4.33 a) Given total bandwidth $BW_{tot} = 30\,MHz$ (one-way)

channel bandwidth $BW = 200\,KHZ$

$\Rightarrow$ total radio channel $S = \frac{BW_{tot}}{BW} = \frac{30 \times 10^6}{200 \times 10^3} = \underline{\underline{150}}$

b) number of users that can be served by a base Station during fully loaded operation $= 8 \times 64 = \underline{\underline{512}}$

c) Given $n=4$, $\sigma = 8\,dB$, $U(\gamma) = 0.9$, from Figure 4.18, we have $P_\gamma(R) \doteq 0.73$, where $\gamma = -90\,dBm$.

$$P_\gamma(R) = Pr[P_r(R) > \gamma] = Q\left[\frac{\gamma - \overline{P_r(R)}}{\sigma}\right] = 0.73$$

$$\Rightarrow \frac{\overline{P_r(R)} - \gamma}{\sigma} \doteq 0.61 \quad \Rightarrow \overline{P_r(R)} = 0.61\sigma + \gamma = 0.61 \times 8 + (-90)$$
$$= -85.12\,dBm$$

$$\Rightarrow \overline{PL(R)} = P_t(dBm) - \overline{P_r(R)}(dBm)$$
$$= 10\log_{10}(20/10^{-3}) - (-85.12) \doteq 128.13\,dB$$

Assume $d_0 = 1km$, $G_r = 0\,dB = 1$, miscellaneous loss $L = 0\,dB = 1$, given $G_t = 10\,dB = 10$, $f_c = 1960\,MHZ$ (corresponding to the largest $\overline{PL}(d_0)$), we have $\lambda = \frac{c}{f_c} \doteq 0.153\,(m)$

$$\Rightarrow \overline{PL(d_0)} = -10\log_{10}\left[\frac{G_t \cdot G_r \cdot \lambda^2}{(4\pi)^2 \cdot d_0^2}\right] = -10\log_{10}\left[\frac{10 \times 1 \times (0.153)^2}{(4\pi)^2 \times (1000)^2}\right]$$
$$\doteq 88.3\,dB$$

Since $\overline{PL(R)} = \overline{PL(d_0)} + 10 \cdot n \log_{10}\frac{R}{d_0}$, for $n=4$, we have

$$R = 10^{\frac{\overline{PL(R)} - \overline{PL(d_0)}}{10n}} \cdot d_0$$
$$= 10^{\frac{128.13 - 88.3}{40}} \cdot 1 = 9.88\,(Km)$$

4.33 Cont'd

$$\Rightarrow N = \frac{\text{Total Area}}{2.6R^2} = \frac{2500}{2.6 \times 9.88^2} \doteq \underline{\underline{10}}$$

(d) Let's first relate the channel number to it's frequency

	Channel Number	Center Frequency (M
Reverse Channel	$1 \le N \le 150$	$0.2N + 1849.9$
Forward Channel	$1 \le N \le 150$	$0.2N + 1929.9$

We can see that the forward and reverse channel each pair are separated by 80 MHz.

Since the cluster size is equal to 4, we divide the 150 radio channel into $4 \times 3 = 12$ subsets. The follow chart illustrates these 12 subsets.

1A	2A	3A	4A	1B	2B	3B	4B	1C	2C	3C
1	2	3	4	5	6	7	8	9	10	11
13	14	15	16	17	18	19	20	21	22	23
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
133	134	135	136	137	138	139	140	141	142	143
145	146	147	148	149	150					

It can be seen from the chart that each subset co about 12 channels. In each subset, the closest adja channel is 12 channels away. In a four cell re system, each cell uses channel chosen from the s $iA + iB + iC$, where i is an integer from 1 to 4 each cell can use about 37 channels. The adjacent c

4.33 Cont'd

g) Given Probability of Blocking = 5%

Number of user channels per cell: $C = 38 \times 8 = 304$

Assume traffic intensity per user $A_u = \mu H = 3 \times \frac{2}{60} = 0.1$ Erlangs

$\Rightarrow$ number of users that can be supported per cell at start-up $= U = A/A_u = 300/0.1 = \underline{\underline{3000}}$

$\Rightarrow$ maximum number of subscribers that can be supported at start up $U_{sernumber} = U \cdot Cell_{number} = 3000 \times 10 = \underline{\underline{3 \times 10^4}}$

h) Cost per user $= \dfrac{3.5 \times 10^7 \times 10\%}{3 \times 10^4} = \underline{\underline{\$116.67}}$

$\boxed{5.1}$ $c = \lambda f \Rightarrow \lambda = \frac{c}{f} = \frac{3\,10^8\, m/s}{1.95\, 10^9\, Hz} = 0.154\, m$

$f_d = \frac{v}{\lambda} \cos\theta \qquad f_{d_{max}} = \frac{v}{\lambda}\ ; \ -f_{d_{max}} = -\frac{v}{\lambda}$

$v = 1\, km/hr \Rightarrow v = 0.278\, m/s \Rightarrow f_d = 1.8\, Hz$

$V = 5\, km/hr \Rightarrow V = 1.39\, m/s \Rightarrow f_d = 9.03\, Hz$

$V = 100\, km/hr \Rightarrow V = 27.8\, m/s \Rightarrow f_d = 180.5\, Hz$

$V = 1000\, km/hr \Rightarrow V = 278\, m/s \Rightarrow f_d = 1805\, Hz$

$\therefore$ @ 1 km/hr, spectral edges are 1949.9999982 mHz
and 1950.0000018 mHz

@ 5 km/hr, spectral edges are 1949.99999097 mHz
and 1950.00000903 mHz

@ 100 km/hr, edges are 1949.9998195 mHz
and 1950.0001805 mHz

@ 1000 km/hr, edges are 1949.998195 mHz
1950.001805 mHz

5.7 (a) $T_s = \frac{1}{100\,\text{kbps}} = 10^{-5}\,s.$ $\boxed{0 \le \sigma_\tau \le 10^{-6}\,s}$

$h_b(\tau) \leftarrow \sigma_\tau$ if $\sigma_\tau \le \frac{1}{10} T_s \Rightarrow$ flat fading

$T_s \ge 10\,\sigma_\tau \qquad \sigma_\tau \le \frac{T_s}{10}$

(b) $f_d = \frac{v}{\lambda}$

$c = \lambda f$

$\lambda = c/f = 3\ 10^8 / 5.8\ 10^9 \approx \underline{\underline{0.05\,m}}$

$$\text{velocity} = \frac{30\ \text{miles}}{hr} \cdot \frac{1\,hr}{3600\ sec} \cdot \frac{5280'}{1\ \text{mile}} \cdot \frac{12''}{1'} \cdot \frac{2.54\,cm}{1''} \cdot \frac{1\,m}{100\,cm}$$

$$= \frac{30 \cdot 5280 \cdot 12 \cdot 2.54}{3600 \cdot 100} = 13\ m/s$$

$f_d = \frac{13}{0.05} = \boxed{260\ Hz}$

5.7 *Cont'd.*

Coherence Time Define $\begin{bmatrix} 90\% \\ 50\% \end{bmatrix}$

$T_c \approx \frac{1}{f_m} = \boxed{0.004\,s}$

$T_c \approx \frac{9}{16\pi f_m} = \frac{1}{5 f_m} = \boxed{0.00125}$

(c) Here we have $f_d = 260\,Hz$; $T_s \approx 10^{-5}\,s$; $T_c \approx 10^{-3}\,s$

slow fading $\Rightarrow T_s \ll T_c$ here $10^{-5} \ll 10^{-3}$

$\boxed{\text{slow fading}}$

d) pick your T_c, then

$\#$ bits sent $= R_b \cdot T_s = \frac{10^5\,b}{s} \cdot 10^{-3}\,s \approx \underline{\underline{100}}$