DISCRETE STRUCTURES - 100 MCQ with Answers

TOPIC 1: PROPOSITIONAL LOGIC (Questions 1-15)

Q1. Which of the following is a proposition?

a) What time is it?

b) x + 5 = 10

c) The Earth is round

d) Close the door

Answer: c) The Earth is round (Declarative sentence with definite truth value)

Q2. The negation of "All students passed" is:

a) No students passed

b) Some students passed

c) Some students did not pass

d) All students failed

Answer: c) Some students did not pass ($\neg \forall x\, P(x) \equiv \exists x\, \neg P(x)$)

Q3. $p \rightarrow q$ is FALSE when:

a) p is true, q is true

b) p is true, q is false

c) p is false, q is true

d) p is false, q is false

Answer: b) p is true, q is false

Q4. Which is logically equivalent to $p \rightarrow q$?

a) $\neg p \rightarrow q$

b) $\neg q \rightarrow p$

c) $q \rightarrow p$

d) $\neg p \vee \neg q$

Answer: b) $\neg q \rightarrow p$ (Contrapositive)

Q5. De Morgan's Law states: $\neg(p \wedge q) \equiv$

a) $\neg p \wedge \neg q$

b) $\neg p \vee \neg q$

c) $\neg p \rightarrow q$

d) $p \vee q$

Answer: b) $\neg p \vee \neg q$

Q6. The truth value of $p \vee \neg p$ is always:

a) True

b) False

c) Depends on p

d) Cannot determine

Answer: a) True (Law of Excluded Middle)

Q7. Which is a tautology?

a) $p \land \neg p$

b) $p \rightarrow (p \lor q)$

c) $p \land q$

d) $p \oplus q$

Answer: b) $p \rightarrow (p \lor q)$

Q8. The biconditional $p \leftrightarrow q$ is true when:

a) p and q have different truth values

b) p is true, q is false

c) p and q have same truth values

d) p is false, q is true

Answer: c) p and q have same truth values

Q9. How many rows in a truth table for 3 variables?

a) 4

b) 6

c) 8

d) 16

Answer: c) 8 ($2^3 = 8$)

Q10. $p \wedge (q \vee r)$ is equivalent to:

a) $(p \wedge q) \vee (p \wedge r)$

b) $(p \vee q) \wedge (p \vee r)$

c) $(p \wedge q) \wedge (p \wedge r)$

d) $(p \vee q) \vee (p \vee r)$

Answer: a) $(p \wedge q) \vee (p \wedge r)$ (Distributive Law)

Q11. Which is NOT a logical connective?

a) $\wedge$

b) $\vee$

c) $\forall$

d) $\rightarrow$

Answer: c) $\forall$ (This is a quantifier, not a connective)

Q12. The statement "If it rains, then ground wet" is:

a) Conjunction

b) Disjunction

c) Implication

d) Biconditional

Answer: c) Implication

Q13. ¬(p ∨ q) is equivalent to:

a) ¬p ∨ ¬q

b) ¬p ∧ ¬q

c) ¬p → q

d) p ∧ q

Answer: b) ¬p ∧ ¬q (De Morgan's)

Q14. Which is a contradiction?

a) p ∨ ¬p

b) p ∧ ¬p

c) p → p

d) p ∨ p

Answer: b) p ∧ ¬p

Q15. The converse of p → q is:

a) ¬p → q

b) ¬q → p

c) q → p

d) p ∨ q

Answer: c) q → p

TOPIC 2: PREDICATE LOGIC (Questions 16-25)

Q16. ∀x P(x) is true if:

a) P(x) is true for at least one x

b) P(x) is true for all x

c) P(x) is false for all x

d) P(x) is true for some x

Answer: b) P(x) is true for all x

Q17. ∃x P(x) is false if:

a) P(x) is true for all x

b) P(x) is false for all x

c) P(x) is true for some x

d) P(x) is true for at least two x

Answer: b) P(x) is false for all x

Q18. ¬∀x P(x) is equivalent to:

a) ∀x ¬P(x)

b) ∃x ¬P(x)

c) ¬∃x P(x)

d) ∀x P(x)

Answer: b) ∃x ¬P(x)

Q19. ¬∃x P(x) is equivalent to:

a) ∃x ¬P(x)

b) ∀x ¬P(x)

c) ¬∀x P(x)

d) ∀x P(x)

Answer: b) ∀x ¬P(x)

Q20. The statement "Everyone loves someone" is:

a) ∃x ∀y L(x,y)

b) ∀x ∃y L(x,y)

c) ∀x ∀y L(x,y)

d) ∃x ∃y L(x,y)

Answer: b) ∀x ∃y L(x,y)

Q21. Which is stronger (implies the other)?

a) ∀x ∃y P(x,y) ⇒ ∃y ∀x P(x,y)

b) ∃y ∀x P(x,y) ⇒ ∀x ∃y P(x,y)

c) Both are equivalent

d) Neither implies the other

Answer: b) ∃y ∀x P(x,y) ⇒ ∀x ∃y P(x,y)

Q22. Modus Ponens rule is:

a) $p \rightarrow q$, $p \therefore q$

b) $p \rightarrow q$, $\neg q \therefore \neg p$

c) $p \vee q$, $\neg p \therefore q$

d) $p \wedge q \therefore p$

Answer: a) $p \rightarrow q$, $p \therefore q$

Q23. Modus Tollens rule is:

a) $p \rightarrow q$, $p \therefore q$

b) $p \rightarrow q$, $\neg q \therefore \neg p$

c) $p \vee q$, $\neg p \therefore q$

d) $p \wedge q \therefore p$

Answer: b) $p \rightarrow q$, $\neg q \therefore \neg p$

Q24. Affirming the consequent is:

a) Valid

b) Invalid (fallacy)

c) Always true

d) A tautology

Answer: b) Invalid (fallacy) ($p \rightarrow q$, $q \therefore p$ is wrong)

Q25. Denying the antecedent is:

a) Valid

b) Invalid (fallacy)

c) Always true

d) Modus Tollens

Answer: b) Invalid (fallacy) ($p \rightarrow q$, $\neg p \therefore \neg q$ is wrong)

TOPIC 3: SETS (Questions 26-35)

Q26. If A = {1,2,3} and B = {2,3,4}, then $A \cup B$ = ?

a) {1,2,3}

b) {2,3}

c) {1,2,3,4}

d) {1,4}

Answer: c) {1,2,3,4}

Q27. If A = {1,2,3} and B = {2,3,4}, then $A \cap B$ = ?

a) {1,2,3}

b) {2,3}

c) {1,2,3,4}

d) {1,4}

Answer: b) {2,3}

Q28. If A = {1,2,3} and B = {2,3,4}, then A-B = ?

a) {1,2,3}

b) {2,3}

c) {1}

d) {4}

Answer: c) {1}

Q29. Which is ALWAYS true?

a) $\varnothing \in A$

b) $\varnothing \subseteq A$

c) $A \subseteq \varnothing$

d) $A \in \varnothing$

Answer: b) $\varnothing \subseteq A$ (Empty set is subset of every set)

Q30. Power set of {a,b} has how many elements?

a) 2

b) 4

c) 8

d) 16

Answer: b) 4 ($2^2 = 4$: $\varnothing$, {a}, {b}, {a,b})

Q31. $|A \times B|$ if $|A|=3$ and $|B|=4$ is:

a) 7

b) 12

c) 81

d) 64

Answer: b) 12 (3 × 4 = 12)

Q32. De Morgan's Law for sets: $A \cup B$ = ?

a) $A \cap B$

b) $A \cup B$

c) $A \cap B$

d) $A \cup B$

Answer: c) $A \cap B$ (Complement of union = intersection of complements)

Q33. If $A \subseteq B$ and $B \subseteq A$, then:

a) $A \subset B$

b) $B \subset A$

c) $A = B$

d) $A \neq B$

Answer: c) $A = B$

Q34. The set of all subsets of A is called:

a) Union

b) Intersection

c) Power set

d) Complement

Answer: c) Power set

Q35. If |A| = 5, then | (A)| = ?

a) 10

b) 25

c) 32

d) 16

Answer: c) 32 ($2^5 = 32$)

TOPIC 4: FUNCTIONS (Questions 36-45)

Q36. A function is injective if:

a) $f(a_1) = f(a_2) \Rightarrow a_1 = a_2$

b) $f(a_1) = f(a_2) \Rightarrow a_1 \neq a_2$

c) $a_1 = a_2 \Rightarrow f(a_1) \neq f(a_2)$

d) Every element in codomain is mapped

Answer: a) $f(a_1) = f(a_2) \Rightarrow a_1 = a_2$

Q37. A function is surjective if:

a) $f(a_1) = f(a_2) \Rightarrow a_1 = a_2$

b) Range = Codomain

c) Domain = Codomain

d) f is invertible

Answer: b) Range = Codomain

Q38. Which function is bijective on $\mathbb{R}$?

a) $f(x) = x^2$

b) $f(x) = e^x$

c) $f(x) = 2x + 1$

d) $f(x) = |x|$

Answer: c) $f(x) = 2x + 1$ (Linear with non-zero slope)

Q39. If $f(x) = 2x$ and $g(x) = x+1$, then $(g \circ f)(x) = ?$

a) $2x + 1$

b) $2(x+1)$

c) $2x + 2$

d) $x + 2$

Answer: a) $2x + 1$ ($g(f(x)) = 2x + 1$)

Q40. A function has an inverse iff it is:

a) Injective only

b) Surjective only

c) Bijective

d) Constant

Answer: c) Bijective

Q41. $f(x) = x^2$ is NOT injective because:

a) $f(2) = f(-2) = 4$

b) $f(0) = 0$

c) $f(1) = 1$

d) Range ≠ Codomain

Answer: a) $f(2) = f(-2) = 4$

Q42. $f(x) = e^x$ is injective but NOT surjective because:

a) Negative numbers not in range

b) $e^0 = 1$

c) It's increasing

d) Domain is $\mathbb{R}$

Answer: a) Negative numbers not in range

Q43. The inverse of $f(x) = 3x - 2$ is:

a) $f^{-1}(x) = (x+2)/3$

b) $f^{-1}(x) = 3x+2$

c) $f^{-1}(x) = (x-2)/3$

d) $f^{-1}(x) = x/3 + 2$

Answer: a) $f^{-1}(x) = (x+2)/3$

Q44. $f^{-1}(x)$ notation means:

a) 1/f(x)

b) Inverse function

c) f(x) squared

d) Derivative

Answer: b) Inverse function

Q45. Composition of functions is:

a) Commutative

b) Associative

c) Always invertible

d) Always surjective

Answer: b) Associative ($(h \circ g) \circ f = h \circ (g \circ f)$)

TOPIC 5: SEQUENCES & SUMMATION (Questions 46-55)

Q46. Σ_{i=1}^{n} i = ?

a) n^2

b) $n(n+1)/2$

c) n(n-1)/2

d) $n^2/2$

Answer: b) n(n+1)/2

Q47. $\Sigma_{i=1}^{100} i = ?$

a) 5050

b) 5000

c) 10000

d) 505

Answer: a) 5050

Q48. $\Sigma_{i=1}^{n} i^2 = ?$

a) n(n+1)(2n+1)/6

b) $[n(n+1)/2]^2$

c) n(n+1)(n+2)/3

d) $n^3/3$

Answer: a) n(n+1)(2n+1)/6

Q49. Sum of first n odd numbers = ?

a) n^2

b) n(n+1)

c) 2n

d) $n^2 - 1$

Answer: a) n^2 $(1+3+5+...+(2n-1) = n^2)$

Q50. $\Sigma_{i=0}^{n} r^i = ?$ $(r \neq 1)$

a) $(r^{n+1}-1)/(r-1)$

b) $(r^n-1)/(r-1)$

c) $(1-r^{n+1})/(1-r)$

d) Both a and c

Answer: d) Both a and c (equivalent formulas)

Q51. Arithmetic sequence: 3,7,11,15,... 10th term = ?

a) 39

b) 40

c) 41

d) 43

Answer: a) 39 ($a_1=3$, $d=4$, $a_{10} = 3 + 9\times4 = 39$)

Q52. Geometric sequence: 2,6,18,54,... 5th term = ?

a) 162

b) 486

c) 324

d) 108

Answer: a) 162 (a_1=2, r=3, $a_5 = 2\times3^4 = 2\times81 = 162$)

Q53. Σ_{i=1}^{10} (2i-1) = ?

a) 100

b) 90

c) 110

d) 120

Answer: a) 100 (Sum of first 10 odd numbers = $10^2 = 100$)

Q54. Σ_{i=0}^{5} 2^i = ?

a) 31

b) 63

c) 32

d) 64

Answer: b) 63 (2^6-1 = 64-1 = 63)

Q55. A sequence with constant difference is called:

a) Geometric

b) Arithmetic

c) Harmonic

d) Fibonacci

Answer: b) Arithmetic

TOPIC 6: PROOF TECHNIQUES (Questions 56-60)

Q56. To prove $p \rightarrow q$ by contrapositive, we prove:

a) $q \rightarrow p$

b) $\neg p \rightarrow q$

c) $\neg q \rightarrow p$

d) $p \wedge \neg q$

Answer: c) $\neg q \rightarrow p$

Q57. In proof by contradiction, we assume:

a) p is true

b) p is false

c) ¬p and derive contradiction

d) q is true

Answer: c) ¬p and derive contradiction

Q58. √2 is irrational is proved by:

a) Direct proof

b) Contrapositive

c) Contradiction

d) Induction

Answer: c) Contradiction

Q59. Proof by cases must be:

a) Mutually exclusive only

b) Exhaustive only

c) Both exhaustive and ideally exclusive

d) None of these

Answer: c) Both exhaustive and ideally exclusive

Q60. For integer n, $n^2 + n$ is always:

a) Odd

b) Even

c) Prime

d) Divisible by 3

Answer: b) Even

TOPIC 7: MATHEMATICAL INDUCTION (Questions 61-68)

Q61. Mathematical induction proves statements for:

a) All real numbers

b) All positive integers

c) All complex numbers

d) All rational numbers

Answer: b) All positive integers

Q62. In induction, the base case is usually:

a) n = 0 or 1

b) n = k

c) n = k+1

d) n = ∞

Answer: a) n = 0 or 1

Q63. Strong induction assumes:

a) P(k) is true

b) P(1),P(2),...,P(k) are true

c) P(k+1) is true

d) P(n) is true for all n

Answer: b) P(1),P(2),...,P(k) are true

Q64. The inductive step proves:

a) $P(k) \Rightarrow P(k+1)$

b) $P(k+1) \Rightarrow P(k)$

c) $P(1) \Rightarrow P(k)$

d) $P(k) \wedge P(k+1)$

Answer: a) $P(k) \Rightarrow P(k+1)$

Q65. $1 + 2 + 3 + \ldots + n = n(n+1)/2$ is proved by:

a) Direct proof

b) Contradiction

c) Induction

d) Cases

Answer: c) Induction

Q66. Structural induction is used for:

a) Numbers only

b) Recursively defined structures

c) Sets only

d) Functions only

Answer: b) Recursively defined structures

Q67. If we skip the base case in induction:

a) Proof is still valid

b) Proof may be invalid

c) Only strong induction works

d) Nothing changes

Answer: b) Proof may be invalid

Q68. The statement "Every integer ≥2 is product of primes" uses:

a) Regular induction

b) Strong induction

c) Contradiction

d) Direct proof

Answer: b) Strong induction

TOPIC 8: COUNTING PRINCIPLES (Questions 69-73)

Q69. $|A \cup B| = ?$

a) $|A| + |B|$

b) $|A| + |B| - |A \cap B|$

c) $|A| \times |B|$

d) $|A| - |B|$

Answer: b) $|A| + |B| - |A \cap B|$

Q70. Pigeonhole principle: If 10 pigeons in 9 holes, then:

a) Each hole has 1 pigeon

b) Some hole has ≥2 pigeons

c) All holes are empty

d) Some hole has 0 pigeons

Answer: b) Some hole has ≥2 pigeons

Q71. Generalized pigeonhole: If n items in m boxes, some box has at least:

a) ⌊n/m⌋

b) ⌈n/m⌉

c) n-m

d) n/m

Answer: b) ⌈n/m⌉

Q72. Among 13 people, at least ___ share birth month:

a) 1

b) 2

c) 3

d) 4

Answer: b) 2 (13 people, 12 months → 2 share)

Q73. Among 100 people, at least ___ share birth month:

a) 8

b) 9

c) 10

d) 12

Answer: b) 9 (⌈100/12⌉ = 9)

TOPIC 9: PERMUTATIONS & COMBINATIONS (Questions 74-83)

Q74. P(n,r) = ?

a) n!/(n-r)!

b) n!/r!(n-r)!

c) n!/r!

d) (n-r)!/n!

Answer: a) n!/(n-r)!

Q75. C(n,r) = ?

a) n!/(n-r)!

b) n!/r!(n-r)!

c) n!/r!

d) (n-r)!/n!

Answer: b) n!/r!(n-r)!

Q76. C(10,3) = ?

a) 720

b) 120

c) 30

d) 100

Answer: b) 120 (10×9×8/6 = 120)

Q77. P(10,3) = ?

a) 720

b) 120

c) 30

d) 1000

Answer: a) 720 (10×9×8 = 720)

Q78. Number of ways to arrange "MISSISSIPPI" = ?

a) 11!

b) 11!/4!4!2!

c) 11!/4!4!

d) 4!4!2!

Answer: b) 11!/4!4!2! (M:1, I:4, S:4, P:2)

Q79. Combinations with repetition formula:

a) C(n,r)

b) C(n+r-1, r)

c) P(n,r)

d) n^r

Answer: b) C(n+r-1, r)

Q80. How many 3-member committees from 8 people?

a) 336

b) 56

c) 24

d) 512

Answer: b) 56 (C(8,3) = 56)

Q81. Circular permutations of n objects = ?

a) n!

b) (n-1)!

c) n!/2

d) (n+1)!

Answer: b) (n-1)!

Q82. 5! = ?

a) 60

b) 120

c) 24

d) 720

Answer: b) 120

Q83. C(n,0) = ?

a) 0

b) 1

c) n

d) ∞

Answer: b) 1

TOPIC 10: BINOMIAL THEOREM (Questions 84-90)

Q84. $(a+b)^n$ = ?

a) $\Sigma\ C(n,r)\ a^r\ b^{n-r}$

b) $\Sigma\ C(n,r)\ a^{n-r}\ b^r$

c) $\Sigma\ P(n,r)\ a^{n-r}\ b^r$

d) $\Sigma\ n!\ a^{n-r}\ b^r$

Answer: b) $\Sigma\ C(n,r)\ a^{n-r}\ b^r$

Q85. Σ_{r=0}^{n} C(n,r) = ?

a) n^2

b) 2^n

c) n!

d) 2n

Answer: b) 2^n

Q86. Coefficient of x^3 in $(1+x)^5$ = ?

a) 5

b) 10

c) 15

d) 20

Answer: b) 10 (C(5,3) = 10)

Q87. Pascal's Identity: C(n,r) = ?

a) C(n-1,r) + C(n-1,r-1)

b) C(n,r-1) + C(n-1,r)

c) C(n-1,r) + C(n,r-1)

d) C(n+1,r) - C(n,r)

Answer: a) C(n-1,r) + C(n-1,r-1)

Q88. In Pascal's triangle, row 4 (starting row 0) is:

a) 1 3 3 1

b) 1 4 6 4 1

c) 1 5 10 10 5 1

d) 1 2 1

Answer: b) 1 4 6 4 1

Q89. Middle term in $(x+y)^6$ has coefficient:

a) 15

b) 20

c) 10

d) 30

Answer: b) 20 (C(6,3) = 20)

Q90. $(1 - x)^4$ expands to:

a) $1 - 4x + 6x^2 - 4x^3 + x^4$

b) $1 + 4x + 6x^2 + 4x^3 + x^4$

c) $1 - 4x - 6x^2 - 4x^3 - x^4$

d) $1 + 4x - 6x^2 + 4x^3 - x^4$

Answer: a) $1 - 4x + 6x^2 - 4x^3 + x^4$

TOPIC 11: PROBABILITY (Questions 91-96)

Q91. P(E) = ? (equally likely outcomes)

a) $|E| \times |S|$

b) $|E| / |S|$

c) $|S| / |E|$

d) $|E| - |S|$

Answer: b) |E| / |S|

Q92. P(E|F) = ?

a) P(E∩F)/P(F)

b) P(E∪F)/P(F)

c) P(E)×P(F)

d) P(E)/P(F)

Answer: a) P(E∩F)/P(F)

Q93. E and F independent if:

a) P(E∩F) = P(E) + P(F)

b) P(E∩F) = P(E) × P(F)

c) P(E|F) = 0

d) P(E∪F) = P(E) + P(F)

Answer: b) P(E∩F) = P(E) × P(F)

Q94. Probability of getting sum 7 with two dice:

a) 1/6

b) 1/12

c) 5/36

d) 1/9

Answer: a) 1/6 (6/36 = 1/6)

Q95. Expected value of fair die roll:

a) 3

b) 3.5

c) 4

d) 2.5

Answer: b) 3.5 ((1+2+3+4+5+6)/6 = 3.5)

Q96. E(X+Y) = ?

a) E(X) × E(Y)

b) E(X) + E(Y)

c) E(X)/E(Y)

d) E(X) - E(Y)

Answer: b) E(X) + E(Y) (Linearity of expectation)

TOPIC 12: RECURRENCE RELATIONS (Questions 97-100)

Q97. Characteristic equation for $a_n = 3a_{n-1} - 2a_{n-2}$ is:

a) $r^2 = 3r - 2$

b) $r^2 = 3r + 2$

c) $r^2 - 3r + 2 = 0$

d) $r^2 + 3r - 2 = 0$

Answer: c) $r^2 - 3r + 2 = 0$

Q98. For distinct roots r_1, r_2, solution is:

a) $a_n = \alpha_1 r_1^n + \alpha_2 r_2^n$

b) $a_n = (\alpha_1 + \alpha_2 n) r^n$

c) $a_n = \alpha_1 r_1^n \times \alpha_2 r_2^n$

d) $a_n = \alpha_1 + \alpha_2 n$

Answer: a) $a_n = \alpha_1 r_1^n + \alpha_2 r_2^n$

Q99. Master Theorem: $T(n) = 2T(n/2) + O(n)$ solves to:

a) $O(n)$

b) $O(n \log n)$

c) $O(n^2)$

d) $O(\log n)$

Answer: b) $O(n \log n)$ (Case 2: $a = b^d$)

Q100. Fibonacci recurrence is:

a) $a_n = a_{n-1} + a_{n-2}$

b) $a_n = 2a_{n-1}$

c) $a_n = a_{n-1} + n$

d) $a_n = n \cdot a_{n-1}$

Answer: a) $a_n = a_{n-1} + a_{n-2}$
