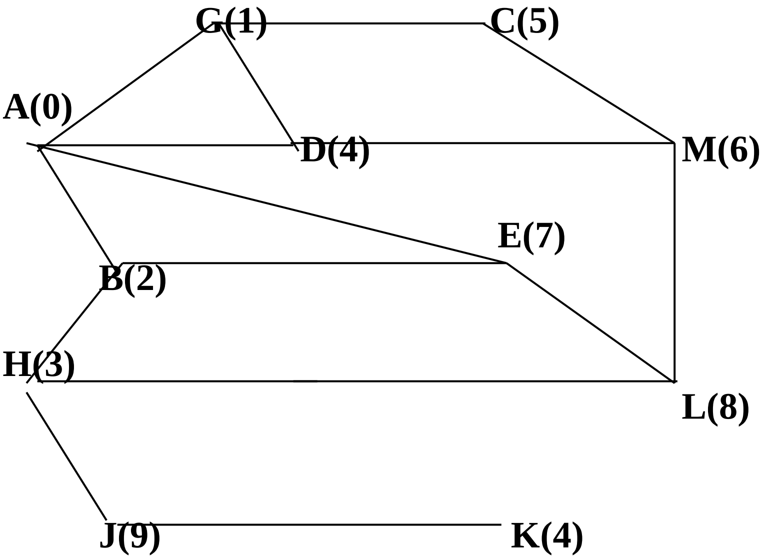
University Of Jordan
KASIT-CIS Department
Artificial Intelligence-Mid-Term
19th November 2020

St. Name: **St-ID:**
Project Title:

Question 1 [5+5+5 Points]

Suppose that we have the following graph **W**:



where the order of the nodes is alphabetical (for example if A and B are child states of a node N, then A is the first child and B is the second) and the numbers represent heuristic values of the nodes (i.e., the Larger is the number, the better or closer to the goal is the node).

(a). Give the order in which nodes are visited in a best-first search for the goal H starting from A.

Answer:

(b) Give the order in which nodes are visited in a depth-first search for the goal J starting from A.

Answer:

(c). Let Open be a stack,

MIN(S) is a function that takes as input a set of elements and returns as output the element in S with a minimal heuristic value.

Delete(X, S) is a function that deletes X from a set of elements S

Consider the following algorithm ALG:

```
OPEN = [START-NODE];
CLOSED = empty;
While OPEN <> empty
      Get S from OPEN;
      add S to closed;
      if S = GOAL
         then
           return SUCCESS
         else
           generate V = {C1, …, Ck}; //children of S
           compute n1,…, nk; //the heuristic values of C1, …, Ck
           while V <> empty
                Y = MIN(V);
                Add Y to OPEN;
                V = delete(Y, V);
```

(c) Give the order in which nodes are visited in a search on graph **W** following the algorithm **ALG** for the goal H starting from D.

Answer:

Question 2 [4*3 Points]

Express each of the following English sentences in First-Order Predicate Calculus

1. a smart student passes every hard exam

2. Not all students who do not study fail every exam

3. Sami does not own a small shop in Amman.

4. Sami likes a cat that knows every dog that has a bird

Question 3 [3 Points]
Answer with T or F as appropriate

1. $\neg[(\forall x)\ (A(x) \rightarrow (B(X) \rightarrow C(x))]$ is equivalent to
   $(\exists x)\ (A(x)\ \&\ B(X) \& \neg C(x)))$

Answer:

2. $(\forall x)\ (A(x) \& D(X) \rightarrow B(X))$ is equivalent to
   $(\forall x)\ (\neg B(x) \rightarrow (\neg A(X) \rightarrow \neg D(x))))$

Answer:

3. $\neg[(\forall x)\ (A(x) V D(X) \rightarrow B(X))]$ is equivalent to
   $(\exists x)\ (A(x)\ V\ D(X) \& \neg C(x)))$

Answer:

The answers :

Q1

a- open

<A,0> <E,7> <D,4> <B,2> <G,1>

<L,8> <B,2>

<M,6> <H,3>

<C,5> <D,4>

close

<A,0> <E,7> <L,8>

<M,6> <C,5> <D,4>

<H,3>

The answer: A, E, L, M, C, D, H

Q1

B.

J
L
H
K
E
H
B
D
E
G
A

open

close

A	B	E	L	h	J
1	2	3	4	5	6

The answer:

A, B, E, L, H, J

Q1

C.

H
L
M
C
G
A
D

open

D

<G,1><A,0><M,6>

A

<G,1><B,2><E,7>

G

<C,5>

C

<M,6>

M

<L,8>

L

<E,7><H,3>

close

D	A	G	C
1	2	3	4
M	L	H	
5	6	7	

The answer:

D, A, G, C, M, L, H

Q2

1. $\exists x \forall y \, (student(x) \land exam(y) \land smart(x) \land hard(y) \rightarrow pass(x,y))$

2. $\neg \forall x \forall y \, (student(x) \land exam(y) \land \neg study(x,y) \rightarrow fail(x,y))$

3. $\forall x \, (small(x) \land shop(x) \land in(x, amman) \rightarrow \neg own(sami, x))$

4. $\exists x \forall y \exists z \, (cat(x) \land dog(y) \land bird(z) \land has(y,x) \land know(x,y) \rightarrow like(sami, x))$

Q3

1. $\neg [\forall x \, (A(x) \rightarrow (B(x) \rightarrow C(x)))]$

$\neg [\forall x (\neg A(x) \lor (\neg B(x) \lor C(x))]$

$\exists x \, (A(x) \land B(x) \land \neg C(x))$ True

2. $\forall x ((A(x) \land D(x)) \rightarrow B(x))$

$\forall x \, (\neg (A(x) \land D(x)) \lor B(x))$

$\forall x \, (\neg A(x) \lor \neg D(x) \lor B(x))$

$\forall x \, (B(x) \lor \neg A(x) \lor \neg D(x))$ False

$\forall x \, (\neg B(x) \rightarrow \neg A(x) \lor \neg D(x))$

$\forall x \, (\neg B(x) \rightarrow (A(x) \rightarrow \neg D(x) \neq \forall x \, (\neg B(x) \rightarrow (\neg A(x) \rightarrow \neg D(x))$

Q3

3. $\neg [\forall x \, (A(x) \lor D(x) \rightarrow B(x))]$

$\exists (x) \neg (A(x) \lor \neg D(x) \lor B(x))$ False

$\exists (x) \, (\neg A(x) \land D(x) \land \neg B(x)) \neq \exists x \, (A(x) \lor D(x) \land \neg B(x))$