

**ECE 733**  
**Final Spring 2009**

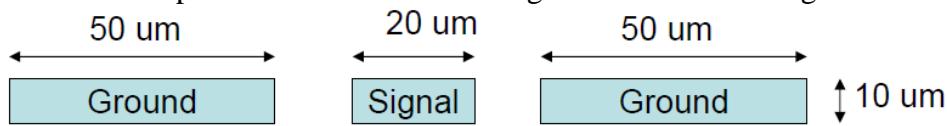
**Name:**

**Student ID:**

This test is open book, open notes. Computers, PDAs and cell phones are NOT allowed (calculators are). You have 90 minutes. Turn in answers in the space provided. [18 points total]

**Question 1**

Consider a Coplanar line that is 0.5 m long. It has the following dimensions:



For the calculations below, please use the following parameters:

- Dielectric constant = 4.3. Loss tangent  $\tan \delta = 0.03$ .
- Copper resistivity =  $1.7E-8$  Ohm.m
- Magnetic permeability =  $4\pi E-7$
- Speed of light in a vacuum =  $3E8$  m/s
- $Z_0=50 \Omega$

Please answer the following questions:

(a) What is the DC resistance per unit length of the transmission line? [2 points]

(b) At what frequency is the skin depth going to start increasing the resistance over the DC resistance? [2 points]

(c) At what frequency does the dielectric loss exceed the skin effect loss? [2 points]

### **Question 2**

Consider PAM-4 Signaling vs. PAM 2 signaling. Please answer the following questions.

(a) If the PAM-2 signal levels for a differential driver are 600 mV, and 900 mV, what would the signal levels be for the PAM-4 driver, if the 0 and “3” level are the same as “0” and “1” are for PAM-2? (This is meant to be a simple question). [1 point]

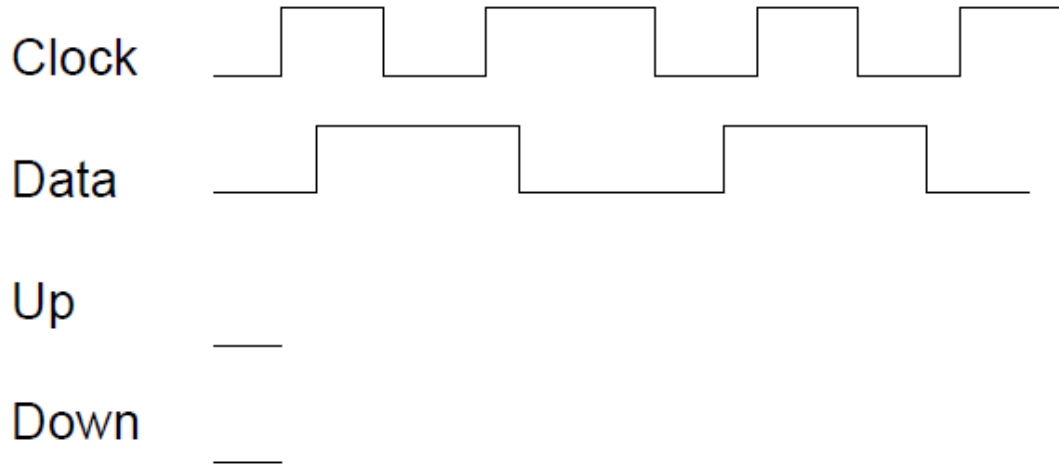
(b) Compare two sets of differential lines next to each other. If using PAM-4, will the impact of crosstalk on the Bit Error Rate be the same, better or worse for PAM-4 when compared to PAM-2 signaling? Please explain your answer clearly. [3 points]

### **Question 3**

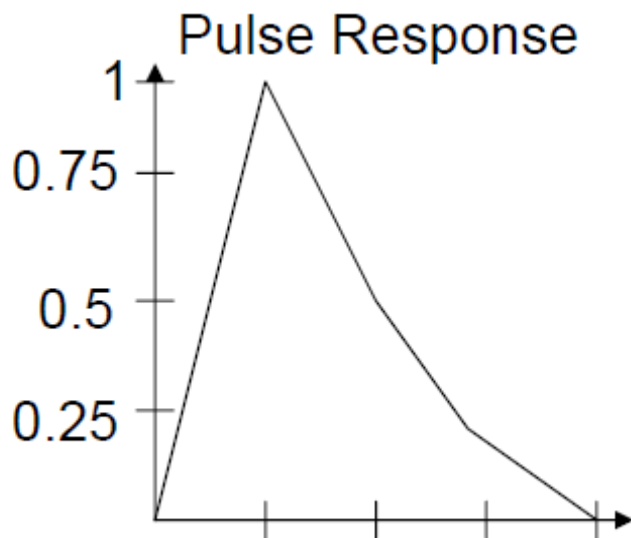
Please answer the following short answer questions:

(a) What is the biggest source of clock jitter in a recovered clock? [2 points]

(b) For the Hogge phase detector, show the Early Late signals for the following clock and data stream. [2 points]



(c) Consider the following unequalized pulse response. If we build a 3-tap filter with tap weights  $a_1=0.3$  and  $a_2=0.1$ , is the resulting waveform likely to be over-equalized or under-equalized? Please explain your reasoning. [2 points]



(d) You are tasked to implement a 10 Gbps transceiver for an existing interconnect system. The customer can supply you with an interconnect structure to measure. You intend to use this to build a simulation model. Will you use TDR or a Vector Network Analyzer to extract the model? Or can you use either? Please explain your reasoning. [2 points]