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Question 4

a. According to the question, set sequence $A = \langle 1, \underbrace{0, 0, 0, \dots, 0,}_{k} \ 1 \rangle$. We need to calculate the A∗A.

For $A = \langle 1, \underbrace{0, 0, 0, \dots, 0,}_{k} \ 1 \rangle$ the associated polynomial is $A(x) = 1 + x^{k+1}$; thus the convolution of A with itself is the sequence of the coefficients of the polynomial $A^2(x) = 1 + 2 * x^{k+1} + x^{2k+2}$. So the $\langle 1, \underbrace{0, 0, 0, \dots, 0,}_{k} \ 1 \rangle * \langle 1, \underbrace{0, 0, 0, \dots, 0,}_{k} \ 1 \rangle = \langle 1, \underbrace{0, 0, 0, \dots, 0,}_{k} \ 2, \underbrace{0, 0, 0, \dots, 0,}_{k} \ 1 \rangle$

b. Since $A = \langle 1, \underbrace{0, 0, 0, \dots, 0,}_{k} \ 1 \rangle$, the corresponding polynomial is $P_A(x) = 1 + x^{k+1}$ and

$$\begin{aligned} DFT(A) &= \left\langle P_A\left(\omega_{k+2}^{0}\right), P_A\left(\omega_{k+2}^{1}\right), \dots, P_A\left(\omega_{k+2}^{k+1}\right) \right\rangle \\ &= \langle 1 + \omega_{k+2}^{0*(k+1)}, 1 + \omega_{k+2}^{1*(k+1)}, \dots, 1 + \omega_{k+2}^{(k+1)*(k+1)} \rangle \\ &= \langle 2, 1 + \omega_{k+2}^{k+1}, 1 + \omega_{k+2}^{2*(k+1)}, \dots, 1 + \omega_{k+2}^{(k+1)^2} \rangle \end{aligned}$$