Programming Languages Lab (CS389) **Lab 5**
Computer Science and Engineering **Out: 2002-10-21**
Indian Institute of Technology Bombay **Due: 2002-10-30**

Thanks to Kedar Bellare for scribing these assignment specs from my lecture.

1. Here is Prolog code for quicksort:

```
qsort([],[]).
qsort([X|Y],Z) :- partition(X,Y,Y1,Y2),
                  qsort(Y1,Z1), qsort(Y2,Z2),
                  append(Z1,[X|Z2],Z).

append([],W,W).
append([A|B],W,[A|V]) :- append(B,W,V).

partition(_,[],[],[]).  (*)
partition(X,[A|B],[A|Y1],Y2) :- A < X,  partition(X,B,Y1,Y2).
partition(X,[A|B],Y1,[A|Y2]) :- A >= X, partition(X,B,Y1,Y2).
```

   (a) In the line marked (*), what is '_'? Can we use a free variable instead of '_'?

   (b) Is the above program reversible, i.e., on giving an unsorted list as the first argument it binds the second argument to a sorted list, but on giving a sorted list as the second argument does it bind the first argument to all possible permutations of the elements? If not, explain why not.

   (c) Implement quicksort in a different manner which does show reversible input-output behavior.

2. Here is Prolog code to generate all permutations of a set of items:

```
remove(X,[X|Xs],Xs).
remove(X,[Y|Ys],[Y|Zs]) :- remove(X,Ys,Zs).

permute(Xs,Ys) :- mystery(Xs,Ys,Ys).

mystery([],[],[]).
mystery([X|Xs],Ys1,[_|Zs]) :- mystery(Xs,Ys,Zs), remove(X,Ys1,Ys).
```

   (a) Consider only the two rules for `remove`. What happens if there are multiple occurences of an item in a list? Are all the occurences of the item removed at once or are the lists outputted with X removed one at a time and the others intact?

   (b) Explain clearly what `mystery` is meant to do.