# 2004 Paper 9 Question 16

## Topics in Concurrency

($a$) Describe the semantics of the modal $\mu$-calculus. [4 marks]

($b$) Describe without proof the meaning of the following modal $\mu$-calculus assertions:

($i$) $\nu Z.\ \langle c \rangle Z$ ; [1 mark]

($ii$) $\mu Z.\ \langle c \rangle Z$ ; [1 mark]

($iii$) $\nu Z.\ (A \wedge ([c]F \vee \langle c \rangle Z))$ (here $F$ means false); [2 marks]

($iv$) $\mu Z.\ (B \vee (A \wedge \langle c \rangle Z))$ ; [2 marks]

($v$) $\nu Z.\ (B \vee (A \wedge \langle c \rangle Z))$ . [2 marks]

($c$) Consider the transition system consisting of two states $p, q$ and two transitions $p \xrightarrow{c} q$ and $q \xrightarrow{c} p$.

($i$) Does $p$ satisfy $\mu Z.\ ([c]F \vee (\langle c \rangle T \wedge \langle c \rangle Z))$ ?

($ii$) Does $p$ satisfy $\nu Z.\ ([c]F \vee (\langle c \rangle T \wedge \langle c \rangle Z))$ ?

(Again, here $F$ means false and $T$ means true.) In this part you should justify your answers carefully. [8 marks]