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Q4

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a) Compute the convolution $\langle 1, \underbrace{0,0,...0}_{k}, 1\rangle * \langle 1, \underbrace{0,0,....0}_{k}, 1\rangle$

The polynomial for $\langle 1, 0, 0, ... 0,1\rangle$ is $P(x) = 1 + x^{k+1}$

$$P(x)^2 = (1 + x^{k+1})^2$$
$$= 1 + 2x^{k+1} + x^{2k+2}$$

∴ The convolution for the above is $\langle 1, \underbrace{0,0,......0}_{k}, 2, \underbrace{0,0,......0}_{k}, 1\rangle$

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b) Compute the DFT of the sequence $\langle 1, \underbrace{0,0,...0}_{k}, 1\rangle$.

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

$$DFT(B) = \langle P_B(\omega_{k+2}^{0}), P_B(\omega_{k+2}^{1}), \ldots, P_B(\omega_{k+2}^{k+1}))$$
$$= \langle 1 + \omega_{k+2}^{0.(k+1)}, 1 + \omega_{k+2}^{1.(k+1)}, \ldots .1 + \omega_{k+2}^{(k+1).(k+1)}\rangle$$
$$= \langle 2, \underbrace{1 + \omega_{k+2}^{(k+1)}, 1 + \omega_{k+2}^{2.(k+1)}, \ldots .1 + \omega_{k+2}^{(k-1)(k+1)}, 1 + \omega_{k+2}^{k(k+1)}}_{k}, 1 + \omega_{k+2}^{(k+1)^2}\rangle$$
$$= \langle 2, \underbrace{1 + \omega_{k+2}^{-1}, 1 + \omega_{k+2}^{-2}, \ldots .1 + \omega_{k+2}^{-(k+1)}, 1 + \omega_{k+2}^{-k}}_{k}, 1 + \omega_{k+2}^{-(k+1)}\rangle$$