1.
   a) True   b) True   c) False
2.
   a) True   b) False   c) False   d) True
5.
   a) There exists at least one student who spends more than five hours every weekday in class.
   b) Every student spends more than five hours every weekday in class.
   c) There exists at least one student who doesn’t spend more than five hours every weekday in class.
   d) Every student doesn’t spend more than five hours every weekday in class.
6.
   a) There is atleast one student who has visited North dakota.
   b) Every student has visited North dakota.
   c) There is no student who has visited North dakota.
   d) There is atleast one student who hasn’t visited North dakota.
   e) There is no student who has visited North dakota.
   f) Every student hasn’t visited North dakota.
7.
   a) Every comedian is funny.
   b) Everyone is comedian and funny.
   c) There is one person, if he is a comedian, then he is funny.
   d) There is one person who's a comedian and funny.
8.
   a) Every rabbits hops.
   b) All rabbits hops.
   c) There is atleast one animal if he is a rabbit, then he hops.
   d) There is an animal who’s a rabbit and hops.
9.
   a) 3x (P(x) /\ Q(x))
   b) 3x (P(x) /\ - Q(x))
   c) Vx (P(x) \/ Q(x))
   d) 3x (-P(x) /\ -Q(x))

10.

a) 3x (C(x) /\ Q(x) /\ F(x))
b) Vx (C(x) \/ Q(x) \/ F(x))
c) 3x (C(x) /\ Q(x) /\ -F(x))
d) Vx - (C(x) \/ Q(x) \/ F(x))
e) 3x C(x) /\ 3x Q(x) /\ 3x F(x)

15.

a) True
b) False
c) True
d) False

16.

a) True
b) False
c) True
d) False

17.

a) P(0) \/ P(1) \/ P(2) \/ P(3) \/ P(4)
b) P(0) /\ P(1) /\ P(2) /\ P(3) /\ P(4)
c) -P(0) \/ -P(1) \/ -P(2) \/ -P(3) \/ -P(4)
d) -P(0) /\ -P(1) /\ -P(2) /\ -P(3) /\ -P(4)
e) -(P(0) \/ P(1) \/ P(2) \/ P(3) \/ P(4))
f) -(P(0) /\ P(1) /\ P(2) /\ P(3) /\ P(4))

18.

a) P(-2) \/ P(-1) \/ P(0) \/ P(1) \/ P(2)
b) P(-2) /\ P(-1) /\ P(0) /\ P(1) /\ P(2)
c) -P(-2) \/ -P(-1) \/ -P(0) \/ -P(1) \/ -P(2)
d) -P(-2) /\ -P(-1) /\ -P(0) /\ -P(1) /\ -P(2)
e) -(P(-2) \/ P(-1) \/ P(0) \/ P(1) \/ P(2))
f) -(P(-2) /\ P(-1) /\ P(0) /\ P(1) /\ P(2))

21.

a) True for CS students, False for every human.
b) True for every person whose age is bigger than 21, False for every person whose age is smaller than 21.
c) True for Brothers, False for Non brothers.
d) True for non cousins, False for every Person.

22.

a) True for Indians, False for people of the world.
b) True for People of the world, False for kindergarten children.
c) True for Ahmed Mahmoud and Ahmed Hossam, False for all the people.
d) True for famous people, False for all the people.

23.

C(x) : “x in your class”

a) P(x) : “x can speak Hindi”
    1. 3x P(x)
    2. 3x (C(x) /\ P(x))

b) P(x) : “x in your class is friendly”
    1. Vx P(x)
    2. 3x (C(x) -> P(x))

c) P(x) : “x was born in California”
    1. 3x -P(x)
    2. 3x (C(x) /\ -P(x))

d) P(x) : “ x has been in a movie”
    1. 3x P(x)
    2. 3x (C(x) /\ P(x))

e) P(x) : “x has taken a course in logic programming. ”
    1. Vx -P(x)
    2. 3x (C(x) -> -P(x))

30.

a) P(1, 3) \/ P(2, 3) \/ P(3, 3)
b) P(1 , 1) /\ P(1 , 2) /\ P(1 , 3)
c) -(P(2 , 1) \/ P(2 , 2) \/ P(2 , 3))
d) -(P(1, 2) /\ P(2, 2) /\ P(3, 2))

35.

a) No Counterexample
b) x = 0
c) all integers except one

36.

a) x = 0 , x = 1
b) sqr(2)
c) x = 0

41.

a) “At least one mail message, among the nonempty set of messages, can be saved if there is a disk with more than 10 kilobytes of free space.”
M(x) : “x is a mail message”
E(x) : “x in the nonempty set of messages”
S(x) : “x can be saved”
F(x) : “disk x has more than 10 kilobytes of free space.”

(3x E(M(x)) <-> 3x F(x)) -> S(x)

---

b) “Whenever there is an active alert, all queued messages are transmitted.”
A(x) : “x is an active alert”
M(x) : “x is a queued message that is transmitted.”
3x A(x) -> Vx M(x)

---

c) “The diagnostic monitor tracks the status of all systems except the main console.”

T(x) : “The diagnostic monitor tracks the status of system x”
C(x) : “x is the main console”
-C(x) -> T(x)

---

d) “Each participant on the conference call whom the host of the call did not put on a special list was billed.”
C(x) : “participant on the conference call.”
H(x) : “the host x of the call put on a special list.”
B(x) : “x is billed”
(Vx C(x) <-> -H(x)) -> B(x)

42.

a) “Every user has access to an electronic mailbox”
U(x) : “x has access to an electronic mailbox”

Vx U(x)

---

b) “The system mailbox can be accessed by everyone in the group if the file system is locked.”

G(x) : “x in the group”
M(x) : “x can access the system mailbox”
L : “The file system is locked.”

L -> (G(x) -> M(x))

---

c) “The firewall is in a diagnostic state only if the proxy server is in a diagnostic state.”

F : “The firewall is in a diagnostic state”
P : “The proxy server is in a diagnostic state.”
F <-> P

---

d) “At least one router is functioning normally if the throughput is between 100 kbps and 500 kbps and the proxy server is not in diagnostic mode.”

e)
R(x) : “x is router that functions normally”
T(x) : “the throughput x is between 100 kbps and 500 kbps”
P : “The proxy server is not in diagnostic mode”

T(x) /\ P -> 3x R(x)

---

43. “Determine whether Vx (P(x) -> Q(x)) and Vx P(x) -> Vx Q(x) are logically equivalent.”

Sufficiency:
By definition Vx(P(x) -> Q(x)) is always True no matter the values of the x are.

Necessity:
Vx P(x) -> Vx Q(x) can be False in the Case that Q(x) is False and P(x) is True which is not necessary for Vx(P(x) -> Q(x)) to be True.

44.“Determine whether Vx (P(x) <-> Q(x)) and Vx P(x) <-> Vx Q(x) are logically equivalent.”

Sufficiency:
By definition Vx(P(x) <-> Q(x)) is always True which is sufficient for
Vx P(x) <-> Vx Q(x).

Necessity:
Vx P(x) <-> Vx Q(x) on the other hand can be:
x = a where P(a) != Q(a) which makes Vx P(x) <-> Vx Q(x) which is not necessary for Vx (P(x) <-> Q(x)).

49.

a) Vx (P(x) -> A) == 3x P(x) -> A

    Vx (-P(x) \/ A)
    Vx -P(x) \/ Vx A
    -3x P(x) \/ A
    3x P(x) -> A #

---

b) 3x (P(x) -> A) == Vx P(x) -> A

3x (P(x) -> A)
3x (-P(x) \/ A)
3x -P(x) \/ 3x A
-3x P(x) \/ A
Vx P(x) -> A #

---

50. Vx (P(x) \/ Q(x)) != Vx P(x) \/ Vx Q(x)

using counterexample:

assume:
P(x) : “x is Tall”
Q(x) : “x is Small”
for the first part is says :
Every person is Tall or Small.
the second part says:
Every person is Tall or Every person is Small.
Which is logically not correct (False).

---

51. 3x (P(x) /\ Q(x)) != 3x P(x) /\ 3x Q(x)

Sufficiency:
for 3x (P(x) /\ Q(x)) to be True, P(x) must be true AND Q(x) must be true, assuming x = a … P(a) /\ Q(a) is True.

Necessity:
for 3x P(x) /\ 3x Q(x) to be True 3x P(x) must be true AND 3x Q(x) must be true, assuming x = a P(a) must be True and assuming x = b Q(x) must be also True but x here doesn’t have the same value. so we cant say that they are logically equivalent.