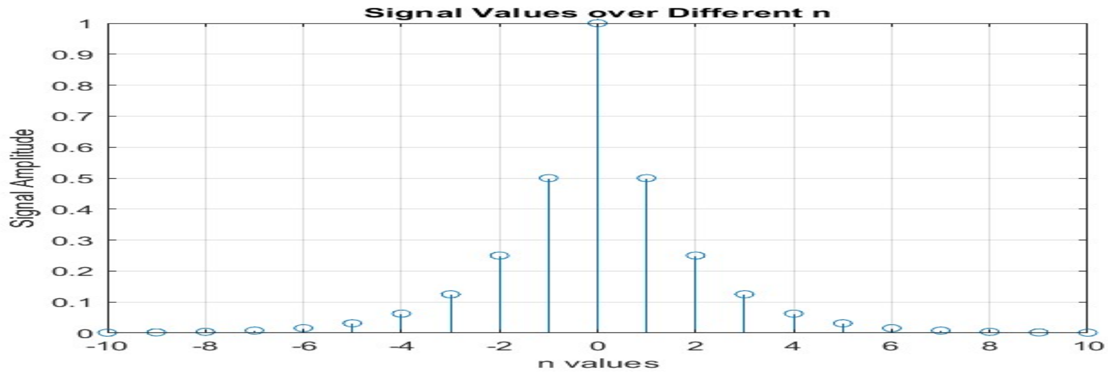
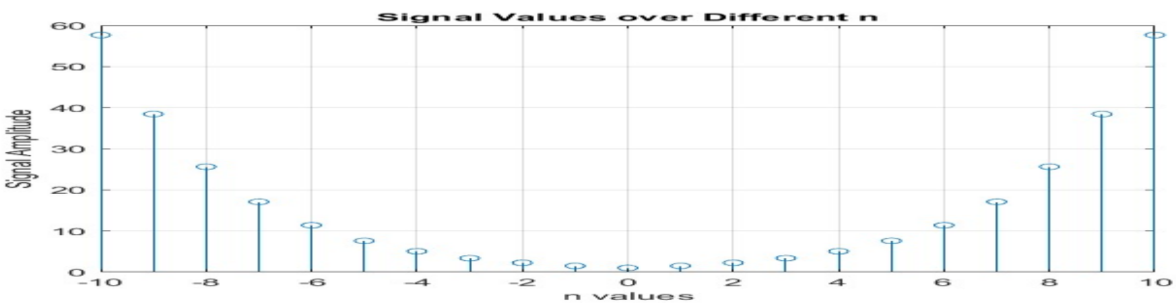
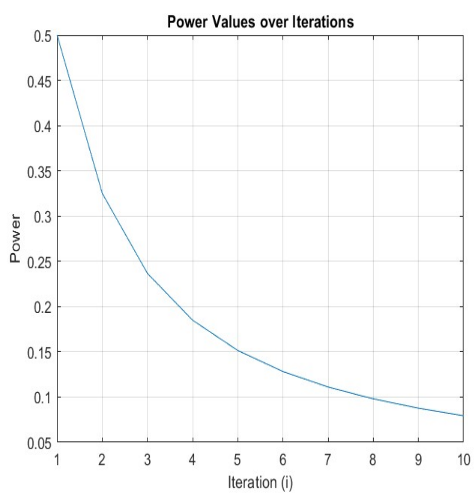
Exercise 1:

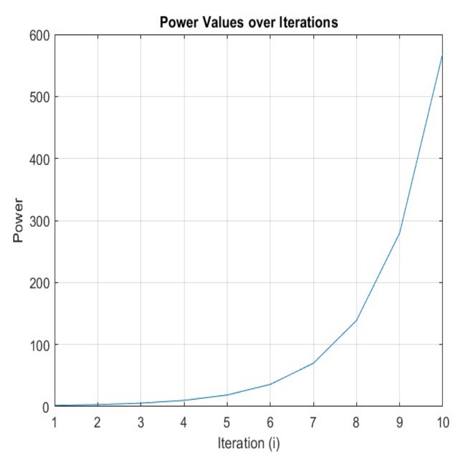


This figure shows the value of the signal for different extensions. The extensions are created by taking n = -i to +I, where i goes from 1 to 10 by using a loop. I have chosen the value of a = 0.5 for the case of |a| < 1. For the case of |a| > 1, I have chosen a = 1.5 and plotted the graph using same method for n extensions.

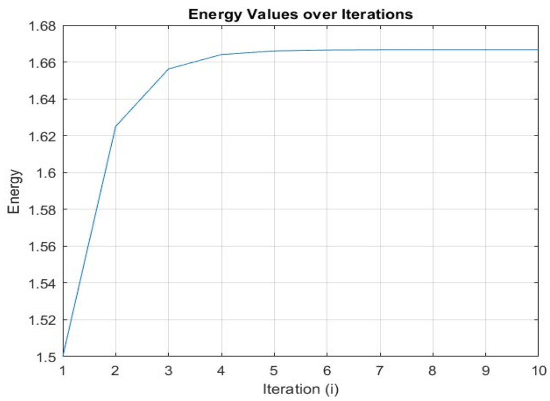


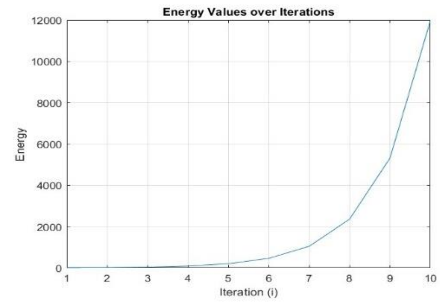
After that I am using arrays to store the energy and power values of each iterations and then plotting them on graph for both cases.





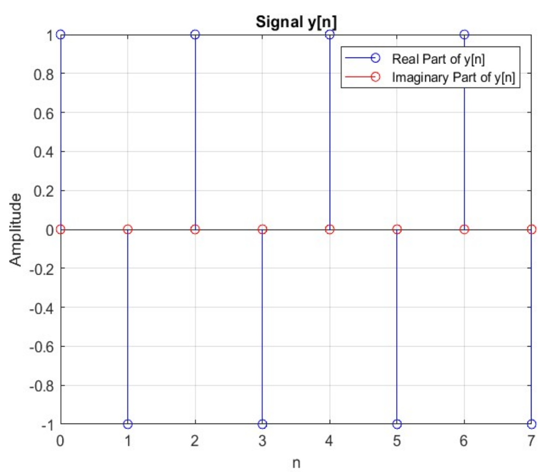
Analyzing the graph I can see the power values converges for |a| < 1 and diverges for |a| >1.

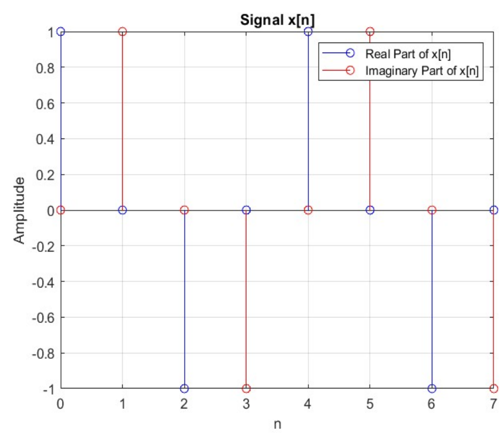




Analyzing the energy values over different extensions, I can see that it converges to a finite value in case of |a| < 1 but diverges to infinity for |a| > 1. The values of energy and power for different extensions and different values of "a" are printed on the MATLAB code. From the graph it is seen that the theoretical value of energy for a = 0.5 is 1.67, which is reached with 0.001% relative error when n = 6. However, for the case of a = 1.5, the power graph diverges.

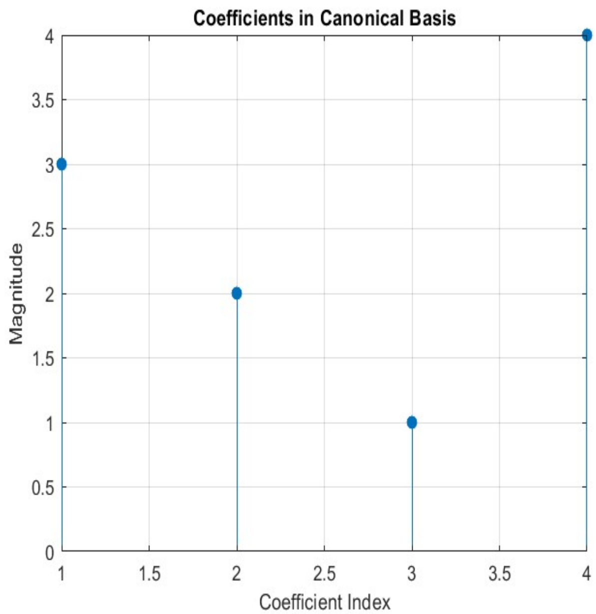
Exercise 2:

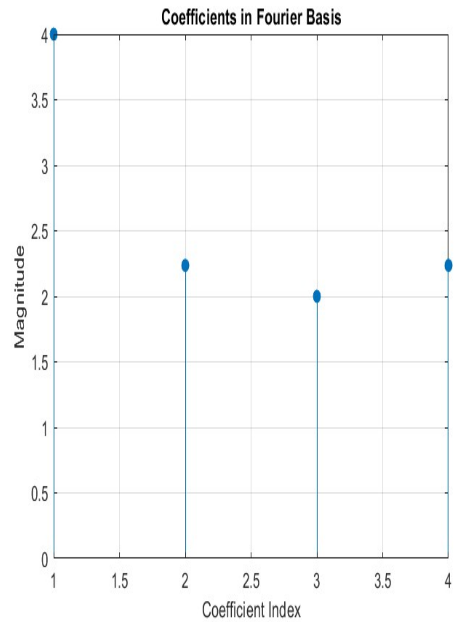




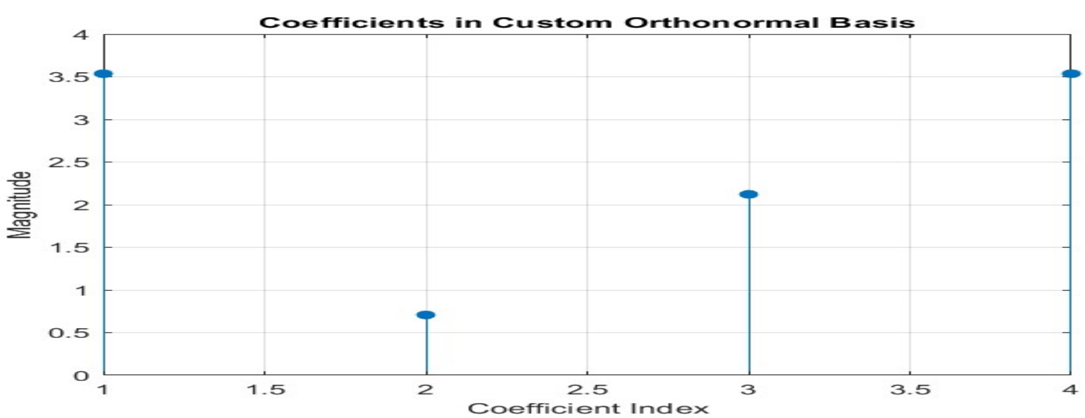
I am plotting here both the signals. The energy of both the signals are 8.00 while the average power is 1.00 for both of them. From the formula I have calculated the inner product of both the signal and it is close to 0, so the signals are orthogonal.

Exercise 3:

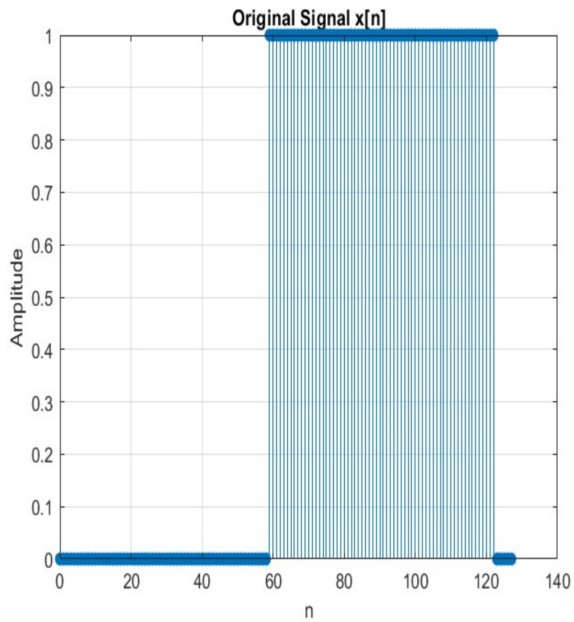


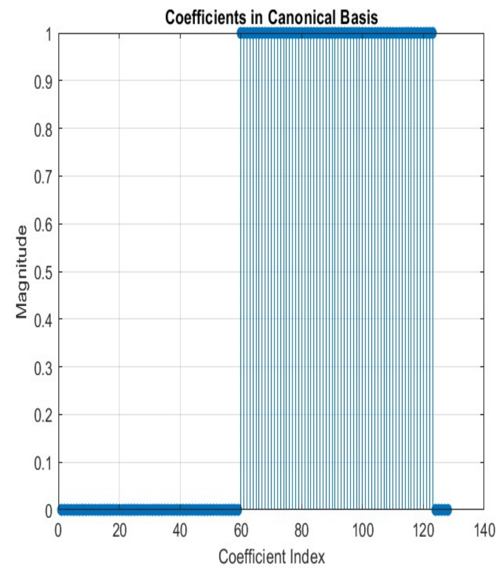


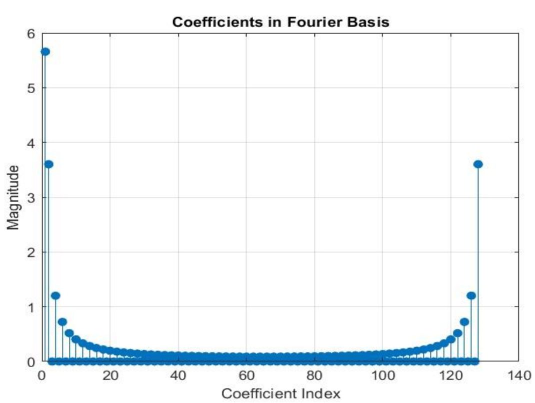
Firstly I defined three bases, the canonical basis Ud, The fourier basis Uf and a custom orthonormal basis that I defined as rotated canonical basis Uc. After that computed projection coefficients for each basis, using the vector a = U'x. Then I plotted the vector representing the signal projection. Also expressed x[n] in terms the computed basis.

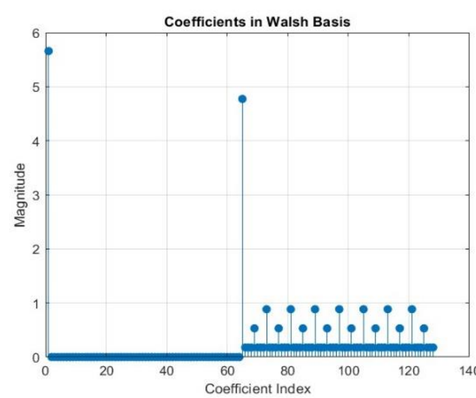


Exercise 4:









I have set n = 128 as the signal length for all calculations. I defined x[n] as a shifted Rademacher sequence r88[n-5]. This sequence is generated by extracted the 7th bit of n+5, effectively producing r88[n-5], which corresponds to a sequence with period and frequency characteristics defined by its binary representation. Then I generated the basis, canonical basis, fourier basis and walsh basis. canonical basis is found using identity matrix, fourier basis is found using the formula and walsh basis is generated by scaling the Hadamard matrix to size N, the Hadamard matrix serves as the walsh basis by providing a set of orthogonal binar-like sequences used for efficient transformations. Calculated projection coefficients and plotted for canonical, fourier and walsh basis. Then verified persival's theorem across all the bases, confirming that the signal's energy remains conserved through each transformation.