UNIVERSITY OF GHANA

BACHELOR OF SCIENCE IN ENGINEERING
SECOND SEMESTER EXAMINATION, 2015/2016
DEPARTMENT OF COMPUTER ENGINEERING
CPEN 302: COMPUTER SYSTEMS ENGINEERING (3 CREDITS)

INSTRUCTIONS:

ANSWER ALL QUESTIONS. ALL ABBREVIATIONS HAVE THEIR USUAL MEANING.

TIME ALLOWED: TWO AND HALF (2¹/2) HOURS

1.

Consider Fig. 1 below; Node B is pre-charged by device M1. The signal on line A falls 2.5V with transition time tr = 300 ps pulling signal B downward through the coupling capacitance Cc. The 0.5 μm/0.35 μm keeper is in the resistive region with a resistance of about 4.6 kΩ. The parasitic capacitance of node B, Co, is about 20pF, and the coupling capacitance, Cc is 10 pF.

a. Determine the system time constant. **(2 Marks)**

b. Evaluate ΔVB assuming there is no keeper. **(2 Marks)**

c. Evaluate ΔVB in the presence of keeper M2 for $t=3\tau_{xp}$ **(4 Marks)**

Note:

$$V_B(t) = \begin{cases} k_c\left(\frac{\tau_{xp}}{t_r}\right)\left[1 - \exp\left(-\frac{t}{\tau_{xp}}\right)\right] \text{ if } t < t_r \\ k_c\left(\frac{\tau_{xp}}{t_r}\right)\left[\exp\left(-\frac{t - t_r}{\tau_{xp}}\right) - \exp\left(-\frac{t}{\tau_{xp}}\right)\right] \text{ if } t \geq t_r \end{cases}$$

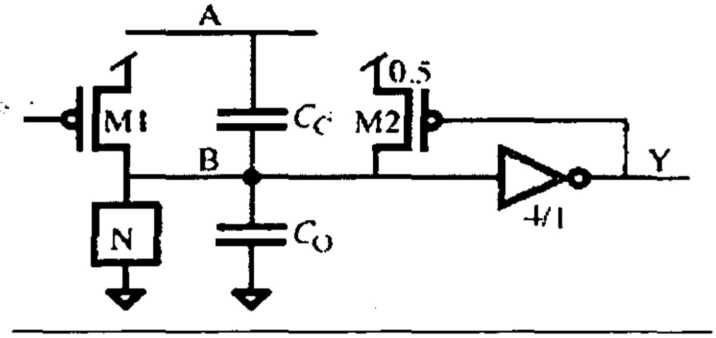

Fig. 1. Cross-talk of a precharged circuit with a keeper

d. Explain the following categories of cross-talk with the aid of diagrams and provide three countermeasures for each of them

   i. Near and Far-end cross talk **(5 Marks)**

   ii. Signal return cross-talk **(5 Marks)**

2.

For a transmission line geometry similar to the one provided in Fig. 2, consider the following parameters: propagation velocity $\vartheta = 1.78 \times 10^{8} m/s$ and the time delay down the line connecting U1 and U2 is given as $TD = 713\ ps$.

a. Calculate the steady state voltage $V_{initial}$, considering a source voltage of 2V, a source impedance of 75Ω and a line impedance of 50Ω. **(2 Marks)**

b. Calculate the source and load reflection coefficient considering the line is terminated in open circuit **(4 Marks)**

c. Sketch the lattice diagram and the response of the lattice diagram (V_{load} and V_{source} vs time) of this undriven transmission line limited to the 5th reflection

(10 Marks)

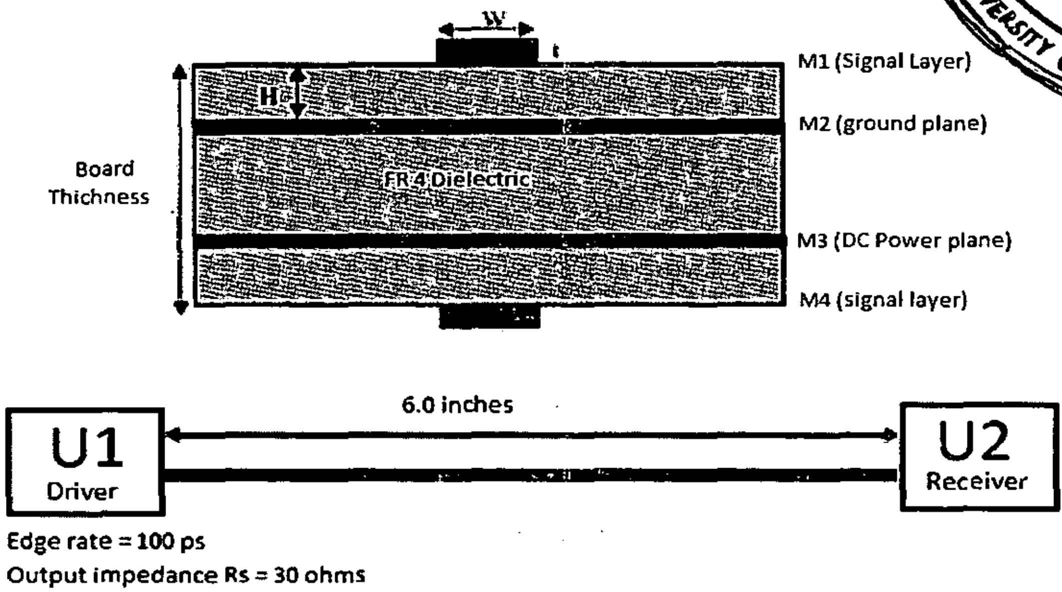

Fig. 2. Sectional view of a standard four layer motherboard stackup

3.

a. With the aid of a circuit, show how overshoots are reduced in off-chip distribution networks **(3 Marks)**

b. Explain the role of bypass capacitor for on-chip network design **(2 Marks)**

c. Differentiate between single supply noise and differential supply noise **(4 Marks)**

d. Based on table 1 below, if the signal swing of an SEMC is increased from 250mV to 750mV, determine the new net noise margin **(6 Marks)**

e. Calculate the ratio of gross noise margin to noise before and after this change and comment on the results. **(4 Marks)**

Table 1. Noise Budget of a Digital System

Noise source	Type	Amount (%)	Amplitude (V)
Gross margin			100
Received Offset	Fixed		±5
Receiver sensitivity	Fixed		±5
Unrejected power supply noise	Fixed		±5
Transmitter offset	Proportional	5	±10
Cross talk	Proportional	10	±20
Intersymbol interference	Proportional	15	±30
Total noise			±75
Net margin			25

4.

a. Differentiate between *microstrip* and *striplines*. **(4 Marks)**

b. With the help of the Fig. 3, show that the impedance of an infinite line is given by the equation **(3 Marks)**

$$Z_0 = \left(\frac{R + Ls}{G + Cs}\right)^{1/2}$$

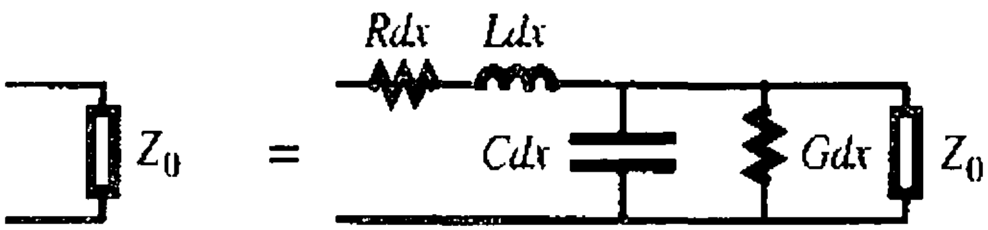

Fig. 3. Model a differential section of a transmission line

c. Considering the standard four layer motherboard stackup model depicted in Fig.2, determine the height H for a line impedance **(2 Marks)**

$$Z_o = 50\Omega$$

Knowing

$$Z_{o\_microstrip} = \frac{87}{\sqrt{\varepsilon_r + 1.41}} \ln\left(\frac{5.48H}{0.8W + t}\right)$$

Assume

$$\varepsilon_r = 4, t = 1$$

d. With the help of the formula below, evaluate the effective dielectric constant, the propagation velocity and the time delay **(8 Marks)**

$$\varepsilon_e = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left(1 + \frac{12H}{W}\right)^2 + F - 0.217(\varepsilon_r - 1)\frac{T}{\sqrt{WH}}$$

$$F = \begin{cases} 0.02(\varepsilon_r - 1)\left(1 - \frac{W}{H}\right)^2 & \text{for } \frac{W}{H} < 1 \\ 0 & \text{for } \frac{W}{H} > 1 \end{cases}$$