MCQ (Discrete Mathematics)

Counting and Probability

1. If A and $\bar{A}$ are complementary events, then P($\bar{A}$) = ……….
   a) 1+P(A)
   b) 1-P(A)
   c) P(A)
   d) – P(A)

2. If A and B are independent events then, conditional probability P(A/B) = ……….
   a) P(A)-P(B)
   b) P(A)
   c) P(B)
   d) P(A)+P(B)

3. If A and B are independent events then, P(A∩B) = ……….
   a) P(A)
   b) P(B)
   c) P(A) + P(B)
   d) P(A) × P(B)

4. Probability can be ……….
   a) Greater than or equal to 10
   b) Greater than 1
   c) Less than 0
   d) Between 0 and 1

5. When two dice are tossed, probability of getting six as uppermost face on both the dice is
   a) ½
   b) 1/6
   c) 1/36
   d) 1/3

6. Which one of the following can be probability ratio ?
   a) 3/2
   b) 17/11
   c) 2/3
   d) -1/2

7. If from a pack of 52 well shuffled cards a card is drawn, the chances of getting a queen is ……….
   a) ¼
   b) 1/52
   c) 1/3
   d) 1/13

8. A box contains 2 red marble balls, 3 white marble balls, 5 green marble balls. If 2 balls are drawn at random, the chances of getting both white is ……….
   a) 2/3
   b) 3/10
   c) 2/10
   d) 3/45

9. All possible outcomes of a statistical experiments are called ……….
   a) Cyber space
   b) Sample space
   c) Space
   d) Experiment

10. An occurrence of an outcome to any statistical experiment is called ……….
   a) Sample space
   b) Experiment
   c) Event
   d) Probability

11. A statistical experiment means ……….
   a) Action which has reaction
   b) Action which has a certain outcome
   c) Action which has no outcome
   d) Action which has uncertain outcome

12. Two events are said to be mutually exclusive when ……….
   a) Both of them occur together
   b) None of them occur
   c) Occurrence is uncertain
   d) Only one them occurs

13. For a statistical experiment every possible outcome is called ……….
   a) Sample
   b) Sample point
   c) Space
   d) Population

14. Two events are said to be exhaustive when ……….
   a) Both of them occur together
   b) Occurrence of one avoids occurrence of other
   c) Occurrence or non-occurrence of one affect occurrence of other event
   d) Taken together constitute sample space

15. Two events are said to be independent if ……….
   a) Occurrence of one prevents occurrence of other
   b) Occurrence or non-occurrence of one does not affect occurrence of other
   c) Both of them always occurs together
   d) Only one of them can occur at a time

16. Complementary events are ……….
    a) Not mutually exclusive
    b) Independent
    c) Exhaustive
    d) Impossible event

17. Complementary events are ……….
    a) Mutually exclusive
    b) Independent
    c) Exhaustive
    d) Impossible event

18. If P(A) denotes probability of event A then ……….
    a) $0 \geq P(A) \geq 1$ is true
    b) $1 \leq P(A) \leq 0$ is true
    c) $-1 \leq P(A) \leq 0$ is true
    d) $0 \leq P(A) \leq 1$ is true

19. An unbiased coin is tossed twice, if A denotes the event all tails then P(A) ……….
    a) ¼
    b) ½
    c) ¾
    d) 1

20. If A and B are any two events associated with an experiment, then probability of occurrence of events A or B or both A and B is given by ……….
    a) Complementary probability theorem
    b) Multiplication theorem of probability
    c) Addition theorem of probability
    d) Joint probability theorem

21. If A and B are any two events associated with an experiment, then probability of occurrence of both A and B simultaneously is given by ……….
    a) Complementary probability theorem
    b) Multiplication theorem of probability
    c) Addition theorem of probability
    d) Bayes theorem of probability

22. If A and B are any two events associated with an experiment, the probability of occurrence of event A or B or both A and B is expressed as ……….
    a) $A \cap B$
    b) $A \cup B$
    c) $\bar{A} \cap B$
    d) $A \cap \bar{B}$

23. If A and B are any two events associated with an experiment, the probability of occurrence of both A and B simultaneously is expressed as ……….
    a) $A \cap B$
    b) $A \cup B$
    c) $\bar{A} \cap B$

c) $A \cap \bar{B}$

24. If A and B are any two events associated with an experiment, then probability of occurrence of only A is expressed as ……….
    a) A ∩ B
    b) A∪ B
    c) $\bar{A}$ ∩ B
    $d)$ $A \cap \bar{B}$

25. For variable x can assume values 10 or 50 with probabilities ¾ and ¼ respectively then expected value of variable is ……….
    a) 30
    b) 20
    c) 40
    d) 10

26. A bag contains 3 copper coins and 7 silver coins. If a coin is drawn, then the chance to get a silver coin is ……….
    a) 7/3
    b) 3/7
    c) 7/10
    d) 3/10

27. A variable x capable of taking values x1, x2, x3, ……, xn with respective probabilities p1, p2, p3, ….. , pn then it is called ……….
    a) Continuous random
    b) Continuous
    c) Discrete random
    d) Discrete

28. If a variable x assumes values x1, x2, x3, ……, xn with respective probabilities p1, p2, p3, ….. , pn then it is called probability distribution provided ……….
    a) Pi ≥ 0 and sum of (Pi) < 1
    b) 0 ≤ Pi ≤ 1 and sum of (Pi) > 1
    c) Pi ≤ 1 and sum of (Pi) = 1
    d) 0 ≤ Pi ≤ 1 and sum of (Pi) = 1

29. A bag contains 4 coins of Rs.5 , 6 coins of Rs.2 , a coin is drawn at random, the expected gain is ……….
    a) 3.5
    b) 5
    c) 8.5
    d) 3.2

30. How many friends must you have to guarantee so that at least 5 of them will have their birthdays in the same month?
    a) 47
    b) 48

c) 49
d) 50

31. How many minimum people are required to guarantee, then at least two of them are born exactly at the same time?

a) 86401
b) 86402
c) 86403
d) 86404

32. How many numbers must be selected from the set {1, 2, 3, 4, 5, 6} to guarantee that at least one pair of these numbers add up to 7?
a) 3
b) 4
c) 5
d) 2

33. There are 38 different time periods during which classes at a university can be scheduled. If there are 677 different classes, how many different rooms will be needed?
a) 16
b) 17
c) 18
d) 19

34. In a class of 50 students, how many minimum number of students are there who were born in the same month?
a) 2
b) 3
c) 4
d) 5

35. Suppose a computer installation how 4 I/O units (A, B, C and D) and 3 CPU's (X, Y and Z). Any I/O unit can be paired with any CPU. How many ways are there to pair an I/O unit with CPU?
a) 11
b) 12
c) 13
d) 14

36. A typical PIN is a sequence of any 4 symbols chosen from 26 letters in the alphabet and 10 digits. How many different PIN's are possible?
a) 1679614
b) 1679615
c) 1679616
d) 1679617

37. Three newspapers A, B and C are published in a city and a survey readers indicate the following : 20% read A, 16% read B, 14% read C, 8% read A and B, 5% read A and C, 4% read B and C and 2% read all the 3. For a person chosen at random, find the probability that he reads at least one of the papers.
a) 35%
b) 65%
c) 75%
d) 25%

38. Given P(B) = 1/6, P(A∩B) = 1/6. Find P(A/B)
a) 1/3
b) 2/3
c) 1/6
d) ¼

39. Find the expected number of heads that can be obtained in a throw of 2 coins.
a) 0
b) 1
c) 2
d) 5

40. The probability that A hits a target is 1/3 and the probability that B hits the target is 2/5 . What is the probability that target will be hit if A and B shoot at the target?
a) 3/5
b) 1/3
c) 2/5
d) 2/15

41. The flag of a newly formed forum is in the form of three blocks, each to be colored differently. If there are six different colors to from, how many such designs ax possible?
a) 120
b) 100
c) 150
d) 170

42. Six students have taken an examination. In how many ways can first three positions be declared?
a) 120
b) 100
c) 150
d) 170

43. How many different signals, each consisting of six flags hung in a vertical line can be formed four identical red flags and two identical blue flags?
a) 10
b) 15
c) 20
d) 17

44. There are 12 points in a plane, no three of which are collinear. Find a) How many straight lines can be drawn? b) How many triangles can be drawn?
66 and 220

45. At an election there are 5 candidates and 3 members are to be elected and a voter is entitled to vote for any number to be elected but not more than members to be elected. In how many ways a voter can caste his vote?
a) 15
b) 20
c) 25
d) 30

Set theory and Logic

1. The set O of odd positive integers less than 10 can be expressed by ______________
   a) {1, 2, 3}
   b) {1, 3, 5, 7, 9}
   c) {1, 2, 5, 9}
   d) {1, 5, 7, 9, 11}
2. Power set of empty set has exactly _________ subset.
   a) One
   b) Two
   c) Zero
   d) Three
3. What is the Cartesian product of A = {1, 2} and B = {a, b}?
   a) {(1, a), (1, b), (2, a), (b, b)}
   b) {(1, 1), (2, 2), (a, a), (b, b)}
   c) {(1, a), (2, a), (1, b), (2, b)}
   d) {(1, 1), (a, a), (2, a), (1, b)}
4. What is the cardinality of the set of odd positive integers less than 10?
   a) 10
   b) 5
   c) 3
   d) 20
5. Which of the following two sets are equal?
   a) A = {1, 2} and B = {1}
   b) A = {1, 2} and B = {1, 2, 3}
   c) A = {1, 2, 3} and B = {2, 1, 3}
   d) A = {1, 2, 4} and B = {1, 2, 3}
6. The set of positive integers is ______________
   a) Infinite
   b) Finite
   c) Subset
   d) Empty
7. What is the Cardinality of the Power set of the set {0, 1, 2}?
   a) 8
   b) 6
   c) 7
   d) 9
8. 10. The members of the set S = {x | x is the square of an integer and x < 100} is _________________
   a) {0, 2, 4, 5, 9, 58, 49, 56, 99, 12}
   b) {0, 1, 4, 9, 16, 25, 36, 49, 64, 81}
   c) {1, 4, 9, 16, 25, 36, 64, 81, 85, 99}
   d) {0, 1, 4, 9, 16, 25, 36, 49, 64, 121}
9. {x: x is an integer neither positive nor negative} is ________
   a) Empty set
   b) Non-empty set
   c) Finite set
   d) Non- empty and Finite set
10. Write set {1, 5, 15, 25,…} in set-builder form.
    a) {x: either x=1 or x=5n, where n is a real number}

b) {x: either x=1 or x=5n, where n is a integer}
c) {x: either x=1 or x=5n, where n is an odd natural number}
d) {x: x=5n, where n is a natural number}

11. Express {x: x= n/ (n+1), n is a natural number less than 7} in roster form.
a) {$\frac{1}{2}$, $\frac{2}{3}$, $\frac{4}{5}$, $\frac{6}{7}$}
b) {$\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{4}$, $\frac{4}{5}$, $\frac{5}{6}$, $\frac{6}{7}$, $\frac{7}{8}$}
c) {$\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{4}$, $\frac{4}{5}$, $\frac{5}{6}$, $\frac{6}{7}$}
d) Infinite set
12. Number of power set of {a, b}, where a and b are distinct elements.
a) 3
b) 4
c) 2
d) 5
13. {x: x ∈ N and x is prime} then it is _________
a) Infinite set
b) Finite set
c) Empty set
d) Not a set
14. Convert set {x: x is a positive prime number which divides 72} in roster form.
a) {2, 3, 5}
b) {2, 3, 6}
c) {2, 3}
d) {∅}
15. The union of the sets {1, 2, 5} and {1, 2, 6} is the set _________________
a) {1, 2, 6, 1}
b) {1, 2, 5, 6}
c) {1, 2, 1, 2}
d) {1, 5, 6, 3}
16. The intersection of the sets {1, 2, 5} and {1, 2, 6} is the set ______________
a) {1, 2}
b) {5, 6}
c) {2, 5}
d) {1, 6}
17. Two sets are called disjoint if there ______________ is the empty set.
a) Union
b) Difference
c) Intersection
d) Complement
18. Which of the following two sets are disjoint?
a) {1, 3, 5} and {1, 3, 6}
b) {1, 2, 3} and {1, 2, 3}
c) {1, 3, 5} and {2, 3, 4}
d) {1, 3, 5} and {2, 4, 6}
19. The difference of {1, 2, 3} and {1, 2, 5} is the set _____________
a) {1}
b) {5}
c) {3}
d) {2}
20. The complement of the set A is ______________
a) A – B
b) U – A

c) A – U
d) B – A

21. The set difference of the set A with null set is __________
a) A
b) null
c) U
d) B
22. If n(A)=20 and n(B)=30 and n(A U B) = 40 then n(A ∩ B) is?
a) 20
b) 30
c) 40
d) 10
23. In the given figure the if n(A)=20,n(U)=50,n(C)=10 and n(A∩B)=5 then n(B)=?
a) 35
b) 20
c) 30
d) 10
Explanation: Here n(B)= n(U) – n(A) + n(A∩B).
24. Let the students who likes table tennis be 12, the ones who like lawn tennis 10, those who like only table tennis are 6, then number of students who likes only lawn tennis are, assuming there are total of 16 students.
a) 16
b) 8
c) 4
d) 10
Explanation: The students who only plays lawn tennis will be a total lawn tennis player – those who play both the sports.

25. If set A has 4 elements and B has 3 elements then set n(A X B) is?
a) 12
b) 14
c) 24
d) 7
26. If set A and B have 3 and 4 elements respectively then the number of subsets of set (A X B) is?
a) 1024
b) 2048
c) 512
d) 4096
27. Which of the following statement is a proposition?
a) Get me a glass of milkshake
b) God bless you!
c) What is the time now?
d) The only odd prime number is 2
28. What is the value of x after this statement, assuming the initial value of x is 5?
‘If x equals to one then x=x+2 else x=0’.
a) 1
b) 3
c) 0
d) 2
29. Let P: I am in Bangalore.; Q: I love cricket.; then q -> p(q implies p) is?
a) If I love cricket then I am in Bangalore

b) If I am in Bangalore then I love cricket
c) I am not in Bangalore
d) I love cricket

30. Let P: If Sahil bowls, Saurabh hits a century.; Q: If Raju bowls, Sahil gets out on first ball. Now if P is true and Q is false then which of the following can be true?
a) Raju bowled and Sahil got out on first ball
b) Raju did not bowled
c) Sahil bowled and Saurabh hits a century
d) Sahil bowled and Saurabh got out

31. Let P: I am in Delhi.; Q: Delhi is clean.; then q ^ p(q and p) is?
a) Delhi is clean and I am in Delhi
b) Delhi is not clean or I am in Delhi
c) I am in Delhi and Delhi is not clean
d) Delhi is clean but I am in Mumbai

32. Let P: This is a great website, Q: You should not come back here. Then 'This is a great website and you should come back here.' is best represented by?
a) ~P V ~Q
b) P ∧ ~Q
c) P V Q
d) P ∧ Q

33. Let P: We should be honest., Q: We should be dedicated., R: We should be overconfident. Then 'We should be honest or dedicated but not overconfident.' is best represented by?
a) ~P V ~Q V R
b) P ∧ ~Q ∧ R
c) P V Q ∧ R
d) P V Q ∧ ~R

34. What is the dual of (A ∧ B) v (C ∧ D)?
a) (A V B) v (C v D)
b) (A V B) ^ (C v D)
c) (A V B) v (C ∧ D)
d) (A ∧ B) v (C v D)

35. Negation of statement (A ∧ B) → (B ∧ C) is ______________
a) (A ∧ B) →(~B ∧ ~C)
b) ~(A ∧ B) v (B v C)
c) ~(A →B) →(~B ∧ C)
d) None of the mentioned

36. ~ A v ~ B is logically equivalent to?
a) ~ A → ~ B
b) ~ A ∧ ~ B
c) A → ~B
d) B V A

37. If A is any statement, then which of the following is a tautology?
a) A ∧ F
b) A ∨ F
c) A ∨ ¬A
d) A ∧ T

38. If A is any statement, then which of the following is not a contradiction?
a) A ∧ ¬A
b) A ∨ F
c) A ∧ F
d) None of mentioned

39. A compound proposition that is neither a tautology nor a contradiction is called a ___________
    a) Contingency
    b) Equivalence
    c) Condition
    d) Inference
40. What is the contrapositive of the conditional statement? "The home team misses whenever it is drizzling?"
    a) If it is drizzling, then home team misses
    b) If the home team misses, then it is drizzling
    c) If it is not drizzling, then the home team does not misses
    d) If the home team wins, then it is not drizzling
41. What is the converse of the conditional statement "If it ices today, I will play ice hockey tomorrow."
    a) "I will play ice hockey tomorrow only if it ices today."
    b) "If I do not play ice hockey tomorrow, then it will not have iced today."
    c) "If it does not ice today, then I will not play ice hockey tomorrow."
    d) "I will not play ice hockey tomorrow only if it ices today."
42. What are the inverse of the conditional statement "If you make your notes, it will be a convenient in exams."
    a) "If you make notes, then it will be a convenient in exams."
    b) "If you do not make notes, then it will not be a convenient in exams."
    c) "If it will not be a convenient in exams, then you did not make your notes."
    d) "If it will be a convenient in exams, then you make your notes
43. $p \rightarrow q$ is logically equivalent to ________
    a) $\neg p \vee \neg q$
    b) $p \vee \neg q$
    c) $\neg p \vee q$
    d) $\neg p \wedge q$
44. $\neg (p \leftrightarrow q)$ is logically equivalent to ________
    a) $q \leftrightarrow p$
    b) $p \leftrightarrow \neg q$
    c) $\neg p \leftrightarrow \neg q$
    d) $\neg q \leftrightarrow \neg p$
45. $p \leftrightarrow q$ is logically equivalent to ________
    a) $(p \rightarrow q) \rightarrow (q \rightarrow p)$
    b) $(p \rightarrow q) \vee (q \rightarrow p)$
    c) $(p \rightarrow q) \wedge (q \rightarrow p)$
    d) $(p \wedge q) \rightarrow (q \wedge p)$

Logic and method of proofs

1. Let P (x) denote the statement “x >7.” Which of these have truth value true?
   a) P (0)
   b) P (4)
   c) P (6)
   d) P (9)
2. “The product of two negative real numbers is not negative.” Is given by?
   a) $\exists x\ \forall y\ ((x < 0) \wedge (y < 0) \rightarrow (xy > 0))$
   b) $\exists x\ \exists y\ ((x < 0) \wedge (y < 0) \wedge (xy > 0))$
   c) $\forall x\ \exists y\ ((x < 0) \wedge (y < 0) \wedge (xy > 0))$
   d) $\forall x\ \forall y\ ((x < 0) \wedge (y < 0) \rightarrow (xy > 0))$
3. Express, “The difference of a real number and itself is zero” using required operators.
   a) $\forall x(x - x! = 0)$
   b) $\forall x(x - x = 0)$
   c) $\forall x \forall y(x - y = 0)$
   d) $\exists x(x - x = 0)$
4. The premises $(p \wedge q) \vee r$ and $r \rightarrow s$ imply which of the conclusion?
   a) $p \vee r$
   b) $p \vee s$
   c) $p \vee q$
   d) $q \vee r$
5. What rules of inference are used in this argument?
   “Jay is an awesome student. Jay is also a good dancer. Therefore, Jay is an awesome student and a good dancer.”
   a) Conjunction
   b) Modus ponens
   c) Disjunctive syllogism
   d) Simplification
   Explanation: $((p) \wedge (q)) \rightarrow (p \wedge q)$ argument is conjunction.
6. “Parul is out for a trip or it is not snowing” and “It is snowing or Raju is playing chess” imply that __________
   a) Parul is out for trip
   b) Raju is playing chess
   c) Parul is out for a trip and Raju is playing chess
   d) Parul is out for a trip or Raju is playing chess
   Explanation: Let p be “It is snowing,” q be “Parul is out for a trip,” and r the proposition “Raju is playing chess.” The hypotheses as $\neg p \vee q$ and $p \vee r$, respectively. Using resolution, the proposition $q \vee r$ is, “Parul is out for a trip or Raju is playing chess.”
7. Let the statement be “If n is not an odd integer then square of n is not odd.”, then if P(n) is “n is an not an odd integer” and Q(n) is “(square of n) is not odd.” For direct proof we should prove _________
   a) $\forall nP ((n) \rightarrow Q(n))$
   b) $\exists\ nP ((n) \rightarrow Q(n))$
   c) $\forall n{\sim}(P ((n)) \rightarrow Q(n))$
   d) $\forall nP ((n) \rightarrow {\sim}(Q(n)))$
8. Which of the following can only be used in disproving the statements?
   a) Direct proof
   b) Contrapositive proofs

c) Counter Example
d) Mathematical Induction

9. Let the statement be “If n is not an odd integer then sum of n with some not odd number will not be odd.”, then if P(n) is “n is an not an odd integer” and Q(n) is “sum of n with some not odd number will not be odd.” A proof by contraposition will be ________
a) ∀nP ((n) → Q(n))
b) ∃ nP ((n) → Q(n))
c) ∀n~(P ((n)) → Q(n))
d) ∀n(~Q ((n)) → ~(P(n)))
10. In proving √5 as irrational, we begin with assumption √5 is rational in which type of proof?
a) Direct proof
b) Proof by Contradiction
c) Vacuous proof
d) Mathematical Induction
11. The greatest common divisor of 12 and 18 is?
a) 2
b) 3
c) 4
d) 6
12. The greatest common divisor of 7 and 5 is?
a) 1
b) 2
c) 5
d) 7
13. The quotient when 19 is divided by 6 is?
a) 1
b) 2
c) 3
d) 0
14. The remainder when 111 is divided by 12 is?
a) 0
b) 1
c) 2
d) 3
15. The quotient and remainder when -1 is divided by 3 is?
a) -1 and -1
b) -1 and 2
c) 1 and 2
d) -1 and -2
16. The value of 12 mod 3 is?
a) 0
b) 1
c) 2
d) 3
17. The value of 155 mod 9 is?
a) 0
b) 1
c) 2
d) 3

18. If a|b and a|c, then?
    a) a|bc
    b) c|a
    c) a|(b+c)
    d) b|a
19. The quotient and remainder when 18 is divided by 5 is?
    a) 2 and 3
    b) 1 and 2
    c) 3 and 2
    d) 3 and 3
20. The value of 15 mod 11 is?
    a) 1
    b) 2
    c) 3
    d) 4
21. A floor function map a real number to ___________
    a) smallest previous integer
    b) greatest previous integer
    c) smallest following integer
    d) none of the mentioned
22. A ceil function map a real number to __________
    a) smallest previous integer
    b) greatest previous integer
    c) smallest following integer
    d) none of the mentioned
23. Floor(2.4) + Ceil(2.9) is equal to __________
    a) 4
    b) 6
    c) 5
    d) none of the mentioned
24. If x, and y are positive numbers both are less than one, then maximum value of floor(x + y) is?
    a) 0
    b) 1
    c) 2
    d) -1

    Explanation: Since x < 1 and y < 1 this implies x + y < 2 which means maximium value of floor(x + y) is 1.
25. If x, and y are positive numbers both are less than one, then maximum value of ceil(x + y) is?
    a) 0
    b) 1
    c) 2
    d) -1

    Explanation: Since x < 1 and y < 1 this implies x + y < 2 which means maximum value of ceil(x + y) is 2
26. If X = Floor(X) = Ceil(X) then __________
    a) X is a fractional number
    b) X is a Integer
    c) X is less than 1
    d) none of the mentioned

27. The number of factors of prime numbers are ___________
    a) 2
    b) 3
    c) Depends on the prime number
    d) None of the mentioned
28. How many prime numbers are there between 1 to 20?
    a) 5
    b) 6
    c) 7
    d) 8
29. If a, b, c, d are distinct prime numbers with an as smallest prime then a * b * c * d is a ___________
    a) Odd number
    b) Even number
    c) Prime number
    d) None of the mentioned
30. If a, b are two distinct prime number than a highest common factor of a, b is ___________
    a) 2
    b) 0
    c) 1
    d) ab

Sequences, Mathematical induction, Recursion and Functions

1. For the sequence 1, 7, 25, 79, 241, 727 … simple formula for $\{a_n\}$ is _____________
   a) $3^{n+1} – 2$
   b) $3^n – 2$
   c) $(-3)^n + 4$
   d) $n^2 – 2$
   Explanation: The ratio of consecutive numbers is close to 3. Comparing these terms with the sequence of $\{3^n\}$ which is 3, 9, 27 …. Comparing these terms with the corresponding terms of sequence $\{3^n\}$ and the nth term is 2 less than the corresponding power of 3.
2. For the sequence 0, 1, 2, 3 an is _____________
   a) $\lceil n/2\rceil+\lfloor n/2\rfloor$
   b) $\lceil n/2\rceil+\lceil n/2\rceil$
   c) $\lfloor n/2\rfloor+\lfloor n/2\rfloor$
   d) $\lfloor n/2\rfloor$
   Explanation: Expand the sequence $\lceil n/2\rceil+\lfloor n/2\rfloor$ where a1 is $\lfloor 0.5\rfloor+\lceil 0.5\rceil = 1+0 = 1$, a2 is $\lfloor 1\rfloor+\lceil 1\rceil = 1 + 1 = 2$ and so on.
3. For the sequence $a_n = \lfloor\sqrt{2n}+ 1/2\rfloor$, $a_7$is _____________
   a) 1
   b) 7
   c) 5
   d) 4
4. For the sequence $a_n = 6. (1/3)^n$, a_4 is __________
   a) 2/25
   b) 2/27
   c) 2/19
   d) 2/13
5. What is the base case for the inequality $7^n > n^3$, where n = 3?
   a) 652 > 189
   b) 42 < 132
   c) 343 > 27
   d) 42 <= 431
6. In the principle of mathematical induction, which of the following steps is mandatory?
   a) induction hypothesis
   b) inductive reference
   c) induction set assumption
   d) minimal set representation
   Explanation: The hypothesis of Step is a must for mathematical induction that is the statement is true for n = k, where n and k are any natural numbers, which is also called induction assumption or induction hypothesis.
7. For every natural number k, which of the following is true?
   a) $(mn)^k = m^k n^k$
   b) m*k = n + 1
   c) $(m+n)^k = k + 1$
   d) $m^k n = mn^k$
8. By induction hypothesis, the series $1^2 + 2^2 + 3^2 + … + p^2$ can be proved equivalent to _____________
   a) $p2+27$
   b) $p*(p+1)*(2p+1)6$

c) p∗(p+1)4
d) $p+p^2$

9. According to principle of mathematical induction, if $P(k+1) = m^{(k+1)} + 5$ is true then _____ must be true.
a) $P(k) = 3m^{(k)}$
b) $P(k) = m^{(k)} + 5$
c) $P(k) = m^{(k+2)} + 5$
d) $P(k) = m^{(k)}$
10. Which of the following is the base case for $4^{n+1} > (n+1)^2$ where n = 2?
a) 64 > 9
b) 16 > 2
c) 27 < 91
d) 54 > 8
11. What is the induction hypothesis assumption for the inequality $m ! > 2^m$ where m>=4?
a) for m=k, $k+1!>2^k$ holds
b) for m=k, $k!>2^k$ holds
c) for m=k, $k!>3^k$ holds
d) for m=k, $k!>2^{k+1}$ holds
12. Suppose that P(n) is a propositional function. Determine for which positive integers n the statement P(n) must be true if: P(1) is true; for all positive integers n, if P(n) is true then P(n+2) is true.
a) P(3)
b) P(2)
c) P(4)
d) P(6)
Explanation: By induction we can prove that P(3) is true but we can't conclude about P(2), p(6) and P(4).
13. Suppose that P(n) is a propositional function. Determine for which positive integers n the statement P(n) must be true if: P(1) and P(2) is true; for all positive integers n, if P(n) and P(n+1) is true then P(n+2) is true.
a) P(1)
b) P(2)
c) P(4)
d) P(n)

Explanation: By induction, we can prove that P(n) is true.

14. Consider the recurrence relation $a_1=4$, $a_n=5n+a_{n-1}$. The value of a_{64} is _________
a) 10399
b) 23760
c) 75100
d) 53700
Explanation: $a_n=5n+a_{n-1}$
$= 5n + 5(n-1) + \ldots + a_{n-2}$
$= 5n + 5(n-1) + 5(n - 2) +\ldots+ a_1$
$= 5n + 5(n-1) + 5(n - 2) +\ldots+ 4$ [since, a1=4]
$= 5n + 5(n-1) + 5(n - 2) +\ldots+ 5.1 - 1$
$= 5(n + (n - 1)+\ldots+2 + 1) - 1$
$= 5 * n(n+1)/ 2 - 1$
$a_n = 5 * n(n+1)/ 2 - 1$
Now, n=64 so the answer is $a_{64} = 10399$.
15. Determine the solution of the recurrence relation $F_n=20F_{n-1} - 25F_{n-2}$ where $F_0=4$ and $F_1=14$.

a) $a_n = 14*5^{n-1}$
b) $a_n = 7/2*2^n−1/2*6^n$
c) $a_n = 7/2*2^n−3/4*6^{n+1}$
d) $a_n = 3*2^n−1/2*3^n$
Explanation: The characteristic equation of the recurrence relation is → $x^2−20x+36=0$
So, (x-2)(x-18)=0. Hence, there are two real roots $x_1=2$ and $x_2=18$. Therefore the solution to the recurrence relation will have the form: $a_n=a2^n+b18^n$. To find a and b, set n=0 and n=1 to get a system of two equations with two unknowns: $4=a2^0+b18^0=a+b$ and $3=a2^1+b6^1=2a+6b$. Solving this system gives b=-1/2 and a=7/2. So the solution to the recurrence relation is,
$a_n = 7/2*2^n−1/2*6^n$.

16. What is the recurrence relation for 1, 7, 31, 127, 499?
a) $b_{n+1}=5b_{n-1}+3$
b) $b_n=4b_n+7!$
c) $b_n=4b_{n-1}+3$
d) $b_n=b_{n-1}+1$

Explanation: Look at the differences between terms: 1, 7, 31, 124,…. and these are growing by a factor of 4. So, 1·4=4, 7·4=28, 31·4=124, and so on. Note that we always end up with 3 less than the next term. So, $b_n=4b_{n-1}+3$ is the recurrence relation and the initial condition is $b_0=1$.

17. If $S_n=4S_{n-1}+12n$, where $S_0=6$ and $S_1=7$, find the solution for the recurrence relation.
a) $a_n=7(2^n)−29/6n6^n$
b) $a_n=6(6^n)+6/7n6^n$
c) $a_n=6(3^{n+1})−5n$
d) $a_n=nn−2/6n6^n$

Explanation: The characteristic equation of the recurrence relation is → $x^2−4x-12=0$
So, (x-6)(x+2)=0. Only the characteristic root is 6. Therefore the solution to the recurrence relation will have the form: $a_n=a.6^n+b.n.6^n$. To find a and b, set n=0 and n=1 to get a system of two equations with two unknowns: $6=a6^0+b.0.6^0=a$ and $7=a6^1+b.1.6^1=2a+6b$. Solving this system gives a=6 and b=6/7. So the solution to the recurrence relation is, $a_n=6(6^n)−6/7n6^n$.

18. Find the value of a_4 for the recurrence relation $a_n=2a_{n-1}+3$, with $a_0=6$.
a) 320
b) 221
c) 141
d) 65
Explanation: When n=1, $a_1=2a_0+3$, Now $a_2=2a_1+3$. By substitution, we get $a_2=2(2a_0+3)+3$.
Regrouping the terms, we get $a_4=141$, where $a_0=6$.

19. The solution to the recurrence relation $a_n=a_{n-1}+2n$, with initial term $a_0=2$ are __________
a) 4n+7
b) 2(1+n)
c) $3n^2$
d) 5*(n+1)/2

Explanation: When n=1, $a_1=a_0+2$. By substitution we get, $a_2=a_1+2$ ⇒ $a_2=(a_0+2)+2$ and so on. So the solution to the recurrence relation, subject to the initial condition should be $a_n=2+2n=2(1+n)$.

20. Determine the solution for the recurrence relation $a_n = 6a_{n-1}−8a_{n-2}$ provided initial conditions $a_0=3$ and $a_1=5$.

a) $a_n = 4 * 2^n – 3^n$
b) $a_n = 3 * 7^n – 5*3^n$
c) $a_n = 5 * 7^n$
d) $a_n = 3! * 5^n$
Explanation: The characteristic polynomial is $x^2−6x+8$. By solving the characteristic equation, $x^2−6x+8=0$ we get x=2 and x=4, these are the characteristic roots. Therefore we know that the solution to the recurrence relation has the form $a_n=a*2^n+b*4^n$, for some constants a and b. Now, by using the initial conditions a_0 and a_1 we have: a=7/2 and b=-1/2. Therefore the solution to the recurrence relation is: $a_n = 4 * 2^n – 1*3^n = 7/2 * 2^n – 1/2*3^n$.

21. A function is said to be ______________ if and only if f(a) = f(b) implies that a = b for all a and b in the domain of f.
a) One-to-many
b) One-to-one
c) Many-to-many
d) Many-to-one

Explanation: A function is one-to-one if and only if f(a)≠f(b) whenever a≠b.

22. Which of the following function f: Z X Z → Z is not onto?
a) f(a, b) = a + b
b) f(a, b) = a
c) f(a, b) = |b|
d) f(a, b) = a – b
Explanation: The function is not onto as f(a)≠b.

23. Let f and g be the function from the set of integers to itself, defined by f(x) = 2x + 1 and g(x) = 3x + 4. Then the composition of f and g is ____________
a) 6x + 9
b) 6x + 7
c) 6x + 6
d) 6x + 8

Explanation: The composition of f and g is given by f(g(x)) which is equal to 2(3x + 4) + 1.

24. The inverse of function $f(x) = x^3 + 2$ is ____________
a) $f^{-1}(y) = (y – 2)^{1/2}$
b) $f^{-1}(y) = (y – 2)^{1/3}$
c) $f^{-1}(y) = (y)^{1/3}$
d) $f^{-1}(y) = (y – 2)$
Explanation: To find the inverse of the function equate f(x) then find the value of x in terms of y such that $f^{-1}(y) = x$.

25. The $g^{-1}(\{0\})$ for the function g(x)= ⌊x⌋ is ___________
a) {x | 0 ≤ x < 1}
b) {x | 0 < x ≤ 1}
c) {x | 0 < x < 1}
d) {x | 0 ≤ x ≤ 1}
Explanation: g({0}) for the function g(x) is {x | 0 ≤ x ≤ 1}. Put g(x) = y and find the value of x in terms of y such that ⌊x⌋ = y.

26. What is the domain of a function?
a) the maximal set of numbers for which a function is defined
b) the maximal set of numbers which a function can take values
c) it is a set of natural numbers for which a function is defined
d) none of the mentioned
Explanation: Domain is the set of all the numbers on which a function is defined. It may be real as well.

27. What is domain of function $f(x)= x^{1/2}$?
a) (2, ∞)
b) (-∞, 1)
c) [0, ∞)
d) None of the mentioned
Explanation: A square root function is not defined for negative real numbers.
28. What is the range of a function?
a) the maximal set of numbers for which a function is defined
b) the maximal set of numbers which a function can take values
c) it is set of natural numbers for which a function is defined
d) none of the mentioned
Explanation: Range is the set of all values which a function may take.
29. An injection is a function which is?
a) many-one
b) one-one
c) onto
d) none of the mentioned
Explanation: One-One functions are also known as injection.
30. A mapping $f : X \rightarrow Y$ is one one if __________
a) $f(x_1) \neq f(x_2)$ for all x_1, x_2 in X
b) If $f(x_1) = f(x_2)$ then $x_1 = x_2$ for all x_1, x_2 in X
c) $f(x_1) = f(x_2)$ for all x_1, x_2 in X
d) None of the mentioned
Explanation: In one one function every element in A should have unique image in B,thus if two image are equal this means there preimages are same.
31. If f(x) = y then $f^{-1}(y)$ is equal to __________
a) y
b) x
c) x^2
d) none of the mentioned
32. A function f(x) is defined from A to B then f^{-1} is defined __________
a) from A to B
b) from B to A
c) depends on the inverse of function
d) none of the mentioned
33. If f is a function defined from R to R, is given by f(x) = 3x – 5 then $f^{-1}(x)$ is given by __________
a) 1/(3x-5)
b) (x+5)/3
c) does not exist since it is not a bijection
d) none of the mentioned

Explanation: y = 3x-5, x = (y+5)/3, $f^{-1}(x)$ = (x+5)/3.

34. Let P(A) denote the power set of A. If P(A) ⊆ B then
(a) 2^|A| ≤ |B|
(b) 2^|A| ≥ |B|
(c) 2|A| < |B|
(d) |A| + 2 ≤ |B|
(e) 2^|A| ≥ 2 ^|B|

35. The number of partitions of {1, 2, 3, 4, 5} into three blocks is $S(5, 3) = 25$. The total number of functions $f : \{1, 2, 3, 4, 5\} \rightarrow \{1, 2, 3, 4\}$ with $|\text{Image}(f)| = 3$ is

(a) 4×6

(b) 4×25

(c) 25×6

(d) $4 \times 25 \times 6$

(e) $3 \times 25 \times 6$

Relations, Graphs and Trees

1. If R_1 and R_2 are binary relations from set A to set B, then the equality ______ holds.
   a) $(R^c)^c = R^c$
   b) $(A \times B)^c = \Phi$
   c) $(R_1 \cup R_2)^c = R_1^c \cup R_2^c$
   d) $(R_1 \cup R_2)^c = R_1^c \cap R_2^c$
   Explanation: To proof $(R_1 \cup R_2)^c = R_1^c \cup R_2^c$,
   if <x,y> belongs to $(R_1 \cup R_2)^c$
   $\Leftrightarrow$ <y,x> $\in (R_1 \cup R_2)$
   $\Leftrightarrow$ <y,x> $\in R_1$ or <y,x> $\in R_2$
   $\Leftrightarrow$ <x,y> $\in R_1^c$ or <x,y> $\in R_2^c$
   $\Leftrightarrow$ <x,y> $\in R_1^c \cup R_2^c$.

2. The condition for a binary relation to be symmetric is _______
   a) $s(R) = R$
   b) $R \cup R = R$
   c) $R = R^c$
   d) $f(R) = R$
   Explanation: If <a,b> ∈ R then <b,a> ∈ R, where a and b belong to two different sets and so its symmetric.
   R^c also contains <b,a>
   $R^c = R$.
3. ______ number of reflexive closure exists in a relation R = {(0,1), (1,1), (1,3), (2,1), (2,2), (3,0)} where {0, 1, 2, 3} ∈ A.
   a) 2^6
   b) 6
   c) 8
   d) 36
   Explanation: The reflexive closure of R is the relation, R ∪ Δ = { (a,b) | (a,b) R (a,a) | a A }. Hence, R ∪ Δ = {(0,1), (1,1), (1,3), (2,1), (2,2), (3,0)} and the answer is 6.
4. The transitive closure of the relation {(0,1), (1,2), (2,2), (3,4), (5,3), (5,4)} on the set {1, 2, 3, 4, 5} is _______
   a) {(0,1), (1,2), (2,2), (3,4)}
   b) {(0,0), (1,1), (2,2), (3,3), (4,4), (5,5)}
   c) {(0,1), (1,1), (2,2), (5,3), (5,4)}
   d) {(0,1), (0,2), (1,2), (2,2), (3,4), (5,3), (5,4)}
   Explanation: Let R be a relation on a set A. The connectivity relation on R* consists of pairs (a,b) such that there is a path of length at least one from a to b in R. Mathematically, $R^* = R^1 \cup R^2 \cup R^3 \cup \dots \cup R^n$. Hence the answer is {(0,1), (0,2), (1,2), (2,2), (3,4), (5,3), (5,4)}.
5. Amongst the properties {reflexivity, symmetry, antisymmetry, transitivity} the relation $R=\{(a,b) \in N^2 \mid a != b\}$ satisfies _______ property.
   a) symmetry
   b) transitivity
   c) antisymmetry
   d) reflexivity
   Explanation: It is not reflexive as aRa is not possible. It is symmetric as if aRb then bRa. It is not antisymmetric as aRb and bRa are possible and we can have a!=b. It is not transitive as if aRb and bRc then aRc need not be true. This is violated when c=a. So the answer is symmetry property.

6. Let R_1 and R_2 be two equivalence relations on a set. Is $R_1 \cup R_2$ an equivalence relation?
a) an equivalence relation
b) reflexive closure of relation
c) not an equivalence relation
d) partial equivalence relation
Explanation: R_1 union R_2 is not equivalence relation because transitivity property of closure need not hold. For instance, (x, y) can be in R_1 and (y, z) be in R_2 and (x, z) not in either R_1 or R_2. However, R_1 intersection R_2 is an equivalence relation.
7. A relation R is defined on the set of integers as aRb if and only if a+b is even and R is termed as ______
a) an equivalence relation with one equivalence class
b) an equivalence relation with two equivalence classes
c) an equivalence relation
d) an equivalence relation with three equivalence classes
Explanation: R is reflexive as (a+b) is even for any integer; R is symmetric as if (a+b) is even (b+a) is also even; R is transitive as if ((a+b)+c) is even, then (a+(b+c)) is also even.
So, R is an equivalence relation. For set of natural numbers, sum of even numbers always give even, sum of odd numbers always give even and sum of any even and any odd number always give odd. So, must have two equivalence classes -> one for even and one for odd.
{…, -4, -2, 0, 2, … } and {…, -3, -1, 1, 3, … }.
8. The binary relation U = Φ (empty set) on a set A = {11, 23, 35} is _____
a) Neither reflexive nor symmetric
b) Symmetric and reflexive
c) Transitive and reflexive
d) Transitive and symmetric
Explanation: U = Φ (empty set) on a set A = {11, 23, 35} need to be hold Irreflexive, symmetric, anti-symmetric, asymmetric and transitive closure property, but it is not Reflexive as it does not contain any self loop in itself.
9. The binary relation {(1,1), (2,1), (2,2), (2,3), (2,4), (3,1), (3,2)} on the set {1, 2, 3} is __________
a) reflective, symmetric and transitive
b) irreflexive, symmetric and transitive
c) neither reflective, nor irreflexive but transitive
d) irreflexive and antisymmetric
Explanation: Not reflexive -> (3,3) not present; not irreflexive -> (1, 1) is present; not symmetric -> (2, 1) is present but not (1, 2); not antisymmetric – (2, 3) and (3, 2) are present; not asymmetric -> asymmetry requires both antisymmetry and irreflexivity. So, it is transitive closure of relation.
10. Consider the binary relation, A = {(a,b) | b = a – 1 and a, b belong to {1, 2, 3}}. The reflexive transitive closure of A is?
a) {(a,b) | a >= b and a, b belong to {1, 2, 3}}
b) {(a,b) | a > b and a, b belong to {1, 2, 3}}
c) {(a,b) | a <= b and a, b belong to {1, 2, 3}}
d) {(a,b) | a = b and a, b belong to {1, 2, 3}}
Explanation: By definition of Transitive closure we have that a is related to all smaller b (as every a is related to b – 1) and from the reflexive property a is related to a.
11. Let R_1 be a relation from A = {1, 3, 5, 7} to B = {2, 4, 6, 8} and R2 be another relation from B to C = {1, 2, 3, 4} as defined below:

i. An element a in A is related to an element b in B (under R_1) if a * b is divisible by 3.
ii. An element a in B is related to an element b in C (under R_2) if a * b is even but not divisible by 3. Which is the composite relation R_1R_2 from A to C?
a) R_1R_2 = {(1, 2), (1, 4), (3, 3), (5, 4), (5,6), (7, 3)}
b) Φ
c) R_1R_2 = {(1, 2), (1,6), (3, 2), (3, 4), (5, 4), (7, 2)}
d) R_1R_2 = {(2,2), (3, 2), (3, 4), (5, 1), (5, 3), (7, 1)}
Explanation: By definition, i) R_1 = {(1,6), (3,2), (3,4), (3,6), (3,8), (5,6), (7,6)} and ii) R_2 = {(1,2), (1,4), (1,8), (5,2), (5,4), (5,8), (7,2), (7,4), (7,8)}. So, R_1R_2 = Φ.

12. Let A and B be two non-empty relations on a set S. Which of the following statements is false?
a) A and B are transitive ⇒ A∩B is transitive
b) A and B are symmetric ⇒ A∪B is symmetric
c) A and B are transitive ⇒ A∪B is not transitive
d) A and B are reflexive ⇒ A∩B is reflexive
Answer: c
Explanation: In terms of set theory, the binary relation R defined on the set X is a transitive relation if, for all a, b, c ∈ X, if aRb and bRc, then aRc. If there are two relations on a set satisfying transitive property then there union must satisfy transitive property.

13. Determine the characteristics of the relation aRb if $a^2 = b^2$.
a) Transitive and symmetric
b) Reflexive and asymmetry
c) Trichotomy, antisymmetry, and irreflexive
d) Symmetric, Reflexive, and transitive
Explanation: Since, $x^2 = y^2$ is just a special case of equality, so all properties that apply to x = y also apply to this case. Hence, the relation satisfies symmetric, reflexive and transitive closure.

14. Let R be a relation between A and B. R is asymmetric if and only if ________
a) Intersection of D(A) and R is empty, where D(A) represents diagonal of set
b) R^{-1} is a subset of R, where R^{-1} represents inverse of R
c) Intersection of R and R^{-1} is D(A)
d) D(A) is a subset of R, where D(A) represents diagonal of set
Explanation: A relation is asymmetric if and only if it is both antisymmetric and irreflexive. As a consequence, a relation is transitive and asymmetric if and only if it is a strict partial order. If D(A) is a diagonal of A set and intersection of D(A) and R is empty, then R is asymmetric.

15. Suppose X = {a, b, c, d} and π_1 is the partition of X, π_1 = {{a, b, c}, d}. The number of ordered pairs of the equivalence relations induced by __________
a) 15
b) 10
c) 34
d) 5
Explanation: The ordered pairs of the equivalence relations induced = {(a,a), (a,b), (a,c), (b,a), (b,b), (b,c), (c,a), (c,b), (c,c), (d,d)}. Poset -> equivalence relations = each partition power set – Φ.

16. The inclusion of ______ sets into R = {{1, 2}, {1, 2, 3}, {1, 3, 5}, {1, 2, 4}, {1, 2, 3, 4, 5}} is necessary and sufficient to make R a complete lattice under the partial order defined by set containment.
a) {1}, {2, 4}
b) {1}, {1, 2, 3}

c) {1}
d) {1}, {1, 3}, {1, 2, 3, 4}, {1, 2, 3, 5}
Explanation: A lattice is complete if every subset of partial order set has a supremum and infimum element. For example, here we are given a partial order set R. Now it will be a complete lattice if whatever be the subset we choose, it has a supremum and infimum element. Here relation given is set containment, so supremum element will be just union of all sets in the subset we choose. Similarly, the infimum element will be just an intersection of all the sets in the subset we choose. As R now is not complete lattice, because although it has a supremum for every subset we choose, but some subsets have no infimum. For example, if we take subset {{1, 3, 5}, {1, 2, 4}}, then intersection of sets in this is {1}, which is not present in R. So clearly, if we add set {1} in R, we will solve the problem. So adding {1} is necessary and sufficient condition for R to be a complete lattice.

17. Suppose a relation R = {(3, 3), (5, 5), (5, 3), (5, 5), (6, 6)} on S = {3, 5, 6}. Here R is known as _________
a) equivalence relation
b) reflexive relation
c) symmetric relation
d) transitive relation
Explanation: Here, [3] = {3, 5}, [5] = {3, 5}, [5] = {5}. We can see that [3] = [5] and that S/R will be {[3], [6]} which is a partition of S. Thus, we can choose either {3, 6} or {5, 6} as a set of representatives of the equivalence classes.

18. Which of the following relations is the reflexive relation over the set {1, 2, 3, 4}?
a) {(0,0), (1,1), (2,2), (2,3)}
b) {(1,1), (1,2), (2,2), (3,3), (4,3), (4,4)}
c) {,(1,1), (1,2), (2,1), (2,3), (3,4)}
d) {(0,1), (1,1), (2,3), (2,2), (3,4), (3,1)
Explanation: {(1,1), (1,2), (2,2), (3,3), (4,3), (4,4)} is a reflexive relation because it contains set = {(1,1), (2,2), (3,3), (4,4)}.

19. Determine the partitions of the set {3, 4, 5, 6, 7} from the following subsets.
a) {3,5}, {3,6,7}, {4,5,6}
b) {3}, {4,6}, {5}, {7}
c) {3,4,6}, {7}
d) {5,6}, {5,7}
Explanation: {3,5}, {3,6,7}, {4,5,6}. It is not a partition because these sets are not pairwise disjoint. The elements 3, 5 and 6 appear repeatedly these sets. {1}, {2,3,6}, {4}, {5} – this is a partition as they are pairwise disjoint. {3,4,6}, {7} – this is not a partition as element 5 is missing.
{5,6}, {5,7} – this is not a partition because it is missing the elements 3, 4 in any of the sets.

20. Determine the number of equivalence classes that can be described by the set {2, 4, 5}.
a) 125
b) 5
c) 16
d) 72
Explanation: Suppose B={2, 4, 5} and B×B = (2,2), (4,4), (5,5), (2,4), (4,2), (4,5), (5,4), (2,5), (5,2). A relation R on set B is said to be equivalence relation if R is reflexive, Symmetric, transitive. Hence, total number of equivalence relation=5 out of 2^3=8 relations.

21. Determine the set of all integers a such that a ≡ 3 (mod 7) such that $-21 \le x \le 21$.
a) {−21, −18, −11, −4, 3, 10, 16}
b) {−21, −18, −11, −4, 3, 10, 17, 24}
c) {−24, -19, -15, 5, 0, 6, 10}
d) {−23, −17, −11, 0, 2, 8, 16}
Explanation: For an integer a we have x ≡ 3 (mod 7) if and only if a = 7m + 3. Thus, by calculating multiples of 7, add 3 and restrict the value of a, so that $-21 \le x \le 21$. The set for a = {−21, −18, −11, −4, 3, 10, 17, 24}.
22. For a, b ∈ R define a = b to mean that |x| = |y|. If [x] is an equivalence relation in R. Find the equivalence relation for [17].
a) {,…,-11, -7, 0, 7, 11,…}
b) {2, 4, 9, 11, 15,…}
c) {-17, 17}
d) {5, 25, 125,…}
Explanation: We can find that [17] = {a ∈ R|a = 17} = {a ∈ R||a| = |17|} = {-17, 17} and [−17] = {a ∈ R|a = −17} = {a ∈ R||a| = |−17|}= {−17, 17}. Hence, the required equivalence relation is {-17, 17}.
23. A directed graph or digraph can have directed cycle in which ______
a) starting node and ending node are different
b) starting node and ending node are same
c) minimum four vertices can be there
d) ending node does not exist
Explanation: If the start node and end node are same in the path of a graph then it is termed as directed cycle i.e, $c_0 = c_n$. For instance, a c b a is a simple cycle in which start and end nodes are same(a). But, a c b b a is not a simple cycle as there is a loop <b,b>.
24. The graph representing universal relation is called _______
a) complete digraph
b) partial digraph
c) empty graph
d) partial subgraph
Explanation: Consider, A is a graph with vertices {a, b, c, d} and the universal relation is A x A. The graph representing universal relation is called a complete graph and all ordered pairs are present there.
25. What is a complete digraph?
a) connection of nodes without containing any cycle
b) connecting nodes to make at least three complete cycles
c) start node and end node in a graph are same having a cycle
d) connection of every node with every other node including itself in a digraph
Explanation: Every node should be connected to every other node including itself in a digraph is the complete digraph. Now, graphs are connected, strongly connected and disconnected
26. Disconnected components can be created in case of ___________
a) undirected graphs
b) partial subgraphs
c) disconnected graphs
d) complete graphs
Explanation: By the deletion of one edge from either connected or strongly connected graphs the graph obtained is termed as a disconnected graph. It can have connected components separated by the deletion of the edges. The edge that has to be deleted called cut edge.

27. A simple graph can have _______
a) multiple edges
b) self loops
c) parallel edges
d) no multiple edges, self-loops and parallel edges
Explanation: If a graph say G = <V, E> has no parallel or multiple edges and no self loops contained in it is called a simple graph. An undirected graph may have multiple edges and self-loops.
28. Degree of a graph with 12 vertices is _______
a) 25
b) 56
c) 24
d) 212
Explanation: Number of edges incident on a graph is known as degree of a vertex. Sum of degrees of each vertex is called total degree of the graph. Total degree = 2 * number of vertices. So, if there are 24 vertices then total degree is 24.
29. In a finite graph the number of vertices of odd degree is always ______
a) even
b) odd
c) even or odd
d) infinite
Explanation: In any finite graph, sum of degree of all the vertices = 2 * number of edges.
Sum of degree of all the vertices with even degree + sum of degree of all the vertices with odd degree = 2 * number of edges. Now, even number + sum of degree of all the vertices with odd degree = even number. It is possible if and only if number of odd degree vertices are even.
30. An undirected graph has 8 vertices labelled 1, 2, …,8 and 31 edges. Vertices 1, 3, 5, 7 have degree 8 and vertices 2, 4, 6, 8 have degree 7. What is the degree of vertex 8?
a) 15
b) 8
c) 5
d) 23
Explanation: Vertices 1, 3, 5, 7 have degree 8 and vertices 2, 4, 6, 8 have degree 7. By definition, sum of degree= 2 * No of edges
Let x = degree of vertex 8
8 + 7 + 8 + 7 + 8 + 7 + 8 + x = 2 * 31
53 + x = 61
x = 8
Hence, degree of vertex 8 is 8.
31. Which of the following relation is a partial order as well as an equivalence relation?
a) equal to(=)
b) less than(<)
c) greater than(>)
d) not equal to(!=)
Explanation: The identity relation = on any set is a partial order in which every two distinct elements are incomparable and that depicts the relation of both a partial order and an equivalence relation. For non-linear orders, there are many advanced properties of posets.

32. The relation ≤ is a partial order if it is ___________
    a) reflexive, antisymmetric and transitive
    b) reflexive, symmetric
    c) asymmetric, transitive
    d) irreflexive and transitive
    Explanation: Let A is a set and ≤ is a relation on A, then ≤ is a partial order if it satisfies reflexive, antisymmetric, and transitive, i.e., for all x, y and z in P. That means, x ≤ x (reflexivity);
    if x ≤ y and y ≤ x then x = y (antisymmetry) and if x ≤ y and y ≤ z then x ≤ z (transitivity).
33. In a poset P({v, x, y, z}, ⊆) which of the following is the greatest element?
    a) {v, x, y, z}
    b) 1
    c) ∅
    d) {vx, xy, yz}
    Explanation: We know that, in a Hasse diagram, the maximal element(s) are the top and the minimal elements are at the bottom of the diagram. In the given poset, {v, x, y, z} is the maximal or greatest element and ∅ is the minimal or least element.
34. Let G be the graph defined as the Hasse diagram for the ⊆ relation on the set S{1, 2,…, 18}. How many edges are there in G?
    a) 43722
    b) 2359296
    c) 6487535
    d) 131963
    Explanation: Here the total number of elements in S is 18 and so number of vertices in Hasse diagram are 2^{18}. Hence, the number of edges in Hasse diagram are 18 * 2^{18-1}=2359296.
35. In a ______ the degree of each and every vertex is equal.
    a) regular graph
    b) point graph
    c) star graph
    d) euler graph
36. If each and every vertex in G has degree at most 23 then G can have a vertex colouring of __________
    a) 24
    b) 23
    c) 176
    d) 54
    Explanation: A vertex colouring of a graph G = (V',E') with m colours is a mapping f:V' -> {1,…,m} such that f(u)!=f(v) for every (u,v) belongs to E'. Since in worst case the graph can be complete, d+1 colours are necessary for graph containing vertices with degree at most 'd'. So, the required answer is 24.
37. If G is the forest with 54 vertices and 17 connected components, G has _______ total number of edges.
    a) 38
    b) 37
    c) 17/54
    d) 17/53
    Explanation: Here we are given a forest with 54 vertices and 17 components. A component is itself a tree and since there are 17 components means that every component has a root, therefore we have 17 roots. Each new vertex of the forest

contributes to a single edge to a forest. So for remaining 54-17 = 37 vertices we can have m-n=37 edges. Hence, answer is 37.

38. The number of edges in a regular graph of degree 46 and 8 vertices is ____________
a) 347
b) 230
c) 184
d) 186
Explanation: In a complete graph which is (n-1) regular (where n is the number of vertices) has edges n*(n-1)/2. In the graph n vertices are adjacent to n-1 vertices and an edge contributes two degree so dividing by 2. Hence, in a d regular graph number of edges will be n*d/2 = 46*8/2 = 184.
39. Any subset of edges that connects all the vertices and has minimum total weight, if all the edge weights of an undirected graph are positive is called _______
a) subgraph
b) tree
c) hamiltonian cycle
d) grid
40. The minimum number of edges in a connected cyclic graph on n vertices is _____________
a) n – 1
b) n
c) 2n+3
d) n+1
Explanation: For making a cyclic graph, the minimum number of edges have to be equal to the number of vertices. SO, the answer should be n minimum edges.
41. Let G be an arbitrary graph with v nodes and k components. If a vertex is removed from G, the number of components in the resultant graph must necessarily lie down between _____ and _____
a) n-1 and n+1
b) v and k
c) k+1 and v-k
d) k-1 and v-1
Explanation: If a vertex is removed from the graph, lower bound: number of components decreased by one = k-1 (remove an isolated vertex which was a component) and upper bound: number of components = v-1 (consider a vertex connected to all other vertices in a component as in a star and all other vertices outside this component being isolated. Now, removing the considered vertex makes all other (v-1) vertices isolated making (v-1) components.
42. Every Isomorphic graph must have ________ representation.
a) cyclic
b) adjacency list
c) tree
d) adjacency matrix
Explanation: A graph can exist in different forms having the same number of vertices, edges and also the same edge connectivity, such graphs are called isomorphic graphs. Two graphs G1 and G2 are said to be isomorphic if −> 1) their number of components (vertices and edges) are same and 2) their edge connectivity is retained. Isomorphic graphs must have adjacency matrix representation.
43. A cycle on n vertices is isomorphic to its complement. What is the value of n?
a) 5

b) 32
c) 17
d) 8
Explanation: A cycle with n vertices has n edges. Number of edges in cycle = n and number of edges in its complement = (n*(n−1)/2) – n. To be isomorphism, both graphs should have equal number of edges. This gives, (n*(n-1)/2) – n = n ⇒ n = 5

44. The _______ of a graph G consists of all vertices and edges of G.
a) edge graph
b) line graph
c) path complement graph
d) eulerian circuit

45. A ______ in a graph G is a circuit which consists of every vertex (except first/last vertex) of G exactly once.
a) Euler path
b) Hamiltonian path
c) Planar graph
d) Path complement graph

46. A walk has Closed property if ____________
a) $v_0=v_k$
b) $v_0>=v_k$
c) v < 0
d) $v_k > 1$
Explanation: A walk in a graph is said to be closed if the starting vertex is the same as the ending vertex, that is $v_0=v_k$, it is described as Open otherwise.

47. A trail in a graph can be described as ______________
a) a walk without repeated edges
b) a cycle with repeated edges
c) a walk with repeated edges
d) a line graph with one or more vertices

48. If a graph G is k-colorable and k<n, for any integer n then it is ___________
a) n-colorable
b) n^2 nodes
c) (k+n)-colorable
d) (k^3+n^3+1) nodes
Explanation: The chromatic number of a graph is the minimal number of colors for which a graph coloring is possible. A graph G is termed as k-colorable if there exists a graph coloring on G with k colors. If a graph is k-colorable, then it is n-colorable for any n>k.

49. For a connected planar simple graph G=(V, E) with e=|E|=16 and v=|V|=9, then find the number of regions that are created when drawing a planar representation of the graph?
a) 321
b) 9
c) 1024
d) 596
Explanation: We know that the number of regions in a planar representation of the graph is r=e-v+2, then the required answer is r=16-9+2=9.

50. A non-planar graph can have ____________
a) complete graph
b) subgraph

c) line graph
d) bar graph

51. Which of the following is the set of m×m invertible matrices?
a) a permutation group of degree m^2
b) a general linear group of degree m
c) a sublattice group of degree m
d) a isomorphic graph of m nodes

52. There exists _______ between group homology and group cohomology of a finite group.
a) homomorphism
b) isomorphism
c) automorphism
d) semilattice structure

53. An undirected graph G which is connected and acyclic is called ____________
a) bipartite graph
b) cyclic graph
c) tree
d) forest

54. An n-vertex graph has ______ edges.
a) n^2
b) n-1
c) n*n
d) n*(n+1)/2

55. The tree elements are called __________
a) vertices
b) nodes
c) points
d) edges

56. In an n-ary tree, each vertex has at most ______ children.
a) n
b) n^4
c) n*n
d) n-1

57. Two labeled trees are isomorphic if ____________
a) graphs of the two trees are isomorphic
b) the two trees have same label
c) graphs of the two trees are isomorphic and the two trees have the same label
d) graphs of the two trees are cyclic

58. A graph which consists of disjoint union of trees is called ______
a) bipartite graph
b) forest
c) caterpillar tree
d) labeled tree

59. If two cycle graphs Gm and Gn are joined together with a vertex, the number of spanning trees in the new graph is ______
a) m+n-1
b) m-n
c) m*n
d) m*n+1

60. A binary cycle space forms a ______ over the two element field.
a) triangular graph
b) vector space

c) binary tree
d) hamiltonian graph

61. If G is a simple graph with n-vertices and n>=3, the condition for G has a Hamiltonian circuit is __________
a) the degree of each vertex is at most n/2
b) the degree of each vertex is equal to n
c) the degree of every vertex is at least n+1/2
d) the degree of every vertex in G is at least n/2

62. What is a separable graph?
a) A disconnected graph by deleting a vertex
b) A disconnected graph by removing an edge
c) A disconnected graph by removing one edge and a vertex
d) A simple graph which does not contain a cycle

63. How many edges are there in a complete graph of order 9?
a) 35
b) 36
c) 45
d) 19
Explanation: In a complete graph of order n, there are n*(n-1) number of edges and degree of each vertex is (n-1). Hence, for a graph of order 9 there should be 36 edges in total.

64. How many cycles are there in a wheel graph of order 5?
a) 6
b) 10
c) 25
d) 7
Explanation: In a cycle of a graph G if we join all the vertices to the centre point, then that graph is called a wheel graph. There is always a Hamiltonian cycle in a wheel graph and there are n^2-3n+3 cycles. So, for order 5 the answer should be 7.

65. Topological sorting of a graph represents _______ of a graph.
a) linear probing
b) linear ordering
c) quadrilateral ordering
d) insertion sorting

66. Breadth First Search traversal of a binary tree finds its application in __________
a) Cloud computing
b) Peer to peer networks
c) Weighted graph
d) Euler path

67. If the weight of an edge e of cycle C in a graph is larger than the individual weights of all other edges of C, then that edge ________
a) belongs to an minimum spanning tree
b) cannot belong to an minimum spanning tree
c) belongs to all MSTs of the graph
d) can not belong to the graph

68. For every spanning tree with n vertices and n edges what is the least number of different Spanning trees can be formed?
a) 2
b) 5
c) 3
d) 4

Explanation: If graph is connected and has ‘n’ edges, there will be exactly one cycle, if n vertices are there. A different spanning tree can be constructed by removing one edge from the cycle, one at a time. The minimum cycle length can be 3. So, there must be at least 3 spanning trees in any such Graph. Consider a Graph with n = 4, then 3 spanning trees possible at maximum (removing edges of cycle one at a time, alternatively). So, any Graph with minimum cycle length ‘3’ will have at least 3 spanning trees.

69. A complete undirected graph of n nodes can have maximum ______ spanning trees.
a) n^{n+1}
b) n^{n-2}
c) n(n+1)2
d) n

70. The spanning tree will be maximally acyclic if ____________
a) one additional edge makes a cycle in the tree
b) two additional edges makes a cycle in the tree
c) removing one edge makes the tree cycle free
d) removing two edges make the tree cycle free

71. In a maximum spanning tree the weighted graph is of _______
a) maximum number of edges
b) maximum number of cyclic trees
c) minimum number of vertices
d) maximum weight