

**CSC 173: Computation and Formal Systems**  
**Final Exam**

85 points

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Randal C. Nelson, Instructor

# Context Free Grammars

## 1. (10 points)

Provide a context free grammar that will correctly parse propositional logic expressions composed of the following restricted set of terminals: {AND, OR, variable, T, F, (, )}. Your grammar should be unambiguous, correctly enforce the precedence of AND over OR, and enforce left to right association.

## 2. (10 points)

Consider the following grammar

```
<sentence>    -> <subject> <predicate>
<subject>    -> <nom-pronoun> | <noun-phrase>
<predicate>  -> <verb> <object>
<object>     -> <acc-pronoun> | <noun-phrase>
<noun-phrase> -> <noun> | <adjective> <noun-phrase> |
                <noun-phrase> and <noun-phrase>
<nom-pronoun> -> I | you | they
<acc-pronoun> -> me | you | them
<noun>        -> lions | tigers | monkeys | gazelles | warthogs
<adjective>  -> young | old | fast | slow | noisy | fierce
<verb>       -> like | hate | eat | chase
```

Give a parse tree for the sentences

1. "I like noisy noisy noisy monkeys"
2. "young fast lions chase gazelles and warthogs"

## 3. (10 points)

The grammar in question 2 is ambiguous. Prove it by giving an example sentence and showing two different parse trees for it.

## Propositional Logic

### 4. (10 points)

Determine using a truth table whether or not the following statement is a tautology:

$A \text{ AND } (\sim B \text{ OR } C) \text{ OR } \sim C \text{ AND } B \text{ OR } \sim A$

### 5. (5 points)

Put the following expression in disjunctive normal form (i.e. make it an OR of ANDs).

$(A \text{ OR } B \text{ OR } C) \text{ AND } D$

### 6. (15 points)

Consider the following set of premises:

1. Either the red or blue or green channel is bad
2. If the red or blue channel is bad then magenta is bad
3. If the red or green channel is bad then yellow is bad
4. If the blue or green channel is bad then cyan is bad
5. Yellow is not bad

Provide a resolution proof using contradiction for the statement that the blue channel is bad. Remember to put everything into conjunctive normal form before you start the proof proper. If you do not use a premise, you can leave it out of the proof.

## Predicate Logic

### 7. (15 points)

Translate the following English statements into predicate logic:

1. Dogs that scratch themselves sometimes have fleas.
2. Nobody hates everybody.
3. Everyone has exactly one mother.
4. Anyone who hates Lisp and Prolog can't be all bad.
5. Some say the world will end in fire; some say in ice.

## Computability

### 8. (10 points)

What is a decision problem? What is meant by an “undecidable” decision problem. Give two examples of undecidable problems.