MAKERERE UNIVERSITY

SCHOOL OF COMPUTING AND INFORMATICS TECHNOLOGY.
END OF SEMESTER 2 EXAMINATION 2020/2021

PROGRAM: BSCS

YEAR OF STUDY: II

COURSE CODE: CSC 1209

COURSE NAME: LOGIC PROGRAMMING

DATE: 14^{th} /01/ 2021

TIME: 8:00-11:00 AM

Instructions:

1. Attempt ALL questions in Section A and THREE(3) in Section B
2. All questions in Section B carry equal marks.
3. Do not open this booklet until you are instructed to do so.
4. Begin each answer in Section B on a NEW page in the answer booklet
5. All rough work should be done in the answer booklet

Section A (40 Marks)

1. Define the following in relation to logic programming [**6 marks**]

   (a) Logic Program

   (b) Logic Programming Language

   (c) Logic Programming system

2. With examples, explain any three(3) successes of Logic Programming [**6 marks**]

3. Define a Dataset in logic programming. State any two roles played by a dataset in logic programming? [**5 marks**]

4. What is the usefulness of each of the following symbol operators in relation to Prolog programming. [**5 marks**]

   (a) =

   (b) is

   (c) _ (underscore)

   (d) ,

   (e) ;

5. Define a constant. With the aid of an example, list three types of constants used in logic programming. [**4 marks**] .

6. Translate each of the following Prolog statement into its equivalent English statement. [**4 marks**]

   (a) rose([X|Y]).

   (b) ?- dean(X,cit).

   (c) ?- head_of_department(_, computer_science).

   (d) beautiful(X):-girl(X),brown(X),has(long_hair).

7. What factors would you consider when implementing efficient recursive rules? [**6 marks**]

8. Consider the following Prolog program below

```
fun([],0).
fun([V|Y],P):-fun(Y,P1),P is P1+V.
```

   State the purpose of the program. What will be the output of the following query `?- fun([1,2,3,4,5,6,7],Y).` [**4 marks**]

Section B. Attempt any 3 questions (20 Marks each).

Question 1

Consider the Prolog knowledge base below. Study it and answer questions that follow.

```
male(tom). male(rich). male(james). male(isaac). male(emma).
female(teddy). female(mary). female(jane). female(jacent). female(ruth).
animal(cate). animal(jerry). animal(puppy).
lecturer(jane). lecturer(tom). lecturer(ruth).
subject(math). subject(science). subject(english). subject(sst).
student(james). student(teddy). student(isaac). student(jacent).
teaches(jane, math). teaches(tom, english). teaches(tom,math).
teaches(ruth,science). teaches(ruth,sst).
takes(rich,math). takes(isaac,math). takes(isaac,science).
takes(teddy, science). takes(puppy,english). takes(jerry,science).
likes(tom, cate).likes(james,jerry).
```

(a.) Without adding any fact or clause to the knowledge base. Pose a query that would retrieve each of the following information from the knowledge base .

i. Any two male students that are taking the same subjects. **[2 marks]**

ii. Any student that do not take any subject. **[2 marks]**

iii. Male lecturer(s) who teach animals and like the animals they teach. **[3 marks]**

iv. Animals that are not taking any subject or animals that are not liked by students. **[3 marks]**

(b.) Write a rule `teacher(X,Y)` which states that `X` is a teacher of `Y` if `X` is a `lecturer`, `Y` is a `student` and `X` teaches a subject taken by `Y` **[3 marks]**

(c.) Write a rule `comrades(X,Y)` which states that `X` and `Y` are comrades if `X` and `Y` take same subjects and like each other. **[3 marks]**

(d.) Pose a query to add the rule `comrades(X,Y)` to the knowledge base via command prompt. **[2 marks]**

(e.) Assuming that the rule has been added to the knowledge base. What will be the output for the query `?- comrades(X,Y).` **[2 marks]**

Question 2

(a) Consider the Prolog program below. The program has syntax errors and singletons. Study it and answer questions that follow.

```
1.Dog(tom).
2.cat(jerry).
3.cat(pet).
4.person(Mary).
5.person(rose).
6.Person(jesica).
7.teach(mary,jesica).
8.teach(jesica,rose).
9.teach(rose,jerry).
10.teach(rose,tom)
11.search(X)- teach(X,Y),person(X),person(Y).
```

(i) Which line(s) of code contains syntax error(s). Explain why they cause syntax errors? **[4 marks]**

(ii) Which line(s) of code contains singleton(s)?. Explain why they are singleton(s)? **[2 marks]**

(iii) Rewrite the program correctly by removing all the syntax errors and singletons. **[5 marks]**

(b) Consider the follow knowledge base below

```
father(hommer,bart).
father(hommer,jane).
father(bart,rose).
father(harry,jerry).
father(bart,john).
mother(jane,ruth).
mother(marge,bart).
mother(marge,ruth).
child(anne,bridget).
child(bridget,caroline).
child(caroline,donna).
child(donna,emily).
sibling(X,Y):-  father(T,X),father(T,Y), X\=Y.
onlychild1(X):- mother(T,X), not((mother(T,Y),Y\=X)).
onlychild(X):-  not(mother(T,X)),mother(T,Y),not(X=Y).
descend(X,Y):-  descend(X,Z),child(Z,Y).
descend(X,Y):-  child(X,Z),child(Z,Y).
descend(X,Y):-  child(X,Y).
```

(i) Explain why the rule `onlychild1(X)` when queried will return some output when an only child exist while the `onlychild(X)` will always return false even if there is an only child in the knowledge base? **[4 marks]**

(ii) If a call to the query `?-descend(X,Y)` is executed. Will it be able to terminated or not? Explain your answer. **[2 marks]**

(iii) Re-arrange the recursive rule `?-descend(X,Y)` so that it can run in the most efficient way when queried . **[3 marks]**

Question 3

For each of the following pairs of Prolog terms (Term 1 and Term 2), say whether or not the unification would succeed and, if it does, the variable bindings that would result. Assume that the same variable name in two different terms in a given pair represents the same variable. We have done the first one for you as an example. **[20 marks]**

	Term1	Term 2	Unify?	Binding
Example	[1,2,3]	[X|Y]	Yes	X = 1, Y =[2,3]
a	[a, [c]]	[X |Y]	Y	X = a , Y= [c]
b	[[a]]	[X, Y]	NY	X = [a] , Y = [3]
c	f(x,a,x)	f(x,y,b)	N	x=b, a=g, x=b
d	p(X,q(Y),r(Z))	p(r(a),q(X),r(b))	N	X=r(a),
e	[X,Y|Z]	[a,b,c,d,e,f,g]	Y	X=a, Y=[b,c,d,e,f,g]
f	[f(Y), 1]	[X | Y]	N	X= f(1) , Y=1
g	f([1, 2, 3])	f([X | Y])	Y	X=1 , Y= [2,3]
h	f(X, g(a))	g(X, Y)	Y	X , Y = g(a)
i	f(X,a,x)	f(a,Y,B)	N	X=a
j	f(X, g([1, 2]))	f(g(a),Y)	Y	X= g(a) , Y = g([1,2])

X = f(Y)
Y = 1
Y = f(1)

f(X, g([1,2])
f(g(a), Y)
X = g(a) Y = [1,2]

Y = g(a)

X = a f(X,a,X)
f(a, Y, a)
X = a,

Question 4

A crime wave has hit Kampala. Your mission is to enlist the help of the Prolog system to solve the crimes. Given below is a series of facts that you are to translate into Prolog, using predicates and constants as specified. The facts and rules you formulate, taken together, will form a Prolog program that can be queried to narrow down the list of crime suspects.

(a) Using a predicate `possible_suspect/1`, and constants for the names of people, formulate the following facts: **Tom, Cate, Rose and Peter are all possible suspects [4 marks]**.

(b) Using a predicate `crime_committed_against/4` and appropriate constants, record the following facts from the police log: **[2 marks]**

(i.) Assault was committed against Teddy on Tuesday in Makerere.

(ii.) Kidnap was committed against Jane on Wednesday in Katanga.

(c) Using a predicate `was_in/3` and appropriate constants to record the following facts.**[4 marks]**

(i.) Tom was in Makerere on Tuesday, and in Makindye on Wednesday.

(ii.) Cate was in Makerere on Tuesday and in Katanga on Wednesday..

(iii.) Rose was in Nakawa on Tuesday and Wednesday.

(iv.) Peter was in Katanga on Tuesday and in Makerere on Wednesday.

(d) Using predicate `jealous_of/2` and appropriate constants write the following facts: [2 marks]

(i.) Rose is jealous of Jane.

(ii.) Peter is jealous of Teddy.

(e) Formulate the following rules in Prolog (using appropriate predicates):[4 marks]

(i.) A suspect had a motive against a victim if the suspect is jealous of the victim.

(ii.) A person is a prime suspect for a crime if the person is a possible suspect and the person was on day and in the place of the crime and the person had a motive against the victim of the crime.

(f) Formulate queries to the program corresponding to the following questions. [4 marks]

(i.) In what crimes is Rose a prime suspect?

(ii.) In what crimes is Peter a prime suspect