Ch 13: 4, 5, 7, 8, 19, 21, 22, 43, 50

13-4 Horizontally and vertically polarized

EM waves have their electric fields horizontal and vertical, respectively.

Horizontal polarization Vertical polarization

\[
\begin{align*}
&H \\
&E \\
&V
\end{align*}
\]

13-5 An electric (E) and a magnetic (H) field emanate from an antenna. They are orthogonal (90°) to each other and to their direction of travel.

13-7 Given: \( r = 22 \text{ km}, \quad P_t = 10 \text{ W} \)

Find: \( \Phi \) (W/m²)

\[
\begin{align*}
\text{Soln:} & \quad 22 \text{ km} = 35,405,568 \text{ m} \\
\Phi & = \frac{P_t}{4\pi r^2} = \frac{10}{4\pi (35,405,568)^2} \quad = 634.8 \text{ W/m}^2
\end{align*}
\]

13-8 Given: \( P_t = 2.0 \text{ W}, \quad r = 22 \text{ km} \)

xcur area = 1600 m² = \( A \)

Find: \( P_r \)

\[
\begin{align*}
\text{Soln:} & \quad P_r = \frac{\Phi}{A} = \frac{P_t + A}{4\pi r^2} = \frac{(2.0)(1.6 \text{ k})}{4\pi (22)^2} \quad = 5.26 \text{ mW}
\end{align*}
\]
1) Direct Wave
2) Ground Wave
3) Reflected wave (can be reflected off of ground)

Ground waves suffer less loss along a conducting ground surface, so they do better when traversing a span of seawater than a desert floor.

As frequency, ground wave range v. Because ground waves rely on diffraction to curve along the earth's surface, lower frequencies yield better diffraction and better ground-wave performance.

<table>
<thead>
<tr>
<th>GEO</th>
<th>LED</th>
</tr>
</thead>
<tbody>
<tr>
<td>altitude = 35.8 Km</td>
<td>= up to 2 Km</td>
</tr>
<tr>
<td>period = 1 day</td>
<td>≈ 1.5 hrs</td>
</tr>
<tr>
<td>coverage time for fixed ground point = 100%</td>
<td>≈ 20 min = 22.2%</td>
</tr>
</tbody>
</table>

- ground xmit/recv antenna remains pointed at same point in sky
- line-of-sight footprint = larger
- velocity w/ respect to ground ≈ 0, no doppler shift
- further from earth, more time required for signal to travel, go lower

- ground xmit/recv antenna either has to track satellite or has to have wide enough pattern to cover horizon to horizon, thus reducing antenna gain
- doppler shift present (∆freq)
- closer to earth, less signal travel time, go higher
perigee - point at which an orbiting object is closest to Earth

apogee - point at which an orbiting object is furthest from Earth