Last Home Work #11

(due ≤ April 27, 2012)

(Knoll book, Chapters 16, 17)

1. Find the transit time of a pulse through 25 m of RG-58/U coaxial cable.

2. Describe a conventional method of measuring the characteristic impedance of a coaxial cable by varying its termination conditions.

3. For each instance given below, determine whether termination is potentially needed to prevent cable reflections:
   (a) transmission of 0.5μs rise time pulses through 10 m of RG-59/U cable.
   (b) transmission of a 5 ns rise time pulses through 6 m of RG-174/U cable.

4. Find the resistance values $R_1$ and $R_2$ in the symmetric T-attenuator network (Knoll Figure 16.5b) if an attenuation factor of 10 is needed while preserving a 50-Ω impedance value.

5. Prove that the resistance values in the symmetric pulse splitter shown in Knoll Figure 16.6 should be 16.6 Ω in order to distribute a pulse to two 50-Ω loads while maintaining a 50-Ω cable impedance level.

6. An input voltage of the form $V(t) = V_0 \times [1 - \exp(-t/\tau)]$, where $V_0$ and $\tau$ are constants, is supplied to a simple $RC$ integrator circuit. Derive the form of the output signal.

7. A differentiating circuit has component values of $C=500 \text{ pF}$ and $R=500 \Omega$. Find the frequency of a sinusoidal input voltage that will be attenuated by a factor of 2 by this circuit.

8. Derive the following expressions:
   (a) $V_{out} \cong -\left(\frac{R_2}{R_1}\right) \cdot V_{in}$ for the voltage-sensitive preamplifier configuration shown in Knoll Figure 17.1. (Note that the input current must flow through both $R_1$ and $R_2$).
   (b) $V_{out} \cong -\frac{Q}{C_f}$ for the charge sensitive preamplifier configuration shown in Knoll Figure 17.2. (Note that the input charge is divided between $C_i$ and $C_f$).
9. Two scintillator counters A and B are positioned in the charge-particle beam line (transversal beam size and multiple scattering effect is significantly smaller than the size of the counters) as a coincidence telescope. Beam intensity is $2 \cdot 10^4$ particles per second. Counting rates of single counter A is 88,400 cps and of single counter B is 112,200 cps are determined by measurement. “Deadtimeless” discriminators connected to the counters A and B have threshold well below average $m.i.p.$ value and each produce pulse width of 30 ns at the inputs of coincidence unit. Estimate counting rate of coincidence and accidental coincidence rate.

10. The following data were obtained for the coincidence-delay curve in a 2-counters coincidence experiment:

(a) what is the resolving time of the coincidence unit?
(b) what is the width of the prompt coincidence peak in the time spectrum?
(c) what is the single rate, assuming that it is about the same in both branches supplied to the coincidence unit?