

You may use either english of finnish language.
Use of literature is not allowed.

1. What is meant by diversity systems and why diversity is used in some radio systems? Present the general principles and implementation alternatives.

2. Explain the terms used in the context of cellular systems:

- a) cell
- b) umbrella cell
- c) frequency reuse, reuse pattern, reuse ratio
- d) handoff

3. Explain the following tropospheric and ionospheric phenomena:

- a) tropospheric refraction
- b) depolarization
- c) tropospheric scintillation
- d) Faraday rotation
- e) dispersion

4. Suppose that in a hexagonal cell the base station is located in the center of the cell and the mobile unit positions are random and uniformly distributed within the cell region. What is the probability that the signal of the base station is 3dB stronger than in the worst case at the mobile unit? It can be assumed that the base station has fixed power level and omnidirectional antenna. Do the calculations for LOS and typical urban channel attenuation behaviors.

5. Derive the free-space attenuation formula.

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$$\frac{\lambda^2}{4\pi} = A_{\text{ess}} \quad \frac{P_r}{4\pi r^2}$$