12 Optimising Compilers (TMJ)

(a) Describe a procedure’s flowgraph and the concept of basic blocks. What language construct makes flowgraph construction imprecise? [3 marks]

(b) Describe the principle of dominance within a flowgraph, including strict dominance, dominance trees and the dominance frontier. [4 marks]

(c) Define data-flow equations to find each node’s dominators and an algorithm to compute this. [5 marks]

(d) Describe how to use dominance information to find loops in a flowgraph. [2 marks]

(e) What is static single assignment (SSA) form? [1 mark]

(f) Use the dominance frontier to place \( \phi \) nodes into the following code and thereby convert it to SSA form.

b1:  LDR x, #0xFF00  
     LDR y, #0xFF08  
     BEQ x, #0, b9  

b2:  BEQ x, #1, b4  

b3:  ADD x, x, #2  
     BR b5  

b4:  ADD x, x, y  

b5:  BEQ x, #8, b7  

b6:  STR x, #0xFFA0  
     BR b8  

b7:  STR y, #0xFFA0  

b8:  ADD x, x, y  
     BR b10  

b9:  ADD y, y, #1  

b10: ADD x, x, #1  
     STR x, #0xFF00  

[5 marks]