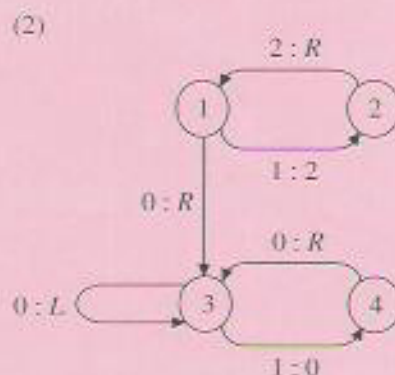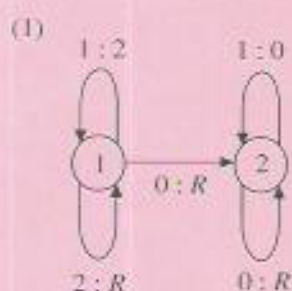## Question 9

(i) We wish to design a Turing machine which, using monadic notation, takes as input a pair (m, n) of positive integers in standard starting position (on an otherwise blank tape) and which halts scanning the left-most of a string of m 2s on an otherwise blank tape.

   (a) Explain why each of the Turing machines below is *not* suitable for this task. (Your answer may include sequences of configurations for appropriate test data.)
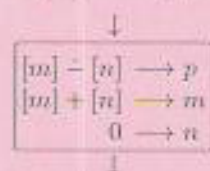

[4]

   (b) Give the flow graph of a Turing machine which correctly performs the task.

[2]

(ii) Give the complete flow chart of an Abacus machine program which has the effect shown in the following block diagram. (You may use extra registers, assumed empty initially, if you wish.)

$$\begin{array}{l}[m] \dot- [n] \longrightarrow p \\ [m] + [n] \longrightarrow m \\ \qquad 0 \longrightarrow n \end{array} \qquad \text{where } x \dot- y = \begin{cases} x - y, & \text{if } x \geq y, \\ 0, & \text{if } x < y. \end{cases}$$

where $[p] = 0$ initially

[5]