3 Computation Theory (amp12)

(a) Define what is meant by a *configuration* and a *computation* of a register machine (RM). Explain carefully what it means to say that a computation *halts*.

[5 marks]

(b) Define the notion of RM *computable* partial numerical function of n arguments.

[2 marks]

(c) What does it mean for a problem (expressed as a property of numbers) to be RM *undecidable*? [2 marks]

(d) A computation of a RM is said to be *circular* if it reaches the same configuration at two different times.

(i) Explain why a circular computation does not halt. Give an example of a RM computation that does not halt, but that is not circular. [2 marks]

(ii) The Circularity Problem is: Decide whether or not the computation of any given RM and initial register contents is circular. Give a proof that the Circularity Problem is undecidable. You may assume suitable functions for encoding and decoding pairs of numbers as numbers, finite lists of numbers as numbers, and RM programs as numbers. [9 marks]