For a system with Transfer Function $G_p(s) = \ldots$

(See below for a list of Transfer Functions)

Use Root locus to design a PI controller

$$G_C(s) = K_p + \frac{K_I}{s} = \frac{K_ps + K_I}{s} = K_p \left[ \frac{s + (K_I/K_p)}{s} \right]$$

that has zero closed loop error and closed-loop time constant and damping ratios of approximately (see below for list of time constants).

Some example systems…

<table>
<thead>
<tr>
<th>Plant Transfer Function</th>
<th>Desired CL time constant</th>
<th>Desired CL damping ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>$G_p(s) = \frac{2}{4s+1} = \frac{0.5}{s+0.25}$</td>
<td>$\tau = 1 \text{ sec}$</td>
<td>$\zeta = 0.7$</td>
</tr>
<tr>
<td>$G_p(s) = \frac{0.25}{0.25s+1} = \frac{1}{s+4}$</td>
<td>$\tau = 1 \text{ sec}$</td>
<td>$\zeta = 1.0$</td>
</tr>
<tr>
<td>$G_p(s) = \frac{0.25}{0.25s+1} = \frac{1}{s+4}$</td>
<td>$\tau = 0.25 \text{ sec}$</td>
<td>$\zeta = 0.7$</td>
</tr>
</tbody>
</table>

Hints:
1) Write the system open-loop transfer function with $K_p$ factored out
2) Place the open-loop poles and zeros on the root locus. Note you will need to place close loop zero $s + (K_I/K_p)$ at some appropriate location. There are usually many possible locations that will work.