1. [2 points] Using the labelling algorithm, calculate the set of states of the following transition system satisfying the CTL formula $EF (p \land AX q)$.

![Diagram of transition system]

2. [1 point] Give a model with a state $s_0$ that satisfies the CTL formula $EF \neg p$ but not $\neg AF p$.

3. [2 points] Exhibit a derivation of the final state of the configuration $<c, \sigma>$, where $\sigma(x) = 2$ and $\sigma(y) = 4$ and $c$ is the following command

$$
\text{while } x \neq y \text{ do } \\
\quad \text{if } x < y \text{ then } y := y - x \\
\quad \quad \text{else } x := x - y \\
\quad \text{fi} \\
\text{do}
$$

4. Give a derivation of the following Hoare triples using the proof system for partial correctness:
   a) [1 point] $\{x \leq 0 \land n > 0\} \text{ while } x \leq n \text{ do } x := x + 1 \text{ od} \{x = n + 1\}$
   b) [1 point] $\{x > 0\} \text{ while } \text{true} \text{ do } x := x + 1 \text{ od} \{x \leq 0\}$

5. [1 point] Give a proof outline for the partial correctness of the following Hoare triple

$$
\{\text{true}\} x := y + 5; \quad \text{if } x = 5 \text{ then } z := 5 \text{ else } z := x \text{ fi} \{z = y + 5\}
$$

6. [2 points] Give a proof outline for the total correctness of the following Hoare triple:

$$
\{0 \leq x\} \\
y := 0; \\
z := 1; \\
\text{while } z \leq x \text{ do } \\
y := y + n; \\
z := z + 1 \\
\text{od} \\
\{y = n \times x\}
$$

The final score is given by the sum of the points obtained.