Answer all questions. You have 60 minutes for this test.

Marks for this test account for 10% of the total credit for COMP218.

Write your answers straight onto the question paper in the space provided below each question. In the unlikely event that you require additional space to answer any question, write on the reverse side of the paper, indicating clearly that you have done this. If you want, you may do rough work on the reverse of the question pages.

Enter your name, University ID Number and degree program and year of study in the spaces below.

Name ____________________________ University ID Number ____________________________

Degree program and year of study ____________________________

*Do not write below this line*
1. Consider the following finite automaton.

(a) Explain why it is a non-deterministic finite automaton, and not a deterministic finite automaton.

(b) Write down an accepting path for the input string \textit{ababac}.

(c) Explain why \textit{abbac} is not accepted by this finite automaton.
2. (a) Write down regular expressions for the following languages, all of which use the alphabet \{a, b, c\}.

i. All words that have at least 2 letters. [2 marks]

ii. All words that have at least one letter a. [2 marks]

ii. All words where any occurrence of the letter a is followed by an occurrence of the letter b. [2 marks]

(b) For each pair of regular expressions below, write down a word over the alphabet \{a, b, c\} that belongs to one language but not the other (and say which language it belongs to).

i. \((a\{b, c\})^*a\) and \((ab)^*a \cup a(ca)^*\). [2 marks]

ii. \(\{a, b, c\}\{b, \epsilon\}\{c, \epsilon\}\) and \(\{a, \epsilon\}\{b, \epsilon\}\{a, b, c\}\). [2 marks]
3. (a) Draw a diagram of a DFA that only accepts the words dog, cat and cats. [3 marks]

(b) Explain what it means for two states of a finite automaton to be indistinguishable. In your answer to part (a) of this question, are there any indistinguishable states? (Explain why, or why not, as the case may be.) [4 marks]
4. I mentioned in lectures that when you simplify a DFA (removing inaccessible and indistinguishable states, so that the number of states is as small as possible) then the resulting DFA is unique. That is, you cannot have two minimal DFAs that accept the same language but have different structures. Explain why this is true. (It is possible to write down a short and precise proof. Alternatively you may like to explain it with reference to an example.) [5 marks]