

4. (a) The use of *abstract machine code* is a popular alternative to three-address code as a class of intermediate representations, as exemplified by the current popularity of the JVM. Compare and contrast these two approaches to intermediate code representation, and explain the benefits of each. [8]
- (b) Explain how the Sethi-Ullman algorithm to minimize the number of registers used works. Consider the statement  $a := b * c - 2 * d * (e + 1)$ . Translate this statement into generalized assembly code using the algorithm. Assume we have two general-purpose registers available. [8]
- (c) Typically booleans and integers are considered distinct types, but some languages allow integers to be used as booleans, with 0 being equivalent to false and any non-zero value being equivalent to true, while still allowing variables to be declared as booleans. Provide syntax-directed definitions for type checking in such a language. You may make assumptions about any precise restrictions and also assume any functions needed to access symbol table. [9]