- Apply quantum Fourier transform on the **equal superposition** of all the inputs of function $f : \{0,1\}^2 \rightarrow \{0,1\}^2, f(x) = x \mod 2$. To that end, you could use quantum implementation of f as $U_f |x\rangle |0^n\rangle = |x\rangle |f(x)\rangle$ Clearly show your output? [**10 Marks**]

- Given our data: $\frac{|00\rangle+|01\rangle+i|10\rangle-|11\rangle}{2}$, undergoes a linear shift of 2, what will be the corresponding phase-shift upon application of the Quantum Fourier Transformation (QFT)? Show both results before and after the phase shift. [**5 Marks**]

- What is $QFT^{-1}\frac{|000\rangle-|010\rangle+|011\rangle}{\sqrt{3}}$ in simplified terms? Here QFT^{-1} refers to the inverse Quantum Fourier Transformation. Noted: You don't need to write the entire matrix, but you may use a more efficient (clever) approach. [**5 Marks**]

- Given our data: $\frac{|00\rangle+|01\rangle+i|10\rangle-|11\rangle}{2}$, undergoes a linear shift of 3, what will be the corresponding phase-shift upon application of the Quantum Fourier Transformation (QFT)? Show both results before and after the phase shift. [**5 Marks**]