assignment EM2

Problem 1

Solution. Consider the boundary condition for graphene

$$
\begin{aligned}
&n \times (E_1 - E_2) = 0 \\
&n \times (H_1 - H_2) = \sigma_s E_t \\
&E_{1t} = E_{2t} = E_t \\
&H_{1t} - H_{2t} = \sigma_s E_t
\end{aligned}
$$

For TE wave

$$
\begin{aligned}
&E_y = e_y(z) e^{-jk_x x} \\
&e_{1y}(z) = e_0 \cdot e^{jk_{1z}z} + R \cdot e_0 \cdot e^{-jk_{1z}z} \\
&e_{2y}(z) = T \cdot e_0 \cdot e^{jk_{2z}z} \\
&h_{1y}(z) = -\frac{k_{1z}}{\omega\mu_1}(e_0 \cdot e^{jk_{1z}z} - R \cdot e_0 \cdot e^{-jk_{1z}z}) \\
&h_{2y}(z) = -\frac{k_{2z}}{\omega\mu_2}(T \cdot e_0 \cdot e^{jk_{2z}z})
\end{aligned}
$$

At z =0

$$
\begin{aligned}
1 + R &= T \\
-\frac{k_{1z}}{\omega\mu_1}(1 - R) &= -\frac{k_{2z}}{\omega\mu_2} \cdot T + \sigma_s \cdot T
\end{aligned}
$$

Solve the equation

$$
\begin{aligned}
R &= \frac{-k_{1z}\mu_2 + k_{2z}\mu_1 - \sigma_s \cdot \omega\mu_1\mu_2}{\sigma_s \cdot \omega\mu_1\mu_2 - k_{1z}\mu_2} \\
T &= \frac{-2k_{1z}\mu_2 + k_{2z}\mu_1}{\sigma_s \cdot \omega\mu_1\mu_2 - k_{1z}\mu_2}
\end{aligned}
$$

For TM wave

$$
\begin{aligned}
&H_y = h_y(z) e^{-jk_x x} \\
&h_{1y}(z) = h_0 \cdot e^{jk_{1z}z} + R \cdot h_0 \cdot e^{-jk_{1z}z} \\
&h_{2y}(z) = T \cdot h_0 \cdot e^{jk_{2z}z} \\
&e_{1y}(z) = -\frac{k_{1z}}{\omega\epsilon_1}(h_0 \cdot e^{jk_{1z}z} - R \cdot h_0 \cdot e^{-jk_{1z}z}) \\
&e_{2y}(z) = -\frac{k_{2z}}{\omega\epsilon_2}(T \cdot h_0 \cdot e^{jk_{2z}z})
\end{aligned}
$$

At z =0

$$1 + R = T + \sigma_s \cdot (-\frac{k_{2z}}{\omega\epsilon_2} \cdot T)$$
$$-\frac{k_{1z}}{\omega\epsilon_1}(1 - R) = -\frac{k_{2z}}{\omega\epsilon_2} \cdot T$$

Solve the equation

■

Problem 2

Solution. $Die1 = 2.5^2 * ones(length(y), 1); Die2 = 1.25^2 * ones(length(y), 1); Die3 = 1.875^2 * ones(length(y), 1);$

It is shown that total reflection can not cover all incidence angles for TM incidence. And a pass band will be opened in the band gap when the defect is introduced. Possible reason is that the break of perfect periodic boundary condition induces destructive interference between incident and reflected wave within some certain frequency range. ■

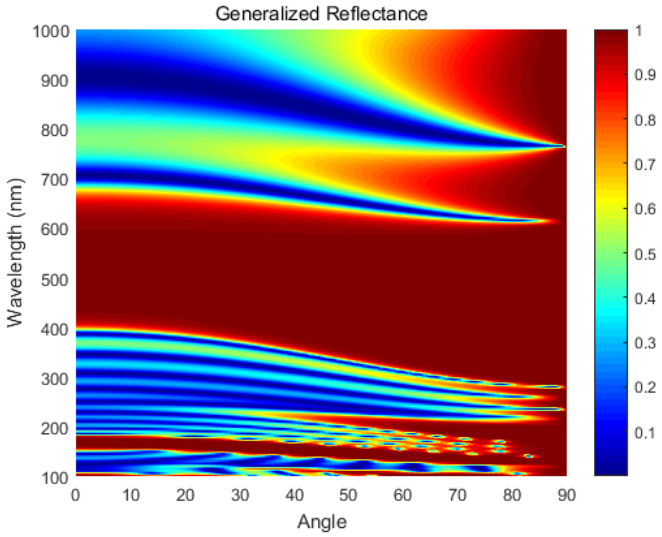

Figure 1: TE incidence

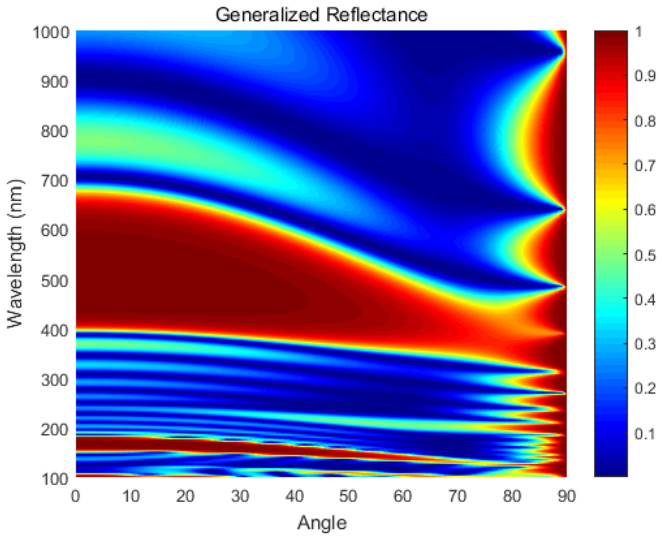

Figure 2: TM incidence

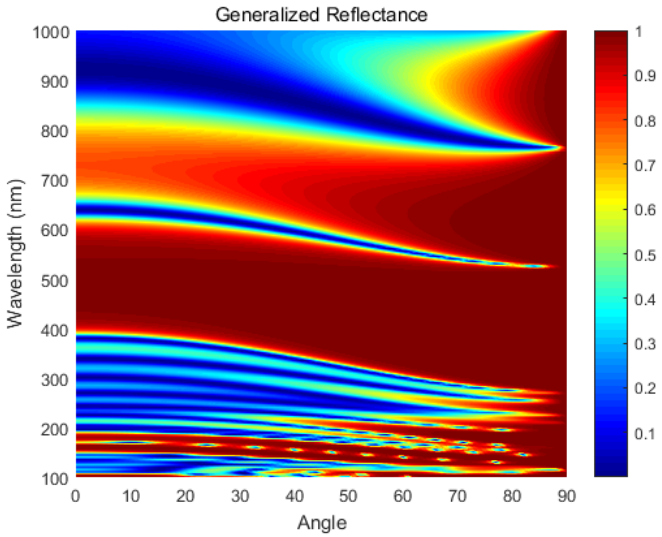

Figure 3: TE incidence with defect

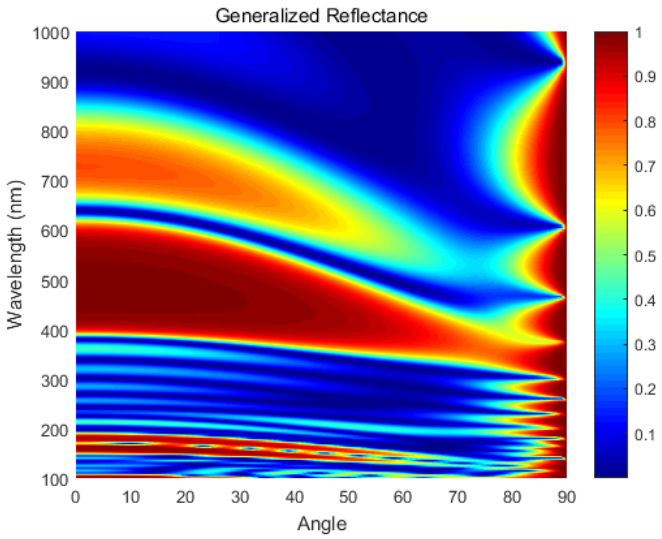

Figure 4: TM incidence with defect