1. In class we mostly worked with DFT for the case where \( n \) is a power of 2, and the polynomial being evaluated has degree \( n - 1 \). However, we also showed that we can apply the DFT and Inverse DFT when \( n \) is not a power of 2, by taking \( n' \) to be the closest power of 2 satisfying \( n \leq n' \), and adding some leading coefficients of value 0.

Make this idea formal: First show how to compute \( n' \). Also show that our DFT or Inverse DFT still takes \( \Theta(n \lg(n)) \) time in terms of the original value \( n \).

2. This exercise asks you to do a few complex number calculations. Evaluate each of these. (See also rules for multiplication and division in the FFT notes.)

   (a) \( 2i(3 - i) \).
   (b) \( 2i(i + 1)^2 + 4(i + 1)^3 \).
   (c) \( 3i/(1 + i) \).

3. Compute \( \text{DFT}_4(0, 1, 2, 3) \). (do this directly, rather than by FFT, if you prefer).

   This is Exercise 30.2-2, p. 838 of [CLRS].

4. Use the FFT to efficiently multiply the two polynomials \( p(x) = x - 4 \) and \( q(x) = x^2 - 1 \).

   Use the following steps:

   (a) First work out what will be the degree of the product polynomial \( pq \). Take \( \deg(pq) + 1 \) as our \( n \) (and if necessary round up to the nearest power of 2).

   (b) For this value of \( n \) (which we made sure was a power of 2), use trigonometry to write down each of the \( n \)th roots-of-unity (so we have them to work with).

   (c) Calculate the DFT for \( p(x) \) for \( n \)th roots of unity.

   (d) Calculate the DFT for \( q(x) \) for \( n \)th roots of unity.

   (e) Do pointwise multiplication of the two DFTs to get the DFT of \( pq(x) \) for \( n \)th roots of unity.

   (f) Calculate the Inverse DFT of the DFT for \( pq(x) \), to obtain the polynomial \( pq \). It’s a good idea to do this via DFT (and then swapping), like we saw in class.

   (g) Check your answer by straight multiplication.