Answers to some exercises in Orfanidis

Note there is a solutions manual for chapters 1 and 2 on Orfanidis' web site. Below, only hints or brief answers are given for some of the selected problems.

3.5 The magnitude is $|F(z,t)| = \exp\left[-\frac{(t-\beta_0' z)^2-(\alpha_0' z)^2}{2\tau_0^2}\right]$. The rest of the exercise is of "show that"-character. Hint: to deduce the maximum of $|F(z,t)|$ for fixed z or t, consider the maximum of the argument in the exponential function.

4.5 Some suggestions for convenient choices of θ_p and θ_a. Linear case: choosing $\theta_p - \theta_a = \pi/2$ implies minimum transmission is obtained when the polarizers are aligned with the optical axes, providing information on the direction of the axes. Circular case: maximum (or minimum) transmission is obtained for $\theta_p - \theta_a = \phi$ or $(\phi + \pi/2)$, providing information on the angle of rotation ϕ.

4.8 $\boldsymbol{H}(\boldsymbol{r}) = \frac{-1}{\mathrm{j}\eta}\boldsymbol{E}(\boldsymbol{r}) = \frac{-1}{\mathrm{j}\eta}E_0(\hat{\boldsymbol{p}} - \mathrm{j}\hat{\boldsymbol{s}})\mathrm{e}^{-\mathrm{j}k_+\hat{\boldsymbol{k}}\cdot\boldsymbol{r}}$ or $\boldsymbol{H}(\boldsymbol{r}) = \frac{1}{\mathrm{j}\eta}\boldsymbol{E}(\boldsymbol{r}) = \frac{1}{\mathrm{j}\eta}E_0(\hat{\boldsymbol{p}} + \mathrm{j}\hat{\boldsymbol{s}})\mathrm{e}^{-\mathrm{j}k_-\hat{\boldsymbol{k}}\cdot\boldsymbol{r}}$. The vectors $\hat{\boldsymbol{p}}$ and $\hat{\boldsymbol{s}}$ can be chosen in a plane orthogonal to $\hat{\boldsymbol{k}}$ as long as $(\hat{\boldsymbol{p}}, \hat{\boldsymbol{s}}, \hat{\boldsymbol{k}})$ is a right-hand triple.

4.13 This is basically the same task as handin 1. The real part of μ_2 is $\mathrm{Re}(\mu_2) = \mu_0\,\mathrm{Re}(\frac{\chi_+-\chi_-}{2}) = \frac{\mu_0\chi_0}{2}\left(\frac{\alpha^2+\omega_H(\omega+\omega_H)}{\alpha^2+(\omega+\omega_H)^2} - \frac{\alpha^2+\omega_H(\omega-\omega_H)}{\alpha^2+(\omega-\omega_H)^2}\right)$, and the imaginary part is $\mathrm{Im}(\mu_2) = \mu_0\,\mathrm{Im}(\frac{\chi_+-\chi_-}{2}) = -\frac{\mu_0\chi_0}{2}\left(\frac{\alpha\omega}{\alpha^2+(\omega+\omega_H)^2} - \frac{\alpha\omega}{\alpha^2+(\omega-\omega_H)^2}\right)$.

5.5 The plate is a good conductor since $\sigma/(\omega\epsilon_0) \gg 1$. $P_{\mathrm{plate}}/P_{\mathrm{inc}} = \mathrm{Re}(\eta/\eta')|\tau|^2 = 8.76\cdot 10^{-5}$, $\alpha = 4.78\cdot 10^5\,\mathrm{m}^{-1} = 4.15\cdot 10^6\,\mathrm{dB/m}$, $\delta = 1.05\cdot 10^{-6}\,\mathrm{m}$.

5.7 a) 0.625 cm, 1.25 cm, 1.875 cm. b) $\Delta f = 6.24$ GHz for 15 dB and 5.64 GHz for 30 dB.

5.11 b) $|T|^2 = 0.265$. c) 20 cm corresponds to 3/2 wavelengths.