This is a “closed book” exam. The parts add up to 50 points, the grade is obtained by dividing the total number of points by 5. Motivate your answers!

**Assignment 1**. Given is the following context-free language:

$$L = \{a^kb^ne^n \mid k, n \geq 0\}.$$

a. Give a recursive specification over Sequential Algebra that generates this language. Use $S$ for the initial variable. Give derivations for $S \triangleright 1$ and $S \triangleright a.b.c.1$.

b. Give a pushdown automaton that has this language.

(12 points)

**Assignment 2**. Given is the following automaton.

a. Give a linear recursive specification for this automaton.

b. Give an iteration expression that is language equivalent to this automaton.

(11 points)
**Assignment 3** Consider the following recursive specification.

\[ S = a.S \cdot T + b.1 \]
\[ T = c.1 \]

Using the operational rules, give the transition system for \( S \). Argue why \( S \) is not a regular process. (11 points)

**Assignment 4**. Two students \( A, B \) are always talking on the telephone, unless they sleep. Define

\[ A = i?\text{call}.i!\text{talk}.(i?\text{talk}.i!\text{talk.}1)^* \cdot \text{sleep}.A \]
\[ B = i!\text{call}.i?\text{talk}.(i!\text{talk}.i?\text{talk.}1)^* \cdot \text{sleep}.B \]

a. Determine the automaton for \( A \) and for \( B \) that is generated by the operational rules.

b. Give an automaton for \( \partial_i(A \parallel B) \). You may use laws and bisimulation to simplify the automaton.

c. Give an automaton for \( \tau_i(\partial_i(A \parallel B)) \). You may use laws and branching bisimulation to simplify the automaton.

(16 points)