1 (10 + 5 = 15 points)
(i) Define $Rev(L) = \{x^R \mid x \in L\}$. Note $x^R$ is the reversal of the string $x$. Thus, e.g., if $L = \{ab, aba, babb\}$ then $Rev(L) = \{ba, aba, bbab\}$.
Let $L_1$ be a regular language that is recognized by a DFA $M_1 = (Q, \Sigma, \delta, s, F)$. Provide a construction (be precise) to create a DFA or an NFA to accept $Rev(L_1)$.
(ii) Apply your construction to the DFA given below.

2. (10 x 3 = 30 points) Give regular expressions that denote the following sets:
a. The set of strings where the third last symbol is an "a". Here, $\Sigma = \{a, b\}$.
b. The set of strings of the form $w_1cw_2$ where $w_1$ and $w_2$ belong to $\{a, b\}^*$ and $w_2$ contains an "b" if and only if $w_1$ has at least 2 occurrences of "a".
c. The set of strings that do not contain the substring "ab". Here, $\Sigma = \{a, b\}$.

3. (10 x 3 = 30 points) Use the pumping lemma to show that the following sets are not regular.
a. $\{a^lbc^n \mid l = 100, m > l, n > m\}$.
b. The set of strings of the form $ww$ where $w \in \{a, b\}^*$. Thus, abbaabba is included in this set but abba is not.
c. The set of strings of the form $a^{n_1}b^{n_2}c^{n_3}d^{n_4}$, where $n_1 = n_3$ or $n_2 = n_4$. ($n_1, n_2, n_3, n_4 \geq 1$)

4. (15 points) Exercise 47 (Parts a and b only) on Page 326 of the textbook.