LIT
DEPARTMENT OF
INFORMATION TECHNOLOGY

Semester: Semester 2 (Summer 2016/17)

Date/Time: Tuesday 9th May 2017, 9:30 AM – 11:30 AM

Programme: Bachelor of Science in Computing
Bachelor of Science (Honours) in Computing (Software Development)
Bachelor of Science (Honours) in Computing (Games Design and Development)

Stage: Year 3

Module: ARTIFICIAL INTELLIGENCE

> **COMP 7003**

Time Allowed: 2 hours

Instructions:	Attempt any four (4) questions

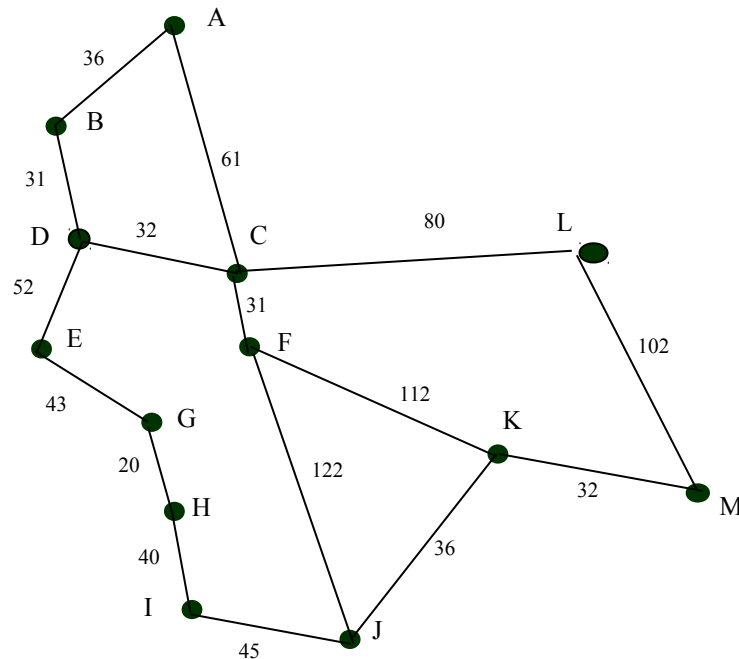**Additional Attachments:**   None

External Examiners: Derek O'Reilly
Internal Examiners: Janice O'Connell, Eugene Kenny

Question No. 1   **(25 Marks)**

(a)   Consider the following map:

Using the A* algorithm work out a route from town A to town M. Use the following cost functions:
- $g(n)$ = The cost of each move as the distance between each town (shown on map)
- $h(n)$ = The Straight Line Distance between any town and town M. These distances are given in the table below.

   i)   Provide the search tree for your solution.   *(10 marks)*

   ii)   Indicate the order in which you expanded the nodes and state the route you would take and the cost of that route.   *(10 marks)*

Straight Line Distance to M

A	223		E	165		H	111		K	32
B	222		F	136		I	100		L	102
C	166		G	122		J	60		M	0
D	192									

(b)   The straight line distance heuristic used above is known to be an *admissible* heuristic. What does this mean and why is it important?   *(5 marks)*

Question No. 2   **(25 Marks)**

Consider the following scenario:

d has been murdered. a, b, and c are suspects (i.e., at most one of a, b, and c are guilty). b claims that he did not know the victim d (i.e., if b did know d, then b is lying). a and c claim that b did know d (i.e., if b did not know d, then a and c are lying). Anyone who lies is guilty.

(a) Express the key facts and relationships using *first order predicate calculus*.   *(5 marks)*

(b) Convert the expressions above into clauses in conjunctive normal form (CNF).   *(0 marks)*

(c) Prove using the resolution refutation process that b committed the murder (is guilty).   *(10 marks)*

Question No. 3   **(25 Marks)**

(a)   What are the main problems in reasoning about actions and change?   *(5 marks)*

(b)   What is meant by regression planning?   *(5 marks)*

(c)   For the operators and initial state description given below, explain how a *(15 marks)* regression planner searches for a plan to satisfy a goal, and give an example of a plan that achieves the goal $On(b, a) \wedge On(c, b) \wedge OnTable(a)$

- blocks are represented by constants: a, b, c, ... etc.
- states are described using the following predicates:

  $On(x, y)$ block x is on block y
  $OnTable(x)$ block x is on the table
  $Clear(x)$ there is no block on top of block x
  $Holding(x)$ the arm is holding block x
  $ArmEmpty$ the arm is not holding any block

- initial state: $On(c, a) \wedge OnTable(a) \wedge OnTable(b) \wedge ArmEmpty$
- goal state: $On(b, a) \wedge On(c, b) \wedge OnTable(a)$
- operators:

  [*Holding(x)*, *Clear(y)*] **STACK**(x, y) [*On(x, y)*, *ArmEmpty*, ¬*Holding(x)*, ¬*Clear(y)*]

  [*On(x, y)*, *Clear(x)*, *ArmEmpty*] **UNSTACK**(x, y) [*Clear(y)*, *Holding(x)*, ¬*On(x, y)*, ¬*ArmEmpty*]

  [*OnTable(x)*, *Clear(x)*, *ArmEmpty*] **PICKUP**(x) [*Holding(x)*, ¬*OnTable(x)*, ¬*ArmEmpty*,]

  [*Holding(x)*] **PUTDOWN**(x) [*OnTable(x)*, *ArmEmpty*, ¬*Holding(x)*,]

Question No. 4 **(25 Marks)**

(a) Draw the Baysian Network that corresponds to each of the following *(10 marks)* conditional probability equations:

    i) P(B|A,C) P(A) P(C|D) P(D)
    ii) P(A) P(B) P(C) P(D)
    iii) P(A|B) P(C|D) P(B) P(D)
    iv) P(D|C) P(C|B) P(B|A) P(A)

(b) You are a robot in a lumber yard, and must learn to discriminate Oak wood *(15 marks)* from Pine wood. You choose to learn a *Decision Tree* classifier. You are given the following examples:

Example	Density	Grain	Hardness	Class
1	Heavy	Small	Hard	Oak
2	Heavy	Large	Hard	Oak
3	Heavy	Small	Hard	Oak
4	Light	Large	Soft	Oak
5	Light	Large	Hard	Pine
6	Heavy	Small	Soft	Pine
7	Heavy	Large	Soft	Pine
8	Heavy	Small	Soft	Pine

    i) Draw the decision tree that would be constructed by recursively applying information gain to determine the most informative attribute.

    ii) Classify these new examples as Oak or Pine using your decision tree above.
             Density = Light, Grain = Small, Hardness = Hard
             Density = Light, Grain = Small, Hardness = Soft

Question No. 5 (25 Marks)

Write an overview on any *two* of the following topics:

  i)   Local search algorithms
  ii) Expert systems
  iii) Neural networks