TLT-6206 Radio Propagation in Wireless Networks Exam 17.01.2011

You may use either English or Finnish language.
Use of literature is not allowed.
Use of the Faculty's calculator is allowed.
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1. Give concise explanation to following:

   a) Path loss exponent
   b) Faraday rotation
   c) Difference between reflection and scattering
   d) Difference between narrowband and wideband radio channel
   e) Knife edge diffraction
   f) Why and how the shadowing effect has to be taken into account in radio network design?

2. Describe all the physical circumstances that relate to a stationary transmitter and a moving receiver such that the Doppler shift at the receiver is equal to:
   a) 0 Hz
   b) $f_{d,\,max}$
   c) $-f_{d,\,max}$
   d) $f_{d,\,max}/2$

   Here $f_{d,\,max}$ is the maximum Doppler frequency.

   Express also $f_{d,\,max}$ with respect to used frequency and velocity of moving receiver.

3. What is Walfisch-Ikegami model? Explain the main idea(s) regarding the model. Compare the modelling principle with free space model.

4. Channel Power-delay profile is defined as

$$p(\tau,t) = 2\cdot\delta(\tau) + a(t)\cdot\delta(\tau-\tau_1),$$

   where τ is seconds, t in seconds and $\delta(\cdot)$ is Dirac impulse function. Furthermore, $a(t) = 1+\cos(2\pi\cdot 20\cdot t)$.

   Assuming that τ_1 =1 μs, determine
   a) the channel frequency correlation (coherence) function,
   b) the mean propagation delay,
   c) the rms delay spread,
   d) the coherence bandwidth, and
   e) the Doppler spectrum of the channel with respect to delay.

   Would the channel be regarded as a frequency selective, if the used symbol period is 30 μs?
   Is the channel fast fading?

5. Derive free space attenuation formula. The effective area of isotropic antenna is, $A_e=\lambda^2/4\pi$, where λ is wavelength. In a case, where the transmitter power is 3 W, the transmitter antenna gain is 10 dB and receiver is located at 2 km distance from the transmitter with the receiver antenna gain of 5 dB. The frequency is 1 GHz.
   a) Calculate the received power.
   b) What is the received power if the distance reduced to 1 km?