1. Write down the letter(s) of the regular expression(s) of which the language equals \( \{ (ab)^n \mid n \geq 0 \} \)
   A. \((a + b)^*\)
   B. \((a \cdot b)^*\)
   C. \(((a + 0) \cdot (b + 0))^*\)
   D. \(((a + 1) \cdot (b + 1))^*\)
   E. \((a \cdot 1 \cdot b)^*\)
   F. \((a \cdot 0 \cdot b)^*\)
   G. \(a \cdot (b \cdot a)^* \cdot b\)

2. Given are alphabet \(\Sigma\) and function \(\partial: \Sigma^* \rightarrow \Sigma^*\) defined recursively by
   \[
   \partial(\varepsilon) = \varepsilon \\
   \partial(au) = aa \partial(u) \quad \text{for all } a \in \Sigma, u \in \Sigma^*
   \]
   (i.e. \(\partial(c_1c_2 \ldots c_k) = c_1c_1c_2c_2 \ldots c_kc_k\) for all \(k \geq 0\) and \(c_1, c_2, \ldots, c_k \in \Sigma\)).
   Prove by induction on the structure of \(w\) that \(|\partial(w)| = 2 \cdot |w|\) for all \(w \in \Sigma^*\).

3. Construct a DFA \(D\) with alphabet \(\{a, b\}\) and no more than 4 states for the language
   \(L = \{ w \in \{a, b\}^* \mid w \text{ has substring } ba \land w \text{ ends in } b \}\).
   Prove that \(L(D) = L\) by providing the pathsets of the states of \(D\).

(please turn over)
4. The transition diagram of NFA $N$ is given by

Using the NFA-to-DFA algorithm transform $N$ into a DFA $D$ that accepts $\mathcal{L}(N)$. Provide both the transition table and the transition diagram of $D$. [hint: the resulting DFA has 4 states]

5. The transition diagram of GFA $G$ is given by

Give the transition diagram of $G \setminus q_1$.

6. Given are an alphabet $\Sigma$, a symbol $c \in \Sigma$, and a regular language $L$ over $\Sigma$. Language $L_{-c}$ is defined by

$$L_{-c} = \{uv \mid ucv \in L\}$$

Let $D = (Q, \Sigma, \delta, q_0, F)$ be a DFA with $\mathcal{L}(D) = L$. Show how to construct an NFA $N$ using copies of $D$ such that $\mathcal{L}(N) = L_{-c}$. Provide a formal definition of $N$ (no further proof is required).