24. Suppose p is number of cars per minute passing through a certain road junction between 5 PM and 6PM, and p has a Poisson distribution with mean 3. What is the probability of observing fewer than 3 cars during any given minute in this interval?

(A) $8/(2e^3)$ (B) $9/(2e^3)$ (C) $17/(2e^3)$ (D) $26/(2e^3)$

Ans: (C)

Exp: $P(p<3) = P(p=0) + P(p=1) + P(p=2)$

$$= \frac{e^{-\mu}\mu^0}{0!} + \frac{e^{-\mu}\mu^1}{1!} + \frac{e^{-\mu}\mu^2}{2!} \quad (\text{where } \mu = 3)$$

$$= e^{-3} + e^{-3} \times 3 + \frac{e^{-3} \times 9}{2}$$

$$= e^{-3}\left(1 + 3 + \frac{9}{2}\right) = \frac{17}{2e^3}$$

25. A binary operation $\oplus$ on a set of integers is defined as $x \oplus y = x^2 + y^2$. Which one of the following statements is TRUE about $\oplus$?

(A) Commutative but not associative (B) Both commutative and associative

(C) Associative but not commutative (D) Neither commutative nor associative

Ans: (A)

Exp: $x \oplus y = x^2 + y^2 = y^2 + x^2 = y \oplus x$

$\therefore$ commutative

Not associative, since, for example

$(1 \oplus 2) \oplus 3 \neq 1 \oplus (2 \oplus 3)$

Q. No. 26 – 55 Carry Two Marks Each

26. Which one of the following is NOT logically equivalent to $\neg\exists x(\forall y(\alpha) \wedge \forall z(\beta))$?

(A) $\forall x(\exists z(\neg\beta) \rightarrow \forall y(\alpha))$ (B) $\forall x(\forall z(\beta) \rightarrow \exists y(\neg\alpha))$

(C) $\forall x(\forall y(\alpha) \rightarrow \exists z(\neg\beta))$ (D) $\forall x(\exists y(\neg\alpha) \rightarrow \exists z(\neg\beta))$

Ans: (A)

27. A RAM chip has a capacity of 1024 words of 8 bits each $(1K \times 8)$. The number of 2×4 decoders with enable line needed to construct a

16K × 16 RAM from 1K × 8 RAM is

(A) 4 (B) 5 (C) 6 (D) 7

Ans: (D)

28. Consider an instruction pipeline with five stages without any branch prediction: Fetch Instruction (FI), Decode Instruction (DI), Fetch Operand (FO), Execute Instruction (EI) and Write Operand (WO). The stage delays for FI, DI, FO, EI and WO are 5 ns, 7 ns, 10 ns, 8 ns and 6 ns, respectively. There are intermediate storage buffers after each stage and the delay of each buffer is 1 ns. A program consisting of 12 instructions $I_1, I_2, I_3, \ldots\ldots I_{12}$ is executed in this pipelined processor. Instruction I_4 is the only branch instruction and its branch target is I_9. If the branch is taken during the execution of this program, the time (in ns) needed to complete the program is

(A) 132 (B) 165 (C) 176 (D) 328

Ans: (A)

29. Consider the following operation along with Enqueue and Dequeue operations on queues, where k is a global parameter

```
MultiDequeue(Q) {
    m = k
    while (Q is not empty) and (m > 0) {
        Dequeue (Q)
        m = m − 1
    }
}
```

What is the worst case time complexity of a sequence of n queue operations on an initially empty queue?

(A) $\Theta(n)$ (B) $\Theta(n+k)$ (C) $\Theta(nk)$ (D) $\Theta(n^2)$

Ans: (C)

30. The preorder traversal sequence of a binary search tree is 30, 20, 10, 15, 25, 23, 39, 35, 42. Which one of the following is the postorder traversal sequence of the same tree?

(A) 10, 20, 15, 23, 25, 35, 42, 39, 30 (B) 15, 10, 25, 23, 20, 42, 35, 39, 30

(C) 15, 20, 10, 23, 25, 42, 35, 39, 30 (D) 15, 10, 23, 25, 20, 35, 42, 39, 30

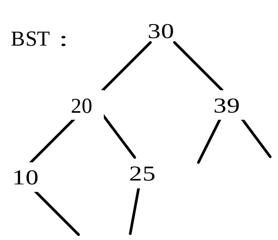
Ans: (D)

Exp:

Preorder : 30, 20, 10, 15, 25, 23, 39, 35, 42

Inorder : 10, 15, 20, 23, 25, 30, 35, 39, 42

BST :



31. What is the return value of $f(p,p)$ if the value of p is initialized to 5 before the call? Note that the first parameter is passed by reference, whereas the second parameter is passed by value.

```
int f (int & x, int c) {
    c = c − 1;
    if (c == 0) return 1;
    x = x + 1;
    return f(x, c) * x;
}
```

(A) 3024 (B) 6561 (C) 55440 (D) 161051

Ans: (B)

32. Which of the following is/are undecidable?

1. G is a CFG. Is $L(G) = \Phi$?
2. G is a CFG. IS $L(G) = \Sigma^*$?
3. M is a Turning machine. Is L(M) regular?
4. A is a DFA and N is a NFA. Is $L(A) = L(N)$?

(A) 3 only (B) 3 and 4 only (C) 1, 2 and 3 only (D) 2 and 3 only

Ans: (D)

33. Consider the following two sets of LR(1) items of an LR(1) grammar

$X \to c.X,\ c/d$ $\quad$ $X \to c.X,\ \$$
$X \to .cX,\ c/d$ $\quad$ $X \to .cX,\ \$$
$X \to .d,\ c/d$ $\quad$ $X \to .d,\ \$$

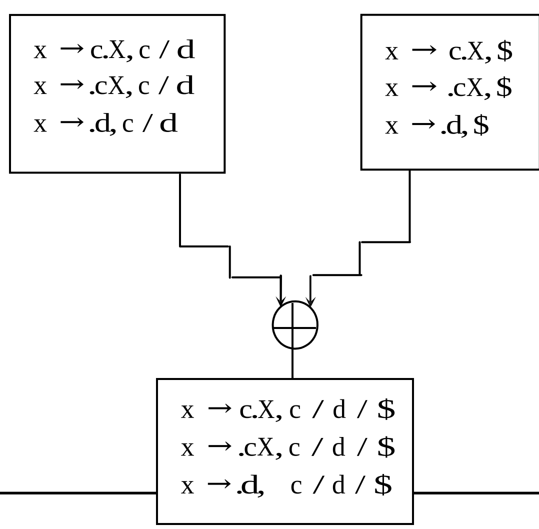
Which of the following statements related to merging of the two sets in the corresponding LALR parser is/are FALSE?

1. Cannot be merged since look aheads are different
2. Can be merged but will result in S–R conflict
3. Can be merged but will result in R–R conflict
4. Cannot be merged since goto on c will lead to two different sets

(A) 1 only (B) 2 only (C) 1 and 4 only (D) 1, 2, 3 and 4

Ans: (D)

Exp:



1. Merging of two states depends on core part (production rule with dot operator), not on look aheads.
2. The two states are not containing Reduce item ,So after merging, the merged state can not contain any S-R conflict
3. As there is no Reduce item in any of the state, so can't have R-R conflict.
4. Merging of stats does not depend on further goto on any terminal.

So all statements are false.

34. A certain computation generates two arrays a and b such that $a[i] = f(i)$ for $0 \le i < n$ and $b[i] = g(a[i])$ for $0 \le i < n$. Suppose this computation is decomposed into two concurrent processes X and Y such that X computes the array a and Y computes the array b. The processes employ two binary semaphores R and S, both initialized to zero. The array a is shared by the two processes. The structures of the processes are shown below.

```
Process X;                     Process Y;
private i;                     private i;
for (i = 0; i < n; i++) {      for (i = 0; i < n; i++) {
    a[i] = f(i);                   EntryY(R, S);
    ExitX(R, S);                   b[i] = g(a[i]);
}                              }
```

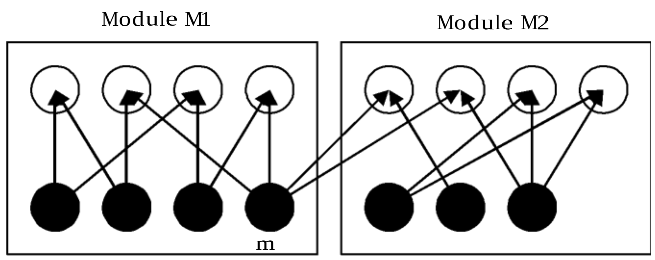
Which one of the following represents the CORRECT implementations of ExitX and EntryY?

```
(A) ExitX(R, S) {              (B) ExitX(R, S) {
        P(R);                          V(R);
        V(S);                          V(S);
    }                              }
    EntryY(R, S) {                 EntryY(R, S) {
        P(S);                          P(R);
        V(R);                          P(S);
    }                              }

(C) ExitX(R, S) {              (D) ExitX(R, S) {
        P(S);                          V(R);
        V(R);                          P(S);
    }                              }
    EntryY(R, S) {                 EntryY(R, S) {
        V(S);                          V(S);
        P(R);                          P(R);
    }                              }
```

Ans: (B)

35. The following figure represents access graphs of two modules M1 and M2. The filled circles represent methods and the unfilled circles represent attributes. IF method m is moved to module M2 keeping the attributes where they are, what can we say about the average cohesion and coupling between modules in the system of two modules?



(A) There is no change.

(B) Average cohesion goes up but coupling is reduced

(C) Average cohesion goes down and coupling also reduces

(D) Average cohesion and coupling increase

Ans: (B)

36. In an IPv4 datagram, the M bit is 0, the value of HLEN is 10, the value of total length is 400 and the fragment offset value is 300. The position of the datagram, the sequence numbers of the first and the last bytes of the payload, respectively are

(A) Last fragment, 2400 and 2789 (B) First fragment, 2400 and 2759

(C) Last fragment, 2400 and 2759 (D) Middle fragment, 300 and 689

Ans: (C)

37. Determine the maximum length of cable (in km) for transmitting data at a rate of 500 Mbps in an Ethernet LAN with frames of size 10,000 bits. Assume the signal speed in the cable to be 2,00,000 km/s

(A) 1 (B) 2 (C) 2.5 (D) 5

Ans: (B)

Exp:

500×10^6 bits ------1 sec

$\therefore 10^4$ bits ------ $\frac{5 \times 10^8}{10^4} = \frac{10^4}{5 \times 10^8}$ sec $= \frac{1}{5 \times 10^4}$ sec

1 sec------2×10^5 km

$\therefore \frac{1}{5 \times 10^4}$ sec----- $\frac{2 \times 10^5}{5 \times 10^4} = 4$ km

$\therefore$ Maximum length of cable $= \frac{4}{2} = 2$ km

38. Consider the following relational schema.
Students(rollno:integer, sname: string) Courses(courseno: integer, cname: string) Registration(rollno:integer,courseno; integer, percent: real)
Which of the following queries are equivalent to this query in English?
"Find the distinct names of all students who score more than 90% in the course numbered 107"

(I) SELECT DISTINCT S.sname
FROM Students as S, Registration as R
WHERE R.rollno=S.rollno AND R.Courseno=107 AND R.percent>90

(II) $\Pi_{sname}\left(\sigma_{courseno=107} \wedge percent > 90 \left(Registration \quad Students\right)\right)$

(III) $\{T \mid \exists S \in Students, \exists R \in Registration\ (S.rollno = R.rollno \wedge R.courseno = 107 \wedge R.percent > 90 \wedge T.sname = S.name)\}$

(IV) $\left\{< S_N > \mid \exists S_R \exists R_P \left(< S_R, S_N > \in Students \wedge < S_R, 107, R_P > \in Registration \wedge R_P > 90\right)\right\}$

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

Ans: (A)

39. A shared variable x, initialized to zero, is operated on by four concurrent processes W, X, Y, Z as follows. Each of the processes W and X reads x from memory, increments by one, stores it to memory, and then terminates. Each of the processes Y and Z reads x from memory, decrements by two, stores it to memory, and then terminates. Each process before reading x invokes the P operation (i.e., wait) on a counting semaphore S and invokes the V operation (i.e., signal) on the semaphore S after storing x to memory. Semaphore S is initialized to two. What is the maximum possible value of x after all processes complete execution?

(A) –2 (B) –1 (C) 1 (D) 2

Ans: (D)

Exp:

	W	X	Y	Z
1	R(x)	R(x)	R(x)	R(x)
2	x++	x++	x=x-2;	x=x-2;
3	w(x)	w(x)	w(x)	w(x)

R(x) is to read x from memory, w(x) is to store x in memory

(I) w_1 $\left(x\ \boxed{0}\right)$ W is Preempted

(II) Y_1, Y_2, Y_3 $\left(x\ \boxed{-2}\right)$ Y is completed

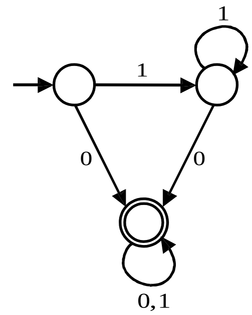
(III) Z_1, Z_2, Z_3 $\left(x\ \boxed{-4}\right)$ Z is completed

(IV)
W_2, W_3 $\left(x\ \boxed{1}\right)$ It increments local copy of x and stores & W is completed

(V) X_1, X_2, X_3 $\left(x\ \boxed{2}\right)$ X is completed

Maximum value of x = 2

40. Consider the DFA given below.



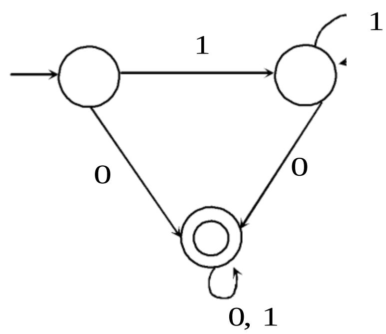
Which of the following are FALSE?

1. Complement of L(A) is context–free
2. $L(A) = L((11*0+0)(0+1)*0*1*)$
3. For the language accepted by A, A is the minimal DFA
4. A accepts all strings over {0, 1} of length at least 2

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

Ans: (D)

Exp:



(1) L(A) is regular, its complement is also regular.
Hence complement of L(A) is CFL.

(2) $L(A) = (11*0+0)(0+1)*\ 0*\ 1* = 1*0\ (0+1)*$
Language has all strings where each string contains '0'.

(3) A is not minimal, it can be constructed with 2 states

(4) Language has all strings, where each string contains '0'. (atleast length one)

41. Consider the following languages

$L_1 = \{0^p1^q0^r \mid p, q, r \geq 0\}$

$L_2 = \{0^p1^q0^r \mid p, q, r \geq 0,\ p \neq r\}$

Which one of the following statements is FALSE?

(A) L_2 is context–free

(B) $L_1 \cap L_2$ is context–free

(C) Complement of L_2 is recursive

(D) Complement of L_1 is context–free but not regular

Ans: (D)

Exp: $L_1 = \{0^p 1^q 0^r \mid p,q,r \geq 0\}$ is regular

$L_2 = \{0^p 1^q 0^r \mid p,q,r \geq 0,\ p \neq r\}$ is CFL

(A) L_2 is CFL (True)

(B) $L_1 \cap L_2$ = CFL (True)

(C) L_2 complement is recursive (True)

(D) L_1 complement is CFL but not regular (False) $\Rightarrow \overline{L_1}$ is regular

42. Consider the following function

```
int unknown(int n){
        int i, j, k = 0;
        for (i = n/2; i <= n; i++)
            for (j = 2; j <= n; j = j*2)
            k = k + n/2;
        return (k);
}
```

(A) $\Theta(n^2)$ (B) $\Theta(n^2 \log n)$ (C) $\Theta(n^3)$ (D) $\Theta(n^3 \log n)$

Ans: (B)

Exp: $i = \left\{\frac{n}{2}, \frac{n}{2}+1, \frac{n}{2}+2, ------n\right\}$

Repeats $\frac{n}{2}$ to $n = \left(\frac{n}{2}+1\right)$ times $\boxed{\left.\begin{array}{l} J = (2, 2^2, 2^3, 2^4, ------n) \\ k = k + \frac{n}{2} \end{array}\right\} k = \theta(n \log n)}$

$k = \frac{n}{2} + \frac{n}{2} + ----\log n \text{ times} = \frac{n}{2}\log n$

$= \frac{n}{2}\log n + \frac{n}{2}\log n + \frac{n}{2}\log n ---- \left(\frac{n}{2}+1\right) \text{times}$

$= \left(\frac{n}{2}+1\right)\frac{n}{2}\log n$

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

43. The number of elements that can be sorted in $\Theta(\log n)$ time using heap sort is

(A) $\Theta(1)$ (B) $\Theta\left(\sqrt{\log n}\right)$ (C) $\Theta\left(\frac{\log n}{\log \log n}\right)$ (D) $\Theta(\log n)$

Ans: (A)