Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati.

Department of BBA (C.A.)

FYBBA (C.A.) Semester I

Question Bank

Subject: Logic in Computer Science(1101)

Objective Question

1. Which of these formulas are semantically equivalent to $p \rightarrow (q \lor r)$?

   A. $q \lor (\neg p \lor r)$ **B.** $q \land \neg r \rightarrow p$
   C. $p \land \neg r \rightarrow q$ **D.** $\neg q \land \neg r \rightarrow \neg p$

2. Identify the valid conclusion from the premises P v Q, Q → R, P → M, ˥M

   A.Contradiction
   B.Valid
   C.Well-formed formula
   D.None of these

3. Identify the valid conclusion from the premises P v Q, Q → R, P → M, ˥M

   A.P ^ (R v R)
   B.P ^ (P ^ R)
   C.R ^ (P v Q)
   D.Q ^ (P v R)

4. Which of the following propositions is tautology?

   A.(p v q)→q

   B.p v (q→p)

   C.p v (p→q)

   D.Both (b) & (c)

5. (P v Q) ^ (P → R)^ (Q →S) is equivalent to

   A. S ^ R
   B. S → R
   C. S v R
   D. All of above

6. (P v Q) ^ (P→R) ^ (Q → R) is equivalent to

   A. P
   B. Q
   C. R
   D. True = T

7. ¬ (P → Q) is equivalent to

A.P ^ ˥Q
B.P ^ Q
C. ¬ P v Q
D.None of these

8. In propositional logic, which of the following is equivalent to p → q?

A.~p → q
B.~p v q
C.~p v~ q
D.p →q

9. The symbolization for a conjunction is

A. p → q b
B. *p & q*
C. *p & q*
D. ~ *p*

10. In a disjunction, even if one of the statements is false, the whole disjunction is still

A. False B. Negated C. True D. Both True and False

11. The four logical connectives are

A. Conjunctions, conditionals, compounds, and disjunctions

B. Conjunctions, statements, disjunctions, and conditionals

C. Conditionals, disjunctions, negations, and conjunctions

D. Conjuncts, disjuncts, conditionals, and negations

12. In a conditional statement, *unless* means "if not" and introduce

A. negation

B. The conjunct

C. The consequent

D. The antecedent

13. **Which of the following is a declarative statement?**

A.It's right

B.He says

C.Two may not be an even integer

D.I work hard.

14. **P → (Q → R) is equivalent to**

A.(P ^ Q) → R
B.(P v Q) → R
C.(P v Q) → ˥R
D.None of these

15. Let p and q be propositions. Using only the truth table decide whether $p \leftrightarrow q$ does not imply $p \rightarrow \neg q$ is

A.True
B.False

16. $\dfrac{\boldsymbol{\Phi \rightarrow \varphi \quad \neg \varphi}}{\neg\ \varphi}$ is the proof rule for

A. →i **B. →e** **C.MT** **D.** ∧i

17. Which of the following is contradiction

A.$(p \rightarrow q) \wedge \neg(p \rightarrow q)$ B. $\neg(p \rightarrow q) \wedge \neg(p \rightarrow q)$

C. $(p \rightarrow q) \vee \neg(p \rightarrow q)$ D. $\neg(p \rightarrow q) \vee \neg(p \rightarrow q)$

18. →, ∧, ∀*and* ∃ are symbols for,

A. Implies, or, for all, there exist B. implies, and, there exist, for all

B. Implies, and, for all, there exist C. Implies, and , not, for all

19. Two key operators in temporal logic are

A. ∃, ∀ B. ◇ ,☐ C.∧,∨ D.→,∨

20. The value of given statement is

'4+3= 7 or 5 is not prime'

A. True B. False

21 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

22. The truth value of given statement is
'If 9 is prime then 3 is even'.
A. False
B. True

23. 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

24. 1. 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

25. What is the value of x after this statement, assuming 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

· **Answer in one sentence**

Define following:

1. Propositional Logic
2. Predicate Logic
3. Temporal Logic
4. Tautology
5. Argument
6. Premise
7. Horn formula
8. Terms
9. Formulas
10. Free and Bound variables
11. State Transition Diagram
12. Linear Temporal Logic
13. List the operators of Temporal Logic.
14. Write any four syntactically correct formulas in Propositional Temporal Logic.
15. What is Binary Decision Diagram?
16. Define Ordered Binary Decision Diagram.
17. Draw formation trees for:
$(p \rightarrow (q \rightarrow r)) \rightarrow ((p \rightarrow q) \rightarrow (p \rightarrow r))$
18. Construct the Truth Table for
$((p \rightarrow q) \rightarrow p) \rightarrow p$.
19. Prove the following logical equivalences using truth tables,
$A \leftrightarrow B \equiv (A \vee B) \rightarrow (A \wedge B)$
20. Define deductive system.

21. Define satisfiable, valid and falsifiable

22. What are the quantifiers?

23. For every x, if x is a student, then there is some y which is an instructor such that x is younger than y.

    Represent .it in predicate logic

24. Give the symbolic form of ,

    Every child is younger than its mother.

25. Translate following into symbolic code,

    The set of predicates with meanings

    S(x, y) : x is a son of y

    F(x, y) : x is the father of y

    B(x, y) : x is a brother of y.

    Every son of my father is my brother

26. What is Semantic Equivalence?

27. When a formula Φ is satisfiable?

28. Define well-formed formula. Give examples of it.

29. Find the propositional logic sequent that corresponds to $\exists x \neg\Phi \vdash \neg\forall x\, \Phi$.

30. Write the proof rule for universal quantification.

Short Answer Question

1. Use ¬, →, ∧ and ∨ to express the following declarative sentences in propositional logic; in each case state what your respective propositional atoms p,q

a. If the sun shines today, then it won't shine tomorrow.

b. Robert was jealous of John, or he was not in a good mood

c. If interest rates go up, share prices go down.

d. If Dick met Jane yesterday, they had a cup of coffee together, or they took a walk in the park

2. Use ¬, →, ∧ and ∨ to express the following declarative sentences in propositional logic; in each case state what your respective propositional atoms p,q

a. Cancer will not be cured unless its cause is determined and a new drug for cancer is found

b . My sister wants a black and white cat.

c . If I study well, I will get good marks.

d. Either I work or pass in Logic

3. Prove the validity of the following sequent :

a. $(p \land q) \land r, s \land t \vdash q \land s$

b. $p \land q \vdash q \land p$

c. $p \land q \to r \vdash (p \to r) \lor (q \to r)$

d. $p \to (q \to r), p, \neg r \mid- \neg q$

4. Give a truth table for each of the following formulas:

a. $((p \rightarrow q) \rightarrow p) \rightarrow p$

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

c. $(p \land \neg q \land r \land s) \lor (p \land q \land \neg r \land \neg s)$

d. $(A \lor \neg B) \rightarrow (C \land \neg A)$

5. Give a truth table for each of the following formulas:

a. $p \land (q \lor r)$

b. $(p \lor q) \land \neg p$

c. $(\neg q \land (p \rightarrow q)) \rightarrow \neg p$

d. $(A \land \neg A) \rightarrow B \lor \neg C$

6. Given the following formulas, draw their corresponding parse tree

a. $(((s \rightarrow (r \lor l)) \lor ((\neg q) \land r)) \rightarrow ((\neg(p \rightarrow s)) \rightarrow r))$

b. $(p \rightarrow q) \land (\neg r \rightarrow (q \lor (\neg p \land r)))$

7. Prove the validity of $S \rightarrow \forall x\, Q(x) \vdash \forall x\, (S \rightarrow Q(x))$, where S has arity 0 (a ‘propositional atom’).

Construct a formula in CNF based on each of the following truth tables:

a.

p	q	φ1
T	T	F
F	T	F
T	F	F
F	F	T

b.

p	q	r	φ2
T	T	T	T
T	T	F	F
T	F	T	F
F	T	T	T
T	F	F	F
F	T	F	F
F	F	T	T
F	F	F	F

8. Show that, with respect to ≡,

a. ∧ and ∨ are idempotent:

I . $\varphi \land \varphi \equiv \varphi$

ii. $\varphi \lor \varphi \equiv \varphi$

b. ∧ and ∨ are commutative:

i. $\varphi \land \psi \equiv \psi \land \varphi$

ii. ii. $\varphi \lor \psi \equiv \psi \lor \varphi$

c. ∧ and ∨ a:re associative

i. $\varphi \land (\psi \land \eta) \equiv (\varphi \land \psi) \land \eta$

ii. $\varphi \lor (\psi \lor \eta) \equiv (\varphi \lor \psi) \lor \eta$

d. ∧ and ∨ are absorptive:

i. $\varphi \land (\varphi \lor \eta) \equiv \varphi$

ii. $\varphi \lor (\varphi \land \eta) \equiv \varphi$

e. ∧ and ∨ are distributive:

i. $\varphi \land (\psi \lor \eta) \equiv (\varphi \land \psi) \lor (\varphi \land \eta)$

ii. $\varphi \lor (\psi \land \eta) \equiv (\varphi \lor \psi) \land (\varphi \lor \eta)$ (f) ≡ allows for double negation: $\varphi \equiv \neg\neg\varphi$

9. Find appropriate predicates and their specification to translate the following into predicate logic:

a. All red things are in the box.

b. Only red things are in the box

c. No animal is both a cat and a dog.

d. Every prize was won by a boy.

10. Find appropriate predicates and their specification to translate the following into predicate logic:

a. Some flat in this colony is 1 BHK.

b. Every flat in this colony is either 1BHK or 2BHK

c. A boy won every prize.

11. Prove the validity of the following sequents in predicate logic, where F, G, P, and Q have arity 1, and S has arity 0 (a 'propositional atom'):

a. $\exists x\ (S \rightarrow Q(x)) \vdash S \rightarrow \exists x\ Q(x)$

b. $S \rightarrow \exists x\ Q(x) \vdash \exists x\ (S \rightarrow Q(x))$

12. By natural deduction, show the validity of

a. $\forall x\ P(a, x, x), \forall x\ \forall y\ \forall z\ (P(x, y, z) \rightarrow P(f(x), y, f(z))) \vdash P(f(a), a, f(a))$

b. $\forall y\ Q(b, y), \forall x\ \forall y\ (Q(x, y) \rightarrow Q(s(x), s(y))) \vdash \exists z\ (Q(b, z) \land Q(z, s(s(b))))$

13. Translate the following argument into a sequent in predicate logic using a suitable set of predicate symbols:

If there are any tax payers, then all politicians are tax payers.
If there are any philanthropists, then all tax payers are philanthropists.
So, if there are any tax-paying philanthropists, then all politicians are philanthropists.

14. Is $\forall x\ (P(x) \lor Q(x)) \models \forall x\ P(x) \lor \forall x\ Q(x)$ a semantic entailment? Justify your answer.

15. For each set of formulas below show that they are consistent:

a. $\forall x\ \neg S(x, x), \exists x\ P(x), \forall x\ \exists y\ S(x, y), \forall x\ (P(x) \rightarrow \exists y\ S(y, x))$

b. $\forall x\ \neg S(x, x), \forall x\ \exists y\ S(x, y), \forall x\ \forall y\ \forall z\ ((S(x, y) \land S(y, z)) \rightarrow S(x, z))$

16. Test for tautology,
$[(p \land q) \rightarrow r] \rightarrow [p \rightarrow (q \rightarrow r)]$

17. Justify whether true or false:
$\sim(p \rightarrow q) \equiv \sim p \rightarrow \sim q$

18. List the connectives and write their truth table.

19. Draw the parse tree of the term $(2 - s(x)) + (y * x)$, considering that $-$, $+$, and $*$ are used in infix in this term.

20. Let φ be $\exists x\ (P(y, z) \land (\forall y\ (\neg Q(y, x) \lor P(y, z))))$, where P and Q are predicate

symbols with two arguments.

a. Draw the parse tree of φ

b. Identify all bound and free variable leaves in φ.

c. Is there a variable in φ which has free and bound occurrences?

21. Show the semantic entailment $\forall x\ P(x) \vee \forall x\ Q(x)\ \ \forall x\ (P(x) \vee Q(x))$.

22. Write the algorithm to obtain Reduced Binary Decision Diagram.

23. Prove that $\exists r\ (p \vee (q \wedge r)) = p \vee q$ and $\forall r\ (p \vee (q \wedge r)) = p$ using BDDs

24. Prove the following logical equivalences:
    $A \wedge (B \vee C) \equiv (A \wedge B) \vee (A \wedge C)$,
    $A \vee B \equiv \neg(\neg A \wedge \neg B)$,
    $A \wedge B \equiv \neg(\neg A \vee \neg B)$,
    $A \rightarrow B \equiv \neg A \vee B$,

25. Construct reduced OBDDs for $p \uparrow (q \uparrow r)$ and $(p \uparrow q) \uparrow r$.

26. Show that following sequent is valid
    $\vdash_K \Box\ p \wedge \Box\ q \rightarrow \Box\ (p \wedge q)$.

27. Write the different properties of binary relation?

28. What is apply algorithm?

29. Find appropriate predicates and their specification to translate the following into predicate logic:
    a. All red things are in the box.
    b. Every prize was won by a boy.
    c. A boy won every prize.
    d. No animal is both a cat and a dog.

30. Find appropriate predicates and their specification to translate the following into predicate logic:
    a. Raj admires every professor.
    b. Some professor admires Raj.
    c. No student attended every lecture.
    d. No lecture was attended by any student.

Short Notes and Long Answer Question

1. Write grammar rules for defining terms

2. Write grammar rules for defining formulas in Predicate Logic

3. Identify and distinguish between free and bound variables in Predicate Logic formulas

4. Explain the need for a substitution operation in applying proof rules of Predicate Logic

5. Explain the structure of natural deduction proofs of predicate logic formulas.

6. State and explain validity and satisfiability in Predicate Logic.

7. Explain and illustrate issues in verifying satisfiability and validity of formulas in Predicate Logic.

8. State all rules of natural deduction for Predicate Logic.

9. State the rules of natural deduction of Propositional Logic

10. Construct a reduced Binary Decision Diagram for the formula A= $p \oplus q \oplus r$

11. Define the linear Temporal Logic How Interpretation is done for an LTL formula?

12. What is total correctness of a program? Explain with example.

13. What are the rule which recursively define Modal Proposition?

14. Draw the parse tree of the term (2-s(x))+(y*x),considering -,+ and * are used in infix in this term.

15. Write short note on Binary Decision diagrams.

16. Explain the need of program verification.

17. Prove that any formula in Propositional logic can be converted into an equivalent formula in Conjunctive Normal Form with example

18. What is total correctness of a program. Explain using example.

19. Write a note on Temporal Logic.

20. Find a (propositional) proof for $\varphi \rightarrow (q1 \wedge q2) \vdash (\varphi \rightarrow q1) \wedge (\varphi \rightarrow q2)$.

21. Find a (predicate) proof for $\varphi \rightarrow \forall x\, Q(x) \vdash \forall x\, (\varphi \rightarrow Q(x))$, provided that x is not free in φ.

22. Consider the formula $\exists x\, \exists y\, (\neg(x = y) \wedge (\forall z\, ((z = x) \vee (z = y))))$. Can you say, in plain English, what this formula specifies? 3

23. Find a propositional logic sequent that corresponds to $\exists x \neg\varphi\ \neg\forall x\ \varphi$. Prove it

24. Explain the framework for software verification.

25. In what circumstances would if (B) {C1} else {C2} fail to terminate?

26. Write a note on Binary Decision Diagram.
27. What is CNF? Explain the requirements that CNF should satisfy.
28. Use mathematical induction to show that the sum 1+2+3+4+ …..+n equals n.(n+1)/2 for all natural numbers n.
29. Prove the sequent $(\exists x\ \Phi) \vee (\exists x\ \Psi) \vdash \exists x\ (\Phi \vee \Psi)$
30. What are the proof rules for partial correctness.
31. Write a note on semantics of predicate logic.