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B.Tech DEGREE EXAMINATION, DECEMBER 2023

Fifth to Seventh Semester

18CSE351T - COMPUTATIONAL LOGIC

(For the candidates admitted during the academic year 2020 - 2021 & 2021 - 2022)

Note:

i. **Part - A** should be answered in OMR sheet within first 40 minutes and OMR sheet should be handed over to hall invigilator at the end of 40^{th} minute.
ii. **Part - B** and **Part - C** should be answered in answer booklet.

Time: 3 Hours **Max. Marks: 100**

PART - A (20 × 1 = 20 Marks)

Answer **all** Questions

	Question	Marks	BL	CO
1.	The valuation for P↔Q is (A) TFFT (B) TTFF (C) FFTT (D) FTTF	1	1	1
2.	If any formula derives true for all valuations, then the formula is said to be (A) Consistent (B) Inconsistent (C) Tautology (D) Satisfiable	1	1	1
3.	Disjunction can also be denoted by ________ (A) → (B) ↑ (C) ↓ (D) ↕	1	1	1
4.	The Valuation of (p ∨ q) ∧ ¬p ∧ ¬q is (A) TTFF (B) FFTT (C) TTTT (D) FFFF	1	2	1
5.	The transitivity rule justifies the _____ development of any mathematical theorem (A) Theoritical (B) Step-by-step (C) Logical (D) Detailed	1	1	2
6.	Which of the following is Derived rules of the Propositional logic (A) LEM (B) Bottom Up Elimination (C) Moddus ponens (D) Rules for Implication	1	1	2
7.	Which one of the following is true in case of ∧i Rule (A) To prove φ ∧ ψ, φ or ψ should be proved separately and then use the rule ∧i. (B) To prove φ ∧ ψ, first φ and ψ should be proved separately and then use the rule ∧i. (C) To prove φ ∧ ψ, first neither φ nor ψ should be proved separately and then use the rule ∧i (D) To prove φ ∧ ψ, first φ should be proved and then use the rule ∧i	1	1	2
8.	Identify which one of the following is not a sub tree for the formula (((¬p) ∧ q) → (p ∧ (q ∨ (¬r)))). (A) p (B) q (C) q ∨ (¬r) (D) r	1	2	2
9.	First-order logic is an extension of (A) temporal logic (B) Predicate logic (C) propositional logic (D) Semantics	1	1	3
10.	In a formula ∀x∃y P(x, y, z),Find the free variable (A) x (B) y (C) z (D) x and y	1	2	3

11. Let φ be $\varphi1 \rightarrow \varphi2$. If φ evaluates to F, then Completeness equation will be we know that $\varphi1$ evaluates to T and $\varphi2$ to F. 1 2 3

(A) $\neg\varphi1 \wedge \neg\varphi2 \mid\!- \neg(\varphi1 \rightarrow \varphi2)(\varphi1 \rightarrow \varphi2)$
(B) $\varphi1 \wedge \neg\varphi2 \mid\!- (\varphi1 \rightarrow \varphi2)$
(C) $\varphi1 \wedge \neg\varphi2 \mid\!- \neg(\varphi1 \rightarrow \varphi2)$
(D) $\varphi1 \wedge \neg\varphi2 \mid\!- (\varphi1 \rightarrow \varphi2)(\varphi1 \wedge \neg\varphi2)$

12. ____is the existential quantifier and is read there exists 1 2 3

(A) φ
(B) μ
(C) $\forall$
(D) $\exists$

13. $\exists x\ (p \rightarrow q)$ -||- 1 1 4

(A) $\forall x\ (p \rightarrow q)$
(B) $p \rightarrow \forall x\ q$
(C) $\forall x\ p \leftrightarrow q$
(D) $\forall x\ p \rightarrow q$

14. $\forall x\varphi \,/\, \varphi[t/x]$. This is the rule for eliminating 1 1 4

(A) over all quantifier
(B) existential quantifier
(C) conjunction
(D) disjunction

15. Let U be a set of closed formulas in first-order logic. "U is a Hintikka set iff the following conditions hold for all formulas A $\in$ U" Which of the following is true according to the above statement. 1 2 4

(A) If A is a γ -formula, then γ (c) $\in$ U for some constants c in formulas in U.
(B) If A is a β-formula, then $\beta1 \notin$ U or $\beta2 \notin$ U.
(C) If A is a δ-formula, then δ(c) $\notin$ U for some constant c.
(D) If A is a δ-formula, then δ(c) $\in$ U for some constant c.

16. Which of the following is commutative property. 1 1 4

(A) $\models \forall x(A(x) \leftrightarrow B(x)) \rightarrow (\exists xA(x) \leftrightarrow \exists xB(x))$
(B) $\models \forall x\forall yA(x,y) \leftrightarrow \forall y\forall xA(x, y)$
(C) $\models \exists xA(x) \leftrightarrow \neg\forall x\neg A(x)$
(D) $\models \forall x(A \rightarrow B(x)) \leftrightarrow (A \rightarrow \forall xB(x))$

17. $\Box$, read is___ 1 1 5

(A) Always
(B) Partially
(C) eventually
(D) rarely

18. In CTL All next state is represented as 1 1 5

(A) EX
(B) EF
(C) AX
(D) AF

19. Computation Tree Logic, is____ 1 1 5

(A) Branching Tree logic
(B) Graph
(C) Logical
(D) Hash

20. x ||- $\Box$q represents 1 1 5

(A) All world associated with x has q
(B) World Associated with x has q
(C) x has label q
(D) q present in W

PART - B (5 × 4 = 20 Marks)

Answer **any 5** Questions

Marks BL CO

21. Write the conditions for the well-formed formula in terms of parse tree with example 4 1 1

22. Identify whether the following equations are semantically entails holds. 4 3 1

(i) $((p \wedge q) \leftrightarrow (q \leftrightarrow r)) \models (p \wedge r)$
(ii) $((p \rightarrow q) \leftrightarrow q) \models p \wedge q$

23. Draw the parse tree for the following formula.Also check whether it is well formed formula and find the height of the parse tree. 4 3 2

$(p \rightarrow q \wedge \neg t) \rightarrow (r \rightarrow s \vee t)$

No.	Question	Marks	BL	CO
24.	"Biconditional binds tightly than implication" State the validity of the statement with justification	4	3	2
25.	With suitable example,list the conditions of parse tree in predicate logic and give the backus-naur form for predicate logic. With an example,define free varibles and bound variables	4	2	3
26.	Solve the following sequences. $\forall x\,(P(x) \wedge Q(x)) \vdash \forall x\,(P(x) \rightarrow Q(x))$	4	3	4
27.	Draw the parse tree for the following: $(\Diamond\Box p \to \Box\Diamond(\Diamond q \to \neg p) \wedge \Diamond(p \vee q))$	4	3	5

PART - C (5 × 12 = 60 Marks)

Answer **all** Questions

No.	Question	Marks	BL	CO
28.	(a) With the help of truth table identify which among the listed are tautology. (i). $(x \rightarrow y) \vee (y \rightarrow x)$ (ii). $\sim A \wedge B \rightarrow \sim(A \vee B)$ (iii). $(P \leftrightarrow Q) \vee (S \rightarrow A) \wedge \neg Q$ (iv). $((P \wedge Q) \rightarrow P) \vee ((P \wedge Q) \wedge \neg T)$ **(OR)** (b) Draw the parse tree and mention sub-formula for the following. (i) $((p \wedge q) \vee (q \vee r)) \leftrightarrow (p \rightarrow r)$ (ii)$((p \rightarrow q)\ A\ q) \rightarrow p$ (iii)$(p \leftrightarrow r) \wedge (q \leftrightarrow p) \leftrightarrow (p \vee r)$ (iv)$(p \vee \neg q) \rightarrow (r\ A\ p)$	12	3	1
29.	(a) Solve the following sequent. (i) $p \rightarrow q, r \rightarrow \neg t, q \rightarrow r \vdash p \rightarrow \neg t$ (ii) $\vdash (p \rightarrow q) \rightarrow ((r \rightarrow s) \rightarrow (p \wedge r \rightarrow q \wedge s))$ (iii) $p \rightarrow (q \vee r), \neg q, \neg r \vdash \neg p$ **(OR)** (b) State and prove completeness theorem for propositional logic	12	3	2
30.	(a) Consider a world with objects A, B, and C. We'll look at a logical language with constant symbols X, Y , and Z, function symbols f and g, and predicate symbols p, q, and r. Consider the following interpretation: $I(X) = A, I(Y) = A, I(Z) = B$ $I(f) = \{(A, B),(B, C),(C, Ci\}$ $I(p) = \{A, B\}$ $I(q) = \{C\}$ $I(r) = \{(B, A),(C, B),(C, C)\}$ For each of the following sentences, say whether it is true or false in the given interpretation I: a. $q(f(Z))$ b. $r(X, Y)$ c. $\exists_w.f(w) = Y$ d. $\forall_w.r(f(w), w)$ e. $\forall_w.f(w) = Y$ **(OR)** (b) Let P be a unary predicate, Q a binary predicate, f a binary function symbol, and let x, y,z be variables. Let I = (N,P ,Q , f) be an interpretation where P = $\{m \in N : m \text{ is prime}\}$, Q be the 'greater than' relation, and $f(m,n) = (m + n)/2$. Let $l(x) = 12, l(y) = 8, l(z) = 4$. Decide whether the state I_l satisfies the following formulas: (a) P f x f x f x f xy (b) $\forall x \forall y Qx\ f(xy) \rightarrow \forall z Qz\ f(xz)$ (c) $\forall x \forall y (Px \wedge Py \rightarrow P\ f(xy)) \leftrightarrow \forall z (Px \wedge Py \rightarrow P\ f(xy))$ (d) $\forall y (\neg P\ f(xy) \leftrightarrow P\ f(yz)) \vee \forall x (Qxy \rightarrow \exists y (Qzy \wedge Qyz))$	12	3	3

31.	(a) Articulate the provable equivalences in predicate logic. Prove the following sequent : $(\exists x\Phi) \vee (\exists x\psi) \dashv\vdash \exists x(\Phi \vee \psi)$	12	3	4
	(OR)			
	(b) (i)State the natural deduction of first order logic(8 Marks) (ii) Justify the need of first order logic.(4 Marks)			
32.	(a) Demonstrate the connectives in CTL and their binding priority with Backus Naur Form.(6 Marks) Draw the parse tree for the following CTL formula.(6 Marks) (a) $F\,p \wedge G\,q \rightarrow p\,W\,r$ (b) $F\,(p \rightarrow G\,r) \vee \neg q\,U\,p$ (c) $p\,W\,(q\,W\,r)$	12	3	5
	(OR)			
	(b) Demonstrate Modal logic with suitable example.			

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