A \rightarrow aA \mid b^* \mid \in$

$A \rightarrow a^* b^* \mid a^*$

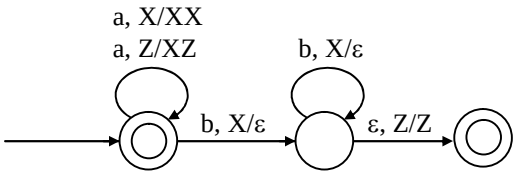
$A \rightarrow a^* b^*$

$S \rightarrow a\,a^* b^* \mid b\,b^*$

$S \rightarrow a^+ b^* \mid b^+$

$L = \{a^m b^n \mid m > 0, n \geq 0\} \cup \{b^n \mid n > 0\}$

43. Consider the transition diagram of a PDA given below with input alphabet $\sum$ = {a, b} and stack alphabet Γ = { X,Z}. Z is the initial stack symbol. Let L denote the language accepted by the PDA.



Which one of the following is **TRUE**?

(A) $L = \{a^n b^n \mid n \geq 0\}$ and is not accepted by any finite automata

(B) $L = \{a^n \mid n \geq 0\} \cup \{a^n b^n \mid n \geq 0\}$ and is not accepted by any deterministic PDA

(C) L is not accepted by any Turning machine that halts on every input

(D) $L = \{a^n \mid n \geq 0\} \cup \{a^n b^n \mid n \geq 0\}$ and is deterministic context-free

43. Ans: (D)

Sol: $L = \{a^n \mid n \geq 0\} \cup \{a^n b^n \mid n \geq 0\}$ and

L is DCFL

44. Let X be a recursive language and Y be a recursively enumerable but not recursive language. Let W and Z be two languages such that $\overline{Y}$ reduces to W, and Z reduces to $\overline{X}$ (reduction means the standard many-one reduction). Which one of the following statements is TRUE?

(A) W can be recursively enumerable and Z is recursive.

(B) W can be recursive and Z is recursively enumerable.

(C) W is not recursively enumerable and Z is recursive.

(D) W is not recursively enumerable and Z is not recursive.

44. Ans: (C)

Sol: X → recursive

Y → REL but not recursive

$$\left.\begin{array}{l}\overline{Y} \to W \\ Z \to \overline{X}\end{array}\right\} \overline{X} - \text{REC}$$

Z is REC

W is REL but not REC

45. The attributes of three arithmetic operators in some programming language are given below.

Operator	Precedence	Associativity	Arity
+	High	Left	Binary
–	Medium	Right	Binary
*	Low	Left	Binary

The value of the expression 2−5+1−7∗3 in this language is _____.

45. Ans: 9

Sol: 2–5+1–7*3

2-6–7*3

2-(–1)*3

3*3

9

46. Consider the following Syntax Directed Translation Scheme (SDTS), with non-terminals {S, A} and terminals {a,b}.

S → aA {print 1}

S → a {print 2}

A → Sb {print 3}

Using the above SDTS, the output printed by a bottom-up parser, for the input **aab** is:

(A) 1 3 2 (B) 2 2 3

(C) 2 3 1 (D) syntax error

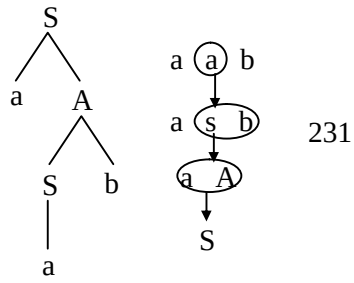
46. Ans: (C)

Sol: S → aA {print 1}

S → a {print 2}

S → Sb {print 3}

Input: aab



47. Consider a computer system with 40-bit virtual addressing and page size of sixteen kilobytes. If the computer system has a one-level page table per process and each page table entry requires 48 bits, then the size of the per-process page table is _____ megabytes.

47. Ans: 384

48. Consider a disk queue with requests for I/O to blocks on cylinders 47, 38, 121, 191, 87, 11, 92, 10. The C-LOOK scheduling algorithm is used. The head is initially at cylinder number 63, moving towards larger cylinder numbers on its servicing pass. The cylinders are numbered from 0 to 199. The total head movement (in number of cylinders) incurred while servicing these requests is .

48. Ans: 346

49. Consider a computer system with ten physical page frames. The system is provided with an access sequence (a_1, a_2,…, a_{20}, a_1, a_2,…a_{20}), where each a_i is a distinct virtual page number. The difference in the number of page faults between the last-in-first-out page replacement policy and the optimal page replacement policy is _____.

49. Ans: 1

50. Consider the following proposed solution for the critical section problem. There are n processes: P_0.....P_{n-1}. In the code, function pmax returns an integer not smaller than any of its arguments. For all i, t[i] is initialized to zero.

Code for P_i:

```
do {
        c[i]=1; t[i] = pmax(t[0],...,t[n-1])+1; c[i]=0;
        for every j ≠ i in {0,...,n-1}
        {
                while (c[j]);
                while (t[j] != 0 && t[j]<=t[i]);
        }
        Critical Section;
        t[i] = 0;
        Remainder Section;
} while (true);
```

Which one of the following is TRUE about the above solution?

(A) At most one process can be in the critical section at any time

(B) The bounded wait condition is satisfied

(C) The progress condition is satisfied

(D) It cannot cause a deadlock

50. Ans: (A)

51. Consider the following two phase locking protocol. Suppose a transaction T accesses (for read or write operations), a certain set of objects $\{O_1,\ldots., O_k\}$. This is done in the following manner.

Step 1: T acquires exclusive locks to $O_1,\ldots.., O_k$ in increasing order of their addresses.

Step 2: The required operations are performed

Step 3: All locks are released.

This protocol will

(A) guarantee serializability and deadlock-freedom

(B) guarantee neither serializability nor deadlock-freedom

(C) guarantee serializability but not dadlock-freedom

(D) guarantee deadlock-freedom but not serializability

51. Ans: (C)

Sol: Two phase locking protocol ensures serializability, but does not ensures freedom from deadlock.

52. Consider that B wants to send a message m that is digitally signed to A. Let the pair of private and public keys for A and B be denoted by K_x^- and K_x^+ for x = A,B respectively. Let $K_x(m)$ represent the operation of encrypting m with a key K_x and H(m) represent the message digest. Which one of the following indicates the **CORRECT** way of sending the message m along with the digital signature to A?

(A) $\left\{m, K_B^+(H(m))\right\}$ (B) $\left\{m, K_B^-(H(m))\right\}$

(C) $\left\{m, K_A^-(H(m))\right\}$ (D) $\left\{m, K_A^+(m)\right\}$

52. Ans: (B)

The concept of digital signature

Message is digested: h(m) and cryptographically protected with sender's private key to become sign and sent along with the message

53. An IP datagram of size 1000 bytes arrives at a router. The router has to forward this packet on a link whose MTU (maximum transmission unit) is 100 bytes. Assume that the size of the IP header is 20 bytes. The number of fragments that the IP datagram will be divided into for transmission is _____.

53. Ans: 13

Sol: L =1000 bytes

MTU = 100 bytes

IP header = 20 bytes

So MTU payload is 100–20 = 80 bytes

Number of fragments = 1000/80 = 13

54. For a host machine that uses the token bucket algorithm for congestion control, the token bucket has a capacity of 1 megabyte and the maximum output rate is 20 megabytes per second. Tokens arrive at a rate to sustain output at a rate of 10 megabytes per second. The token bucket is currently full and the machine needs to send 12 megabytes of data. The minimum time required to transmit the data is _____seconds.

54. Ans: 1.2

Sol: Given

Maximum burst rate, M = 20 MB

Token arrival rate, P = 10 MB

Constant rate(bucket o/p), P = 10 MB

Bucket capacity, C = 1 MB

Time for 1 MB, $S = \frac{C}{(M-P)} = \frac{1}{(20-10)} = 0.1$ sec

For the total message of 12 MB is 1.2 sec

55. A sender uses the Stop-and-Wait ARQ protocol for reliable transmission of frames. Frames are of size 1000 bytes and the transmission rate at the sender is 80 Kbps (1Kbps = 1000 bits/second). Size of an acknowledgement is 100 bytes and the transmission rate at the receiver is 8 Kbps. The one-way propagation delay is 100 milliseconds. Assuming no frame is lost, the sender throughput is _____ bytes/second.

55. Ans: 2500

Sol: B = 80 kbps

L = 1000 bytes

T_p = 100 ms

T_x = L/B = 100 ms

Tax = ack size/ bandwidth = 100 ms

Efficiency = tx/(tx +2tp+tax)

Throughput = efficiency * bandwidth = .25 *10^4 bytes

= 2500 bytes