In this assignment, you will develop a code in MATLAB to generate spatially-variant lattices. Start with the following header:

```matlab
% HW9.m
% Homework #9
% ECE 53222 -- 21ST CENTURY ELECTROMAGNETICS
% INITIALIZE MATLAB
close all;
clear all;
% UNITS
degrees = pi/180;
% OPEN FIGURE WINDOW WITH WHITE BACKGROUND
fig = figure('Color','w');

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%% DASHBOARD
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

% UNIT CELL PARAMETERS
a   = 1;
Nxu = 512;
Nyu = Nxu;

% GRID PARAMETERS
Sx = 10;
Sy = Sx;
NRESLO = 10;
NRESHI = 10;

% SVL PARAMETERS
NP = 21;
NQ = NP;

Problem #1: Build a Grayscale Triangle Unit Cell

This homework will use an equilateral triangle unit cell centered inside a square unit cell. In order to spatially vary the fill factor, the starting unit cell should be grayscale as shown below. Add a section to your code to build and visualize this grayscale unit cell.

![Grayscale Triangle Unit Cell](image)

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Problem #2: Calculate Grids
Add a section to your code to calculate the parameters for both the low-resolution and high-resolution grids. Report your values of $dx$, $Nx$, $Ny$, $dy$, $dx2$, $Nx2$, $Ny2$, and $dy2$.

Problem #3: Generate Input Maps for Spatial Variance
Add a section to your code to generate the following input maps for your algorithm. Period PER should be set to $0.5a$ inside a centered-circle of radius $3.33a$ and to $a$ everywhere else. The orientation THETA should fan from $90^\circ$ to $0^\circ$ in the manner shown below with the center of the fan located at the lower left portion of the grid. The threshold parameter THRESH should taper linearly from $0.15$ on the left to $0.35$ on the right.

Problem #4: Generate List of Planar Gratings
Add a section to your code to decompose the high-resolution grayscale unit cell into a set of $9 \times 9$ planar gratings, but don’t forget to change back to $21 \times 21$ planar gratings after this problem. Visualize the magnitude of the Fourier coefficients. Visualize the grating vector expansion to convey the magnitude and direction for each planar grating.

Problem #5: Generate Spatially-Variant lattices
For the following lattices, use $21 \times 21$ planar gratings and visualize both the analog lattice and binary lattice.

Lattice #1 – Uniform Lattice
Generate a uniform lattice by setting PER to $a$, THETA to $0^\circ$, and THRESH to $0.3$ at all points on the grid.

Lattice #2 – Spatially-Variant Threshold Only
Generate a spatially-variant lattice from the input maps created in Problem #3, but set PER to $a$ and THETA to $0^\circ$ at all points on the grid.

Lattice #3 – Spatially-Variant Period Only
Generate a spatially-variant lattice from the input maps created in Problem #3, but set THETA to $0^\circ$ and THRESH to $0.3$ at all points on the grid.
Lattice #4 – Spatially-Variant Orientation Only
Generate a spatially-variant lattice from the input maps created in Problem #3, but set PER to $a$ and THRESH to 0.3 at all points on the grid.

Lattice #5 – Spatially-Variant Everything
Generate a spatially-variant lattice using all of the input maps created in Problem #3.