Aalto/TKK/LH

S-72.3310 Transmission Media in Communications
EXAMINATION 23.5.2011

ONLY FIVE BEST ANSWERS ARE TAKEN INTO ACCOUNT
Lecture and exercise material can be freely used in examination.

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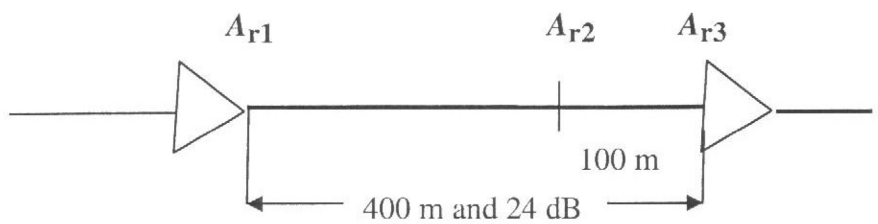
1. A repeater section of a cable television system is about **400 m** and attenuation (vaimennus) at 400 MHz is **24 dB**. At a **100 m** distance from the end of the repeater section there is a reflection point, which return loss (heijastusvaimennus) is A_{r2}**=16 dB**. The return loss of the repeaters at both ends of the repeater section is **14 dB** (=A_{r1}=A_{r3}). Calculate the worst case forward echo attenuation (Mitfluss-Dämpfung, myötävuovaimennus) caused by the reflections A_{r1}, A_{r2} and A_{r3}. All reflection coefficients are resistive. The reflection losses (sovitusvirhevaimennukset) A_S are not taken into account.



2. Estimate the effect of structural inhomogeneity (rakenteellinen epähomogeenisyys) to the transmission properties of a **36.5dB (4.2 Np)** attenuating repeater section.
The periodic structural inhomogeneity gives a spike which return loss measured from the near-end is A_p = **15 dB**. (1 Np = 8.7 dB or 1 dB = 0.115 Np).

a) What is the forward echo attenuation (Mitfluss-Dämpfung, myötävuovaimennus) A_q?
b) What is the maximum capacity C [bit/s/Hz] which could be achieved if the corresponding forward echo were white noise with a signal to noise ratio **S/N =** A_q?
c) What would the **maximum capacity** [Mbit/s] of a **Cat** 6_A data cable be with the above **S/N** ?

Ref.: According to Shannon $C \approx \frac{1}{3}\left(\frac{S}{N}/\mathrm{dB}\right)$[bit/s/Hz].

3. The power levels of **–31 dBm** and **–62 dBm** were measured at the far-end of the disturbing (1) and disturbed (2) line, correspondingly. At the near-end of line (2) the measured power level was **–54 dBm**. Both lines are identical and their attenuation is **25 dB**. All impedances are Z=100 ohm. Define, calculate and draw a picture for:

a) NEXT, Near-end crosstalk (A_n)

b) FEXT, Far-end crosstalk (A_f)

c_1) EL-FEXT, equal level far end crosstalk (Δ_f)

c_2) ACR-F, Attenuation to crosstalk Ratio at the Far-end

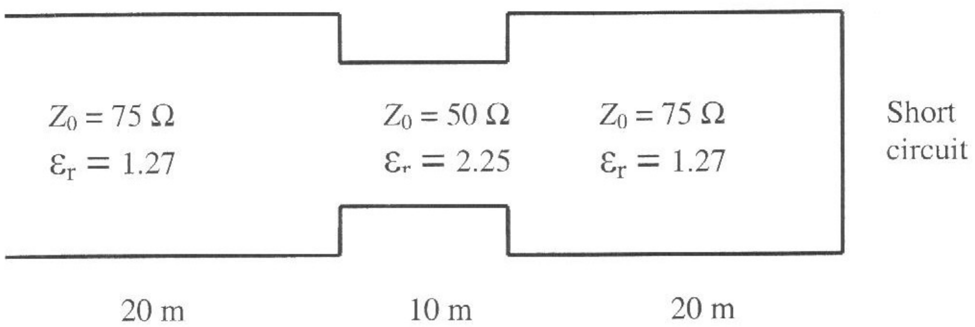
c_{3a}) "S/N-F", Signal to crosstalk Noise ratio at the Far-end

c_{3b}) the maximum capacity ***C* [bit/s/Hz]** which could be transmitted due to "S/N-F"

d) the transmitted power of the generator.

Ref.: According to Shannon $C \approx \frac{1}{3}\left(\frac{S}{N}/\,\mathrm{dB}\right)$[bit/s/Hz].

4. The lossless line below is measured with **a) 50 ns** (half amplitude) sin^2-pulse and with **b) 50 ns** (10 % to 90% amplitude) rise time step.



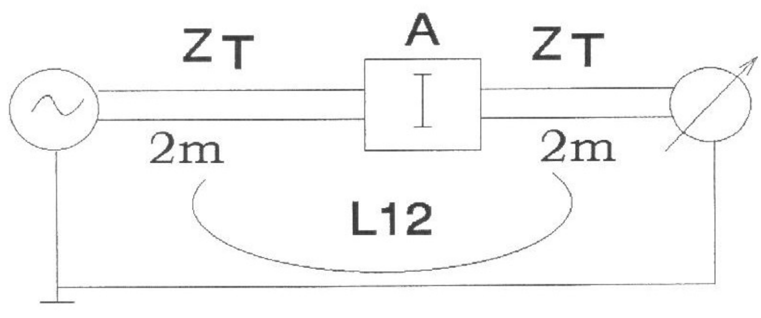
Draw the a) pulse response and b) step response and provide the figure with time and amplitude scale.

c) What is the mathematical relation between step response and pulse response?

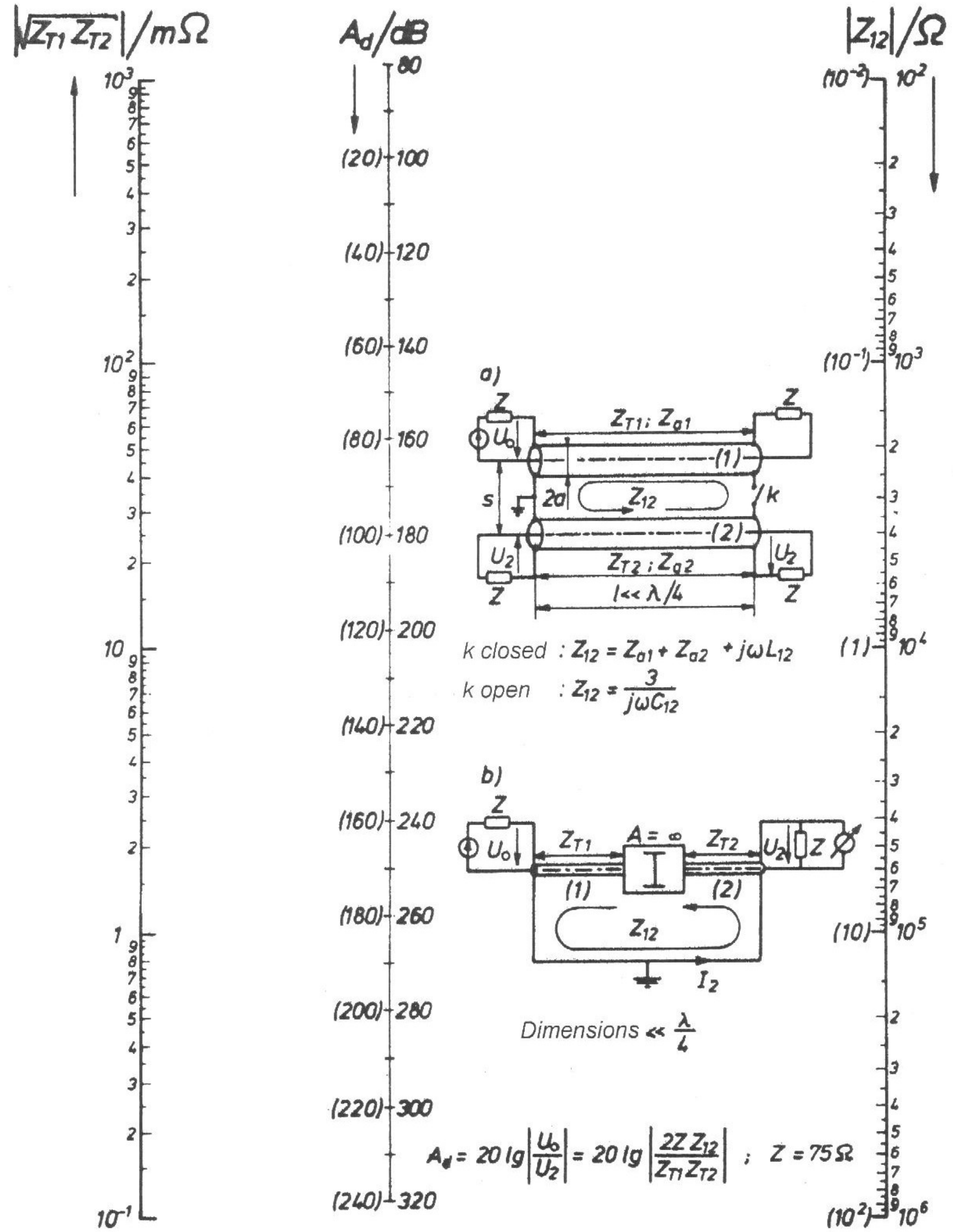
d) How do the pulse and step responses change if the 10 m cable is shortened from 10 to 3 m?

Guidance: Compare Part L8: Chapter 8.4 and Figs 8.4–8 and 8.4–9.

5. What should be the maximum resulting transfer impedance Z_T of the 2 m test leads (cable assemblies) if we like to measure **80 dB** attenuation at **4 MHz** with an accuracy of **0.1 dB**? The system impedance **Z= 75 Ω** and the ground loop inductance $L_{12} = 1\mu H$.



The attached monogram can be used.



$|\sqrt{Z_{T1} Z_{T2}}|/m\Omega$
A_d/dB
$|Z_{12}|/\Omega$
a)
$Z_{T1}; Z_{a1}$
$Z_{T2}; Z_{a2}$
$l \ll \lambda/4$
k closed : $Z_{12} = Z_{a1} + Z_{a2} + j\omega L_{12}$
k open : $Z_{12} = \frac{3}{j\omega C_{12}}$
b)
$A = \infty$
Dimensions $\ll \frac{\lambda}{4}$
$A_d = 20 \lg \left|\frac{U_0}{U_2}\right| = 20 \lg \left|\frac{2Z Z_{12}}{Z_{T1} Z_{T2}}\right|$; $Z = 75\,\Omega$