(a) Describe concisely a model checking algorithm for judgements of the form $p \models A$, where $p$ is a finite-state process and $A$ is an assertion of the modal $\mu$-calculus. [4 marks]

(b) Show how to express a minimum fixed point assertion $\mu X.A$ in terms of a maximum fixed point assertion. [2 marks]

(c) Let $\mu X\{p_1, \ldots, p_n\}A$ mean $\mu X.(\neg\{p_1, \ldots, p_n\} \land A)$. From (a), or otherwise, show that:

(i) when $q \in \{p_1, \ldots, p_n\}$, the judgement $q \models \mu X\{p_1, \ldots, p_n\}A$ is false;

(ii) when $q \notin \{p_1, \ldots, p_n\}$,

$$q \models \mu X\{p_1, \ldots, p_n\}A \iff q \models A[\mu X\{q, p_1, \ldots, p_n\}A/X].$$

[7 marks]

(d) From the algorithm you have described in (a), using (c) if it is helpful, decide whether or not the following judgement holds:

$$P \models \mu X.([a]F \lor \langle a \rangle X)$$

where $P$ is the CCS process defined by

$$P \overset{\text{def}}{=} a.Q \quad Q \overset{\text{def}}{=} a.P + a.nil.$$  [7 marks]