Consider the following statement:

\[ \text{repeat } S \text{ until } b \]

a. Extend the natural operational ("big-step") semantics of the WHILE language (Table 2.1 from [1]) by a rule for \( \rightarrow \) for the repeat-construct. (The semantics for the repeat-construct should not rely on the existence of a while-construct)

b. Two statements in a natural semantic are considered equivalent if for all states \( s \) and \( s' \):

\[ \langle S_1, s \rangle \rightarrow s' \iff \langle S_2, s \rangle \rightarrow s' \]

How can you show that the repeat construct is semantically equivalent to \( S; \text{while } \neg b \text{ do } S \)? Why does this lead to the conclusion that the extended semantics is deterministic?
2. Consider the following statement:

\textbf{repeat } \textbf{S until } \textbf{b}

a. Define the structural operational (“small-step”) semantics as in Table 2.2 from [1] for the \textbf{repeat}-construct. (The semantics for the repeat-construct should not rely on the existence of a while-construct)

b. How must the notion of semantic equivalence be defined for structural operational semantics?

3. What distinguishes the two notions of semantic equivalence in 1) and 2)?