

AI Mid-Term Exam
KASIT
University of Jordan

Student Name: _____

Student Number: _____

Section: _____

Question 1 [6 Points]

Represent the following sentences in first-order predicate logic.

1. Every white cat is larger than a black dog

$$(\forall X)(\exists Y)(W(X) \& C(X) \& B(Y) \& D(Y) \rightarrow L(X, Y))$$

2. If it rains at the weekend (WE), Rana will be sad.

$$R(WE) \rightarrow Sad(Rana)$$

3. All frogs are green if only birds are white

$$(\forall X)[W(X) \rightarrow B(X)] \rightarrow (\forall Y)[F(Y) \rightarrow G(Y)]$$

4. All cats do not like dogs.

$$(\forall X)(\forall Y)[C(X) \& D(Y) \rightarrow \neg L(X, Y)]$$

5. Only frogs are green or yellow

$$(\forall X)[G(X) \vee Y(X) \rightarrow F(X)]$$

6. Sami is happy if he pass all his IT exams

$$(\forall X)(IT-E(X) \& P(sami, X) \rightarrow H(X))$$

Question 2 [1+4 Points]**(a) Translate each of the following sentences into an appropriate clause.**

1. $(\forall X)(B(X) \rightarrow F(X))$

$\neg B(X) \vee F(X)$

2. $(\forall X)[P(X) \& A(X,N) \& \text{greater}(N,2) \rightarrow F(X)]$

$\neg [P(X) \& A(X,N) \& \text{greater}(N,2)] \vee F(X)$

3. $(\forall X)(F(X) \rightarrow W(X))$

$\neg F(X) \vee W(X)$

4. $B(j) \vee (P(j) \& A(j,5))$

(b) Prove $W(j)$ **Case1:**

$$\begin{array}{l} \{\neg B(X), F(X)\} \text{ _____} \\ \{B(j)\} \text{ _____} \end{array} \quad \begin{array}{l} | \\ | \end{array} \quad \begin{array}{l} \text{_____} \\ \text{_____} \end{array} \quad \{F(j)\}$$

$$\begin{array}{l} \{\neg F(X), W(X)\} \text{ _____} \\ \{F(j)\} \text{ _____} \end{array} \quad \begin{array}{l} | \\ | \end{array} \quad \begin{array}{l} \text{_____} \\ \text{_____} \end{array} \quad \{W(j)\}$$

$$\begin{array}{l} \{W(j)\} \text{ _____} \\ \{\neg W(j)\} \text{ _____} \end{array} \quad \begin{array}{l} | \\ | \end{array} \quad \begin{array}{l} \text{_____} \\ \text{_____} \end{array} \quad \{\}$$

Case2:

$$\{\neg [P(X) \& A(X, N) \& \text{greater}(N, 2)], F(X)\} \text{_____} \text{_____} \{F(j)\}$$

$$\{(P(j) \& A(j, 5))\} \text{_____} \text{_____}$$

Note that N is unified with 5. Hence, Greater(N, 2) will be true.

$$\{\neg F(X), W(X)\} \text{_____} \text{_____} \{W(j)\}$$

$$\{F(j)\} \text{_____} \text{_____}$$

$$\{W(j)\} \text{_____} \text{_____} \{\}$$

$$\{\neg W(j)\} \text{_____} \text{_____}$$

Question 3 [4 Points]

(1) After eliminating \rightarrow , the following formula:

$$(\forall X)(\forall Y)(\forall Z)[g(X) \& (h(Z, X) \rightarrow h(Z, Y)) \rightarrow s(X, Y)].$$

is equivalent to:

$$[g(X) \& (h(Z, X) \rightarrow h(Z, Y)) \rightarrow s(X, Y)] \leftrightarrow$$

$$\neg[g(X)\&(h(Z, X) \rightarrow h(Z, Y)) \vee s(X,Y)] \leftrightarrow$$

$$\neg g(X)\vee \neg (h(Z, X) \rightarrow h(Z, Y)) \vee s(X,Y)] \leftrightarrow$$

$$\neg g(X)\vee (h(Z, X)\& \neg h(Z, Y)) \vee s(X,Y)]$$

(2) Choose in each of the following questions the correct answer.

- (i) $((\exists X)(\forall Y)(\text{believe}(Y, \text{bob})\&\text{like}(Y, \text{mary}) \rightarrow \text{like}(X,Y))$
is equivalent to:
- Someone likes everyone that believes mary and likes Bob
 - Someone likes everyone and believes bob and likes mary
 - everyone likes someone that believes bob and likes mary
 - Someone likes everyone that believes Bob and likes mary

Answer: D

- (ii) All boiled eggs are heavier than some raw ones
is equivalent to:
- $(\exists X)(\exists Y)(\text{egg}(X)\&\text{egg}(Y) \text{ boiled}(X)\&\text{raw}(Y) \rightarrow \text{heavier}(X,Y))$
 - $(\forall X)(\forall Y)(\text{egg}(X)\&\text{egg}(Y) \text{ boiled}(X)\&\text{raw}(Y) \rightarrow \text{heavier}(X,Y))$
 - $(\forall X)(\exists Y)(\text{egg}(X)\&\text{egg}(Y) \text{ boiled}(X)\&\text{raw}(Y) \rightarrow \text{heavier}(X,Y))$
 - $(\forall X)(\exists Y)(\text{egg}(X)\&\text{egg}(Y) \text{ boiled}(X)\&\text{raw}(Y)\&\text{heavier}(X,Y))$

Answer: C

Question 4 [3 Points]

For each of the following pairs of Prolog terms, say whether or not the unification would succeed and, if it does, what is the value of each of the variables in the term.

1. $p(X, q(Y), r(Z)) = p(r(a), q(X), r(b)).$

X = r(a)

Y = r(a)

Z = b

2. $\text{father}(P1, P1) = \text{father}(X, \text{john}).$

P1 = john

X = john

3. $[X, Y] = [a, b \mid Z]$

X = a
Y = b
Z = []

Question 5 [6 Points]

(a) Write a PROLOG predicate, **split(L, L1,L2)** , that splits a list, L, of integer numbers into two sublists, L1 and L2, where L1 contains the odd values of L and L2 contains the even values of L.

Example :

? **split([2,4,5,7,8],L1,L2) .**

Should give

L1=[5,7]

L2=[2,4,8]

split([], [], []).

split([X|Y], [X|L1], L2) :- X mod 2 == 1, split(Y, L1, L2).

split([X|Y], L1, [X|L2]) :- split(Y, L1, L2).

(b) Write a PROLOG predicate, **locate(A, L, N)**, that takes as input an integer number A and a list L and returns as output the index (position) N of the first occurrence of A in L.

Example :

? **locate(10, [2,4,5,7,10,21,37], B) .**

Should give

B = 5.

Locate(A, [A|L], 1) .

Locate(A, [X|L], N) :- Locate(A, L, N1), N is N1+1.

.

Question 6 [8 Points]

What is the value of each of the Zi's in each of the following Prolog Clauses?

- $d(X, N, [], [])$.
 $d(X, N, L, L) :- N < 0$.
 $d(X, 0, L, L)$.
 $d(X, N, [X|L], L1) :- N1 \text{ is } N - 3, d(X, N1, L, L1)$.
 $d(X, N, [Y|L], [Y|L1]) :- N1 \text{ is } N - 2, d(X, N1, L, L1)$.
 ?- $d(8, 8, [8,9,10,8,12,80,8,15,16], Z1)$.

Z1 = [9, 10, 12, 80, 8, 15, 16]

- $r(X, 1, L, [X|L])$.
 $r(X, N, [Y|L], L1) :- N1 \text{ is } N - 1, r(X, N1, L, L1)$.
 ?- $r(a, 8, [a, b, d, e, c, e, f, g, h, i], Z2)$.

Z2 = [a, g, h, i]

- $a1([], [], [])$.
 $a1([X], [X], []) :- X \bmod 3 == 0$.
 $a1([X], [], [X]) :- X \bmod 2 == 1$.
 $a1([X|Y], [X|L1], L2) :- X \bmod 2 == 0, a1(Y, L1, L2)$.
 $a1([X|Y], L1, [X|L2]) :- Y = [V|H], a1(H, L1, L2)$.
 ?- $a1([1,4,5,16,6,18,23,3,171,2,3,5], Z3, Z4)$.

Z3 = [6, 18]

Z4 = [1,5,23,171,3]