PROBLEM 1. (Paper and Pencil)

1.
$$\boldsymbol{s}_{\mathcal{F}}[k] = \begin{cases} \frac{1}{T_s} s_{\mathcal{F}}\left(\frac{k}{T_p}\right), & k = 0, 1, \dots, \frac{N}{2} - 1 \\ \frac{1}{T_s} s_{\mathcal{F}}\left(\frac{k-N}{T_p}\right), & k = \frac{N}{2}, \dots, N-1. \end{cases}$$

2.
$$\boldsymbol{u}_{\mathcal{F}}[k] = \begin{cases} \frac{2}{T_s} s_{\mathcal{F}}\left(\frac{k}{T_p}\right), & k = 0, 1, \dots, N - 1 \\ \frac{2}{T_s} s_{\mathcal{F}}\left(\frac{k-2N}{T_p}\right), & k = N, \dots, 2N-1. \end{cases}$$

Notice that $s_{\mathcal{F}}\left(\frac{k}{T_p}\right)$ vanishes when k is bigger than $N/2$ or smaller than $-N/2$. Comparing the expressions of $\boldsymbol{u}_{\mathcal{F}}[k]$ and $\boldsymbol{s}_{\mathcal{F}}[k]$ we see that

$$\boldsymbol{u}_{\mathcal{F}}[k] = \begin{cases} 2\boldsymbol{s}_{\mathcal{F}}[k], & k = 0, 1, \dots, \frac{N}{2} - 1 \\ 0, & k = \frac{N}{2}, \dots, N-1 \\ 0, & k = N, \dots, \frac{3N}{2} - 1 \\ 2\boldsymbol{s}_{\mathcal{F}}[k-N], & k = \frac{3N}{2}, \dots, 2N-1. \end{cases}$$

To say in words, the expression above tells us that we can obtain $\boldsymbol{u}_{\mathcal{F}}$ by simply inserting N zeros in the middle of $2\boldsymbol{s}_{\mathcal{F}}$.

3.
```
function uf = upsampleBy2(sf)
  N = length(sf);
  uf = [sf(1:N/2), zeros(1,N), sf(N/2+1:N)];
end
```