Consider an n-state NFA with states $0, 1, \ldots, n-1$, the initial state 0, the accepting states $\{n-1\}$ and transitions on two symbols:
$a : 0 \to 1 \to ... \to n-1$,
$b : n-1 \to n-2 \to ... \to 0$.
Let L be the language accepted by this NFA.

For $k = 0, 1, \ldots, n-1$, consider the following sets of pairs of strings

$$\mathcal{B}_k = \{(b^k a^i, a^{2n-2-i} b^{n-1-k}) \mid i = 0, 1, \ldots, 2n-2 \text{ and } i \neq n-1\},$$

and

$$\mathcal{C}_k = \{(b^k a^{n-1}, b^{n-1} a^{2n-2} b^{n-1-k}), (b^k a^{2n-2} b^{n-1}, a^{n-1} b^{n-1-k})\},$$

i.e., $\mathcal{B}_k$ it the same as $\mathcal{A}_k$ from the yesterday's proof but without the pair $(b^k a^{n-1}, a^{n-1} b^{n-1-k})$ and $\mathcal{C}_k$ contains two more pairs. So, we have $2n$ pairs in any $\mathcal{B}_k \cup \mathcal{C}_k$.

We will show that the set $\mathcal{F} = \mathcal{B}_0 \cup \mathcal{C}_0 \cup \mathcal{B}_1 \cup \mathcal{C}_1 \ldots \cup \mathcal{B}_{n-1} \cup \mathcal{C}_{n-1}$ is a fooling set for the language $shift(L)$. We need to show that
(1) for any pair (x_i, y_i) in $\mathcal{F}$, the string $x_i y_i$ is in the language $shift(L)$,
(2) for any two different pairs $(x_i, y_i), (x_j, y_j)$ in $\mathcal{F}$, **at least one** of the strings $x_i y_j$ and $x_j y_i$ is not in the language $shift(L)$.

To prove (1) note that for any k and any $i \neq n-1$, we have:

$$b^k a^i a^{2n-2-i} b^{n-1-k} = b^k a^{2n-2} b^{n-1-k},$$

which is in $shift(L)$ since the string $a^{n-1} b^{n-1-k} b^k a^{n-1}$ is in L. Next, for any k, the string

$$b^k a^{n-1} b^{n-1} a^{2n-2} b^{n-1-k}$$

is in $shift(L)$ since the string $a^{n-1} b^{n-1-k} b^k a^{n-1} b^{n-1} a^{n-1}$ is in L. Finally, for any k, the string

$$b^k a^{2n-2} b^{n-1} a^{n-1} b^{n-1-k}$$

is in $shift(L)$ since the string $a^{n-1} b^{n-1} a^{n-1} b^{n-1-k} b^k a^{n-1}$ is in L.

To prove (2) we have five cases to consider:

(i) Two different pairs in $\mathcal{B}_k$:
$(b^k a^i, a^{2n-2-i} b^{n-1-k})$ and
$(b^k a^j, a^{2n-2-j} b^{n-1-k})$,
where $0 \leq i < j \leq 2n-2$ and $i, j \neq n-1$. Take the first part of the j-th pair and the second part of the i-th pair:

$$b^k a^j a^{2n-2-i} b^{n-1-k} = b^k a^{2n-2+j-i} b^{n-1-k},$$

where $2n-2+j-i > 2n-2$ which means that any cyclic shift of this string contains a string a^r with $r > n-1$ as a substring, and so is not in L. Thus, the string $b^k a^j a^{2n-2-i} b^{n-1-k}$ is not in $shift(L)$.

(ii) A pair $(b^k a^i, a^{2n-2-i} b^{n-1-k})$, where $i \neq n-1$, in $\mathcal{B}_k$ and the pair $(b^k a^{n-1}, b^{n-1} a^{2n-2} b^{n-1-k})$ in $\mathcal{C}_k$. Take the first part of the former pair and the second part of the latter one to get the string

$$b^k a^i b^{n-1} a^{2n-2} b^{n-1-k}.$$

The only cyclic shift of this string that could be in L is $a^{n-1} b^{n-1-k} b^k a^i b^{n-1} a^{n-1}$. But this string is not in L if $i \neq n-1$. Thus, the string $b^k a^i b^{n-1} a^{2n-2} b^{n-1-k}$ is not in $shift(L)$ for $i \neq n-1$.

(iii) A pair $(b^k a^i, a^{2n-2-i} b^{n-1-k})$, where $i \neq n-1$, in $\mathcal{B}_k$ and the pair $(b^k a^{2n-2} b^{n-1}, a^{n-1} b^{n-1-k})$ in $\mathcal{C}_k$. Take the first part of the latter pair and the second part of the former pair to get the string

$$b^k a^{2n-2} b^{n-1} a^{2n-2-i} b^{n-1-k}.$$

Again, the only cyclic shift of this string that could be in L is $a^{n-1} b^{n-1} a^{2n-2-i} b^{n-1-k} b^k a^{n-1}$ which is not in L for $i \neq n-1$. Thus the string $b^k a^{2n-2} b^{n-1} a^{2n-2-i} b^{n-1-k}$ is not in $shift(L)$ for $i \neq n-1$.

(iv) The pair $(b^k a^{n-1}, b^{n-1} a^{2n-2} b^{n-1-k})$ in $\mathcal{C}_k$ and the pair $(b^k a^{2n-2} b^{n-1}, a^{n-1} b^{n-1-k})$ in $\mathcal{C}_k$. Take the first part of the latter pair and the second part of the former pair to get the string

$$b^k a^{2n-2} b^{n-1} b^{n-1} a^{2n-2} b^{n-1-k}$$

which, evidently, is not in $shift(L)$.

(v) A pair $(b^k u, v b^{n-1-k})$ in $\mathcal{B}_k \cup \mathcal{C}_k$ and a pair $(b^l x, y b^{n-1-l})$ in $\mathcal{B}_l \cup \mathcal{C}_l$, where $0 \leq k < l \leq n-1$. Take the first part of the latter pair and the second part of the former pair to get the string

$$b^l x v b^{n-1-k}.$$

Note that any cyclic shift of this string not ending in b contains a string $b^{n-1+l-k}$, where $n-1+l-k > n-1$, as a substring, and so is not in L. Thus, the string $b^l x v b^{n-1-k}$ is not in $shift(L)$.

Hence the set $\mathcal{F}$ is a fooling set for the language $shift(L)$ of size $2n^2$ which follows that any NFA for the language $shift(L)$ needs at least $2n^2$ states.