



THE UNIVERSITY OF  
**WESTERN  
AUSTRALIA**

DESK No.

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FAMILY NAME: \_\_\_\_\_

GIVEN NAMES: \_\_\_\_\_

SIGNATURE: \_\_\_\_\_

STUDENT NUMBER:

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**SEMESTER 2, 2022 EXAMINATIONS**

**CITS3005**

**Knowledge Representation**

This paper contains: **6 Pages (including title page)**

Time Allowed: **2:00 hours**

**INSTRUCTIONS:**

Complete this exam online in the time provided. Your solutions must be submitted before the time elapses.

You may complete this exam in a venue of your choosing. Please make sure that it is free of distractions and has reliable power and internet access.

The work you submit, must be your own work. You are not to communicate or collaborate with anyone during the exam.

This is an open book test. You may use any books or online resources you choose, provided their use does not involve direct communication.

**THIS IS AN OPEN BOOK EXAMINATION**

**SUPPLIED STATIONERY**

**None. Students are do supply all stationery they deem necessary.**

**ALLOWABLE ITEMS**

**Students are allowed to use any physical existent object, provided the possession and use of that object does not constitute a crime in the student's current location.**

**PLEASE NOTE**

*Examination candidates may only bring authorised materials into the examination room. If a supervisor finds, during the examination, that you have unauthorised material, in whatever form, in the vicinity of your desk or on your person, whether in the examination room or the toilets or en route to/from the toilets, the matter will be reported to the head of school and disciplinary action will normally be taken against you. This action may result in your being deprived of any credit for this examination or even, in some cases, for the whole unit. This will apply regardless of whether the material has been used at the time it is found.*

*Therefore, any candidate who has brought any unauthorised material whatsoever into the examination room should declare it to the supervisor immediately. Candidates who are uncertain whether any material is authorised should ask the supervisor for clarification.*

*Candidates must comply with the Examination Rules of the University and with the directions of supervisors.*

*No electronic devices are permitted during the examination.*

*All question papers and answer booklets are the property of the University and remain so at all times.*

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1.

Clearly describe the differences, as you understand them, between:

- a **Database**,
- a **Knowledge Base**, and
- an **Ontology**.

For each of the above terms give a clear definition, and sufficient examples to distinguish the concepts from one another.

15 marks

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2. (15 marks)

- (a) Describe the main steps in *SLD Resolution*, and show how those steps are applied in the following prolog program, which is used to determine if a binary tree is *inorder*, i.e. every leaf element in the left subtree is less than every leaf element in the right subtree.

```
%inorder takes a recursive binary tree, where the leaves are numbers,  
%and is true if the tree is inorder  
inorder(tree(L,R)) :- !, inorder(L), inorder(R), right(L,X), left(R,Y), X<Y.  
inorder(_).
```

```
%Z is the rightmost leaf in the tree.  
right(tree(_,Y),Z) :- !, right(Y,Z).  
right(Z,Z).
```

```
%Z is the leftmost leaf in the tree.  
left(tree(X,_),Z) :- !, left(X,Z).  
left(Z,Z).
```

10 marks

- (b) Show the SLD tree for the query `inorder(tree(tree(1,3),tree(2,4)))`.

5 marks

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3. (15 marks)

Design an ontology to represent the content of the unit *CITS3005 Knowledge Representation*. You should include the concepts:

- Topic *e.g. logic programming*
- Lecture *e.g. lecture 3: first order logic*
- Laboratory *e.g. laboratory 6: OWL*
- Workshop *e.g. workshop 3: recursion*
- Assessment *e.g. homework 2*
- Reference *e.g. Simply Logical chapter 4*
- Tool *e.g. protégè*.

You may include additional concepts.

(a) Given a clear description of each class in your ontology.

5 marks

(b) Describe the relationships between the classes, including description logic axioms.

5 marks

(c) Give an example instance of each class and relationship in your ontology, using the content from CITS3005.

5 marks

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4.

(a) Describe the key differences between *Prolog* and *ProbLog* (or more generally, *logic programming* and *probabilistic logic programming*). Particularly describe:

- the similarities and differences in programming syntax.
- the differences in the way programs are interpreted.
- the different applications each has.

5 marks

(b) Use ProbLog2 to write a probabilistic logic program representing a Bayesian Network representing the following scenario:

- if you studied hard for the exam, and you got enough rest, then you are well-prepared for the exam.
- if you are well-prepared for the exam or the lecturer is kind, then you will pass the exam.
- if you studied hard for the exam, then the lecturer will be kind.

For each of these axioms propose a conditional probability table, and show how this is implemented in ProbLog.

5 marks

(c) In the scenario from Part (b), suppose that you are unsure of how much *studying hard* will effect the *kindness of the lecturer*. Demonstrate how you could learn the values in the conditional probability tables based on observations of the lecturer's class. That is, for each student in the class we know if they studied hard, if they got enough rest, and if they passed the exam.

5 marks