**CS 6097 Wireless and Mobile Networking**

**Homework No. 1 dated Wednesday September 3, 2014**

**P2.2.** A random digit generator on a computer is activated three times consecutively to simulate a random three-digit number.

1. How many random three-digit numbers are possible?
2. How many numbers will begin with the digit 2?
3. How many numbers will end with the digit 9?
4. How many numbers will begin with the digit  and end with the digit 9?
5. What is the probability that a randomly formed number ends with  given that it begins with a 2?

**[Solution]**

1. 9x10x10=900
2. 2X10x10=100
3. 9x10x1=90
4. 1x10x1=10
5. 10/900=1/90

**P2.3.** A snapshot of the traffic pattern in a cell with  users of a wireless system is given as follows:

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| User Number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Call Initiation Time | 0 | 2 | 0 | 3 | 1 | 7 | 4 | 2 | 5 | 1 |
| Call Holding Time | 5 | 7 | 4 | 8 | 6 | 2 | 1 | 4 | 3 | 2 |

1. Assuming the call setup/connection and call disconnection time to be zero, what is the average duration of a call?
2. What is the minimum number of channels required to support this sequence of calls?
3. Show the allocation of channels to different users for part (b) of this problem.
4. Given the number of channels obtained in part (b), for what fraction of time are the channels utilized?

**[Solution]**

1. Average duration of a call is



1. By plotting the number of calls by all users, we can determine how many users need to have a channel simultaneously. This gives us the minimum number of channels required to support the sequence of calls as 6.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| User number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Call duration | 0-5 | 2-9 | 0-4 | 3-11 | 1-7 | 7-9 | 4-5 | 2-6 | 5-8 | 1-3 |
| Channel Number | 1 | 5 | 2 | 4 | 3 | 2 | 2 | 6 | 1 | 4 |

1. Allocation of channels to various users is

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Channel number | 1 | 2 | 3 | 4 | 5 | 6 |
| User number | 1 | 3 | 5 | 4 | 2 | 8 |
| User number (allocated to same channel) | 9 | 6,7 |  | 10 |  |  |

1. Total duration of the calls is 42.

Total amount of time channels are available is .

Therefore fraction of time channels are used is .

**P2.4.** A department survey found that four of ten graduate students use CDMA cell phone service. If three graduate students are selected at random, what is the probability that the three graduate students use CDMA cell phones?



**[Solution]**

**P3.2.** Consider an antenna transmitting a power of  W at  MHz. Calculate the received power at a distance of  km if propagation is taking place in free space.

**[Solution]**

Transmitted power = *Pt* = 5 W

Carrier frequency = 900 MHz ⇒ λ = *c/f* = 0.33 m

*d* = 2 km

Assuming unit gain in free space model, i.e., *Gt* = *Gr* = 1

Received power can be calculated by the formula



**P3.4.** The transmission power is 40 W, under a free-space propagation model,

1. What is the transmission power in unit of dBm?
2. The receiver is in a distance of 1000 m; what is the received power, assuming that the carrier frequency  and ?
3. Express the free space path loss in dB.

**[Solution]**

1. 10 × log (40 × 1000) = 46 dBm.
2. Carrier frequency = 900 MHz ⇒ λ =  = 1/3 m



1. Substitute values in the following equation:

*Lf* (dB) = 32.45 + 20 log10(*fc*) + 20 log10(*d*) = 91.5349 dB.

**P3.7.** Consider an antenna transmitting at  MHz. The receiver is traveling at a speed of  km/h. Calculate its Doppler shift if angle  is 410.

**[Solution]** Doppler shift =cos 40,000 cos41/900=400\*0.7541/9=33.53 Hz