Problem #1: `convmat()`

Write a MATLAB function to construct Fourier-space convolution matrices for use in the plane wave expansion method and rigorous coupled-wave analysis. Use the code provided in the course notes.

Install `test_convmat.p` in the same directory as your function `convmat()`. Run the tester function and report its output including the verification code.

Problem #2: Benchmark PWEM

Write MATLAB program that uses the plane wave expansion method (PWEM) to calculate the eigen-values and eigen-vectors for each Bloch wave vector in a list of Bloch wave vectors. The program should be generic enough that it can be easily modified to simulate different unit cells or a different Bloch wave vector.

Run your PWEM code against the benchmarking document and verify that all the data matches. For the benchmarking example, your list of Bloch wave vectors contains just the three key points of symmetry. Use only 3×3 spatial harmonics to benchmark. Confirm in your homework that your code matches the benchmarking document. Do not include the actual data from the benchmarking. Just confirm that you did it and that your data matched.

Problem #3: Band Diagrams

Modify your code from Problem #2 to calculate and plot the electromagnetic band diagram for the square lattice described in Lecture 19. Use approximately 40 points for the horizontal axis. Plot the eigen-values as discrete points, not lines. Scale, normalize, and label the axes so that you generate a professional looking band diagram. Plot band diagrams for both E and H modes using 11×11 spatial harmonics. Your plots should look something like the following:
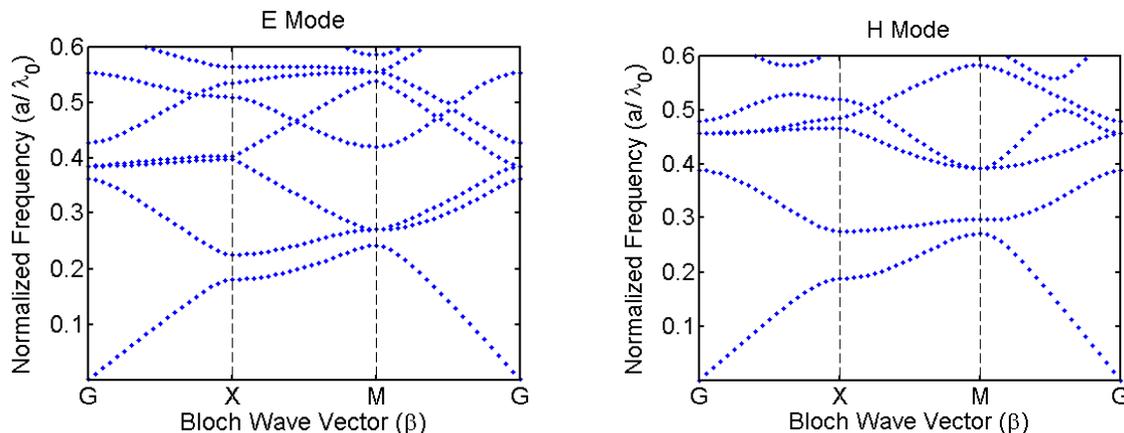
Problem #4: Professional Plots

Generate professional looking band diagrams for the data calculated above. Show the bands as continuous lines, include the BZ and IBZ, label the key points of symmetry following convention, include dashed vertical lines at the key points, label the axes, include proportional spacing between the key points, etc.