S.72-1140 Transmission Methods in Telecommunication Systems

Closed-book exam on Thursday 30.10.2008

1. Probability density function of Rayleigh distributed envelop is given by $p(r) = \frac{r}{\sigma^2}\exp\left(\frac{-r^2}{2\sigma^2}\right)$, where σ^2 is the variance.

   a) Derive the cumulative distribution function.
   b) Find the percentage of time that a signal is 10 dB or more below the RMS value for a Rayleigh fading signal.

2. Consider the signal $x(t) = e^{-\alpha t}u(t), \alpha > 0$

   a) Is *x(t)* a power or an energy signal?
   b) Compute the respective Fourier transform.
   c) Compute the respective autocorrelation function.
   d) Show that the autocorrelation function can be written in terms of convolution.

3. Consider matching of a communication channel with $Z_L = 30 + j2\pi fL, L = 10\,\text{nH}$ to the source of having impedance $Z_g = 10 + 1/(j2\pi fC), C = 1\text{nF}$.

   a) Describe goodness of matching as a function of frequency.
   b) Is there any frequency where matching is optimized?

4. An angle modulated signal with the carrier frequency $\omega_C = 2\pi \cdot 10^6$ is described by the equation $x(t) = 10 \cdot \cos[\omega_c t + 0.1 \cdot \sin(\pi 2000t)]$

   a) Find the average power of the signal when the impedance (resistance) level is 1 Ω
   b) Find the respective frequency deviation Δf
   c) Find the respective phase deviation $\Delta\varphi$
   d) Estimate the required transmission bandwidth for *x(t)*

5. For a (6,3) systematic linear block code, the three parity-check digits c_4, c_5 and c_6 are: $c_4 = d_1 \oplus d_2 \oplus d_3$, $c_5 = d_1 \oplus d_2$ and $c_6 = d_1 \oplus d_3$

   a) Construct the appropriate generator matrix for this code
   b) Construct the code(s) generated by this matrix
   c) Determine the error correction capabilities of the code
   d) Prepare a suitable decoding table
   e) Decode the word: 101100