Answer the questions in 75 minutes.

1. **(35 points)** Let $L = \{a^m b^n c^k$: two of m, n, k are equal and the other is 1 (e.g. $aabbc \in L$, $abbbccc \in L$, $aaaabcccc \in L$, $aabbbccc \notin L$.)

   1. Show a context-free grammar for L.
   2. Show a natural PDA that accepts L.

2. **(35 points)** Construct a Turing machine that prints the strings on $\{0, 1\}^*$ in the lexicographic order.

   Hint:

   The tape's initial contents: $\sqcup 0$

   The output is: $\sqcup 0 \sqcup 1 \sqcup 00 \sqcup 01$...

3. **(30 points)** Let L be a language that is represented by the following regular expression:

   $(0 \cup 10)^*$

   Write a regular expression to represent the complement of L ($\bar{L}$).