CSE 230 MIDTERM EXAM

7 February 2002

Each question is worth 20 points.

1. Given the following Post system, with signs $\{N, |, =, \cdot, Q\}$:

$$\frac{}{N} \quad \frac{Nx}{Nx|} \quad \frac{Nx}{\cdot x =} \quad \frac{x \cdot y = z}{x| \cdot y = zy} \quad \frac{Nx \quad Ny}{xQy} \quad \frac{wQx \quad yQz \quad w \cdot z = y \cdot x}{wQx = yQz} \quad \frac{x \cdot y = z \quad u \cdot v = z}{x \cdot y = u \cdot v}$$

   where zy in the fourth rule represents the juxtoposition of strings.
   - (a) [5 points] Give an intuitive interpretation for this system.
   - (b) [15 points] Sketch a derivation for $|Q|| = ||Q||||$.

2. For 10 points each:
   - (a) Give an OBJ program for the Post system of the above question. (You will not be penalized for minor syntactic errors in OBJ.)
   - (b) Explain how OBJ would prove the assertion of the second part of the above question.

3. For 10 points each, briefly define, and give an example for, each of the following:
   - (a) abstract syntax;
   - (b) synthesized attribute grammar.

4. For 4 points each, briefly define, and give an example for, each of the following:
   - (a) infix, postfix, mixfix syntax;
   - (b) dereferencing;
   - (c) environment and storage;
   - (d) aliased variables;
   - (e) regular expression.

5. Given the following OBJ module,

```
th NATLIST is pr NAT .
   sort List .
   subsort Nat < List .
   op nil : -> List .
   op __ : List List -> List [assoc id: nil].
   op head_ : List -> Nat .
   op tail_ : List -> List .
   var L : List . var N : Nat .
   eq head N L = N .
   eq tail N L = L .
endth
```

   where `NAT` is the usual natural numbers, then:
   - (a) Describe two different models of `NATLIST`, at least one of which is not (i.e., is not isomorphic to) the standard model.
   - (b) Say how to get the standard model in OBJ, and say why this works.
   - (c) Now use the distinction getween loose and standard semantics to describe the approach in algebraic denotational semantics for building a programming language semantics over a semantics for storage.

(This differs from the version of the exam that was actually given, in that certain questions have been clarified.)