Q.2 a. Define the following with respect to cellular communication:

(i) frequency reuse
(ii) spectrum efficiency
(iii) path loss
(iv) multipath propagation **(8)**

Answer:

b. Calculate the number of times the cluster of size 4 has to be replicated in order to approximately cover the entire service area of 1569 km^2 with the adequate number of uniform sized cells of 7 km^2 each. **(4)**

Answer:

Size of the cluster, $K = 4$

Area of a Cell, $A_{Cell} = 7 km^2$

step 1: To determine area of the cluster

$A_{cluster} = K \times A_{Cell} = 4 \times 7 = 28 km^2$ (02)

step 2: To determine number of clusters in the servic area

Total service area, $A_{sys} = 1569 km^2$

No. of clusters reqd to cover the given area $= \frac{A_{sys}}{A_{cluster}} = \frac{1569}{28}$

$= 56$

c. Compare discrete random variables and continuous random variables. **(4)**

Answer: Refer Page 30 of Text Book-I

Q.3 a. Briefly discuss the following terms with reference to cellular system:-

(i) Co channel interference & it's reduction factor
(ii) Cell splitting
(iii) Cell sectoring **(9)**

Answer:

b. In a certain cellular system, the base station radiates 15W. Suppose that the cells are split and the new cells have one fourth the radius of the original cells. Find the power that the base stations in the new layouts must transmit to maintain the SNR at the cell boundaries. The path loss exponent $\gamma = 4$. **(7)**

Answer:

Let P_{r_1} be the reference power measured at d_0 in the original cell configuration.

For $r=4$, the received power at the cell boundary, $d = R_1$ is

$$P_r = \frac{P_{r_1}}{(R_1/d_0)^4} \quad (02)$$

When the cells are split, $R_2 = R_1/4$.

We want to maintain the received powers at the cell radius at P_r. Then,

$$P_r = \frac{P_{r_1}}{(R_1/d_0)^2} = \frac{P_{r_2}}{\left(\frac{R_1/4}{d_0}\right)^2} \quad (02)$$

Where P_{r_2} is the new reference power measured at d_0. Rearranging, we have

$$P_{r_2} = P_{r_1}(1/4)^2 \quad (01)$$

The transmitted power change in the same proportion as the reference powers. Hence,

$$P_{r_2} = 15(1/4)^2 = 0.0585\ W. \quad (02)$$

Q.4 a. Briefly discuss the following:
(i) ACI
(ii) Near far effect
(iii) Power control **(9)**

Answer:

b. If a 100 W power is applied to a unit gain antenna with a 600 MHz carrier frequency, find the received power in dBm at a distance of 200m from the antenna. What is P_r (10km)? **(7)**

Answer:

$$\lambda = \frac{c}{f} = \frac{3\times10^8}{600\times10^6} = 0.5\,m \quad (01)$$

$$P_{t(d)} = \frac{P_t G_t G_r \cdot \lambda^2}{(4\pi)^2 d^2} = \frac{100(1)(1)(0.5)^2}{(4\pi)^2(200)^2}$$

$$= 3.95\times10^{-3}\,mW \quad (02)$$

$$P_r(dBm) = 10\log P_r(mW) =$$

$$= 10\log(3.95\times10^{-3}\,mW) = -24.03\,dBm \quad (01)$$

We have $P_r(d_0) = P_r(d_0) + 20\left(\frac{d}{d_0}\right)$ (01)

$$\therefore P_r(10km) = P_r(200) + 20\log\left(\frac{10\times10^3}{200}\right)$$

~~$= -58\,dBm$~~

$$= -24.03\,dBm - 33.979\,dBm$$

$$= -58\,dBm \quad (02)$$

Q.5 a. Write a detailed note on indoor & outdoor mobile radio propagation models. **(8)**

Answer:

b. Assuming the speed of a vehicle to be equal to 60mph, carrier frequency of 860MHz and rms delay bandwidth. At a coded symbol rate of 19.2 kbps, what kind of symbol

distortion will be experienced? What type of fading will be experienced by the channel? **(8)**

Answer:

(6) $V = 60 \text{ mph} = 88 \text{ ft/s}$.

$\lambda = \frac{c}{f} = \frac{9.84 \times 10^8}{820 \times 10^6} = 1.1442 \text{ ft}$ — (01)

Max. Doppler shift $= \frac{V}{\lambda}$

$= \frac{88}{1.442} = 77 \text{ Hz}$ (01)

$T_c = \frac{1}{2\pi f_m} = \frac{1}{2\pi \times 77} = 0.0021 \text{ s}$ (01)

Symbol interval $T_s = \frac{10^6}{19,200} = 52 \text{ µs}$. (01)

The symbol interval is much smaller compared to the channel coherence time. Hence, symbol distortion is minimum. In this case fading is slow. (01)

Coherence B/W, $B_c = \frac{1}{2\pi C_d} = \frac{1}{2\pi \times 2 \times 10^{-6}}$

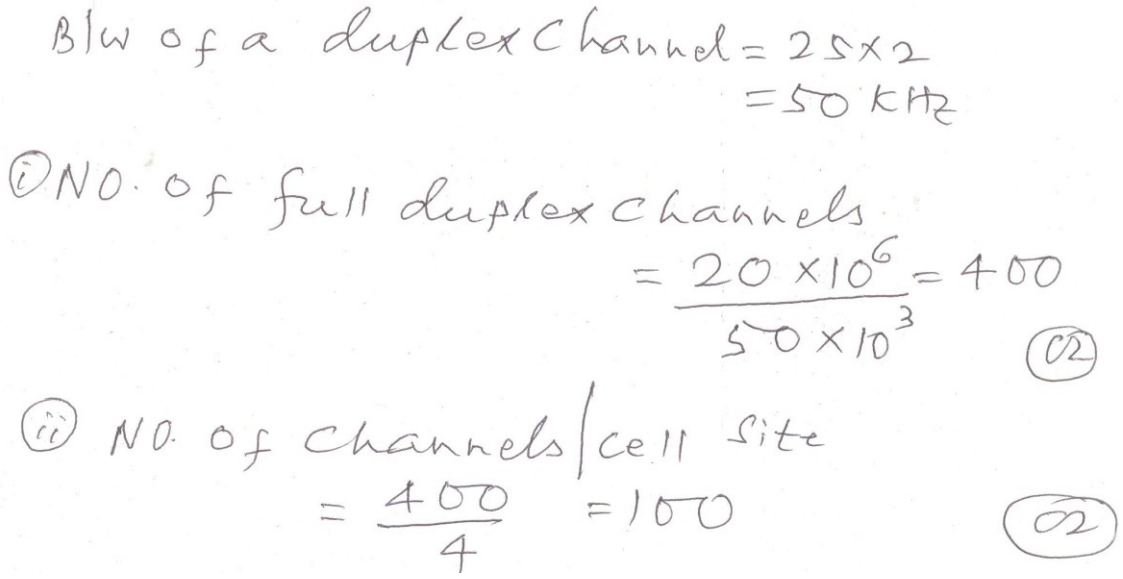
$= 79.56 \text{ kHz}$ (01)

This shows that the channel is wide band system in this multi path situation and experiences selective fading only over 6.5% ($79.56 / 1228.8 = 0.0648 \approx 6.5\%$) of it's B/W = 1228.8 KHz). (02)

Q.6 a. A full duplex cellular system is allocated a total spectrum of 20 MHz and each simplex channels has 25kHz spectral width, Determine the

(i) total number of full duplex channels available
(ii) number of channels per cell site if K = 4 cell reuse pattern is employed. **(4)**

Answer:

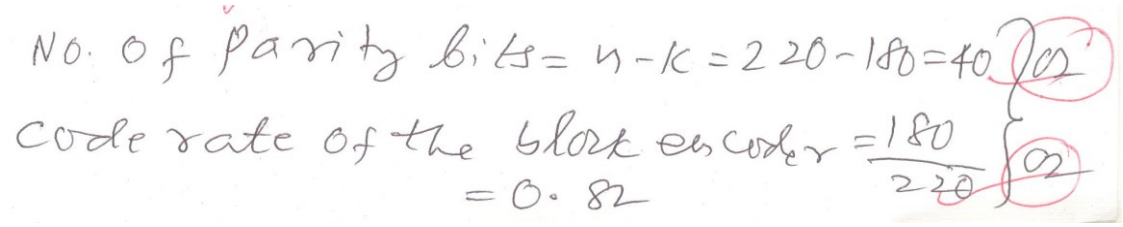


b. Bring out the distinguishing features of the following error control coded:
(i) block (ii) convolution (iii) and cyclic (iv) turbo codes **(8)**

Answer: **Refer page 440 of Text Book-I**

c. In a GSM cellular communication system, a data block of 180 bits is encoded into 220 bits of code word on the control channel before sending it to a convolution encoder. Determine the number of parity check bits added and the code rate of the block encoder used. **(4)**

Answer:



Q.7 a. Briefly discuss the packet radio access protocols. Compare their performances. **(10)**

b. A normal GSM has 3 start bits and 3 stop bits, 26 training bits for allowing adaptive equalization, 8.25 guard bits and 2 burst of 58 bits of encrypted data which is transmitted at 270.833 kbps in the channel. Find (i) number of overhead bits per frame (ii) total number of bits per frame (iii) frame rate (iv) time duration of a slot (v) frame efficiency **(6)**

Answer:

A time slot has

$6 + 8.25 + 26 + 2(58) = 156.25$ bits (01)

(i) No. of overhead bits

$= 8(6) + 8(8.25) + 8(26)$

$= 322$ bits (01)

(ii) No. of bits/ frame

$= 8 \times 156.25 = 1250$ (01)

(iii) Frame rate $= 270.833$ kbps $/ 1250$ bits/frame

$= 216.66$ frame/s. (01)

(iv) Time duration of a slot

$$= \frac{156.25 \times 1}{270.833 \text{ kbps}}$$

$= 576.92$ µs (01)

(v) Frame effiency

$$\eta = \left[1 - \left(\frac{322}{1250}\right)\right] = 74.24\% \quad (01)$$

Q.8 a. Explain the different types of interfaces used to connect the units of BSS in GSM. **(6)**

b. Compare the characteristics of LEO, MEO and GEO satellites. **(6)**

Answer:

We know that

$G = 6.67$ → Earth's gravitational Constant

$M = 5.98 \times 10^{24}$ kg → Mass of the earth

Given, $R = 6360$ km

$H = 640$ km

$$\text{Orbital Velocity} = \sqrt{\frac{GM}{(R+H)}}$$

$$= \sqrt{\frac{6.67 \times 10^{-11} \times 5.98 \times 10^{24}}{(6360+640) \times 10^{3}}} = 7.54 \text{ km/s.}$$ (02)

$$\text{Orbital period} = \frac{2\pi(R+H)}{V}$$

$$= \frac{6.28 \times 7000}{7.54}$$

$$= 5830 \text{ sec}$$

$$= 1 \text{ hr } 37 \text{ min}$$ (02)

c. A satellite is moving in a near earth circular orbit at a distance of 640 km. Determine its orbital period. Assume (R = 6360 km). **(4)**

Answer:

Q.9 a. Discuss the evaluation of the mobile standards: 2G, GPRS, EDGE and LTE. **(8)**

b. Explain how adhoc networks differ from infrastructure based wireless networks. **(8)**

TEXT BOOK

Introduction to Wireless and Mobile Systems, Second Edition (2007), Dharma Prakash Agrawal and Qing-An Zeng, Thomson India Edition