Skill Audit Exam Review

Why do we have to have another “high stakes” exam?

- ELM, MPE, WST, EE101, @#$%T?

This is not a high stakes exam!

Yes you have to pass, but it is really an “opportunity” to review material you may have forgotten over the years before:

- starting your senior design project
- starting your interview process

Opportunity is defined is this case as mandatory.

Senior Design Project

- I know it may seem that courses you have been taking do not relate to the “real” world. (So why have a comprehensive exam?)
  - Not true! In fact I have found that students who can not pass certain parts of this exam do poorly on their projects as well.

Interview Questions

- I have found that even though we have some great students doing great projects..
  - They can not get past the interview!
  - It is the simple questions that students are having trouble with!

Why is this different from the ELM, MPE, WST, EE101, @#$%T exams?

- Even though you have to pass with a 70% I know everyone can pass.
- There will be reviews, sample exams, and make up exams.
- The exam will test what you know, not what you don't know.
- Trust me…..

Exam Overview

- Digital Circuits/Systems
- Analog Circuits
- Systems
- Device Physics
- Electromagnetism

Electromagnetism

- Maxwell's equations
- Wireless
- RF
- Antennas
- Radar

A ping-pong ball of radius R = 1.5cm is filled with a charged gas with volume charge density $\rho v = 100/(R\sin\theta)$ (C/m3), what is the total amount of charge (C) inside the ball?

- 0.14
- 0.22
- 0.51
- 0.75
- 0.63

$$Y := \int_0^{\pi}\int_0^{2\pi}\int_0^{1.5\cdot 10^{-2}} \frac{100\, r^2 \cdot \sin(\theta)}{r\cdot \sin(\theta)}\, dr\, d\phi\, d\theta$$

$$Y = 0.222$$

The electric field intensity in free space at point P(1, 1, 4) due to a point charge Q = 10μC located at (1, 1, 0) is:

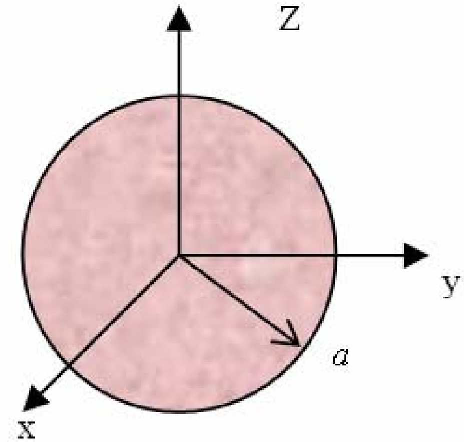
a) 5625 $\hat{z}$
b) 6500 $\hat{z}$
c) 7850 $\hat{z}$
d) 4 $\hat{x}$
e) 4 $\hat{y}$

$Q := 10 \cdot 10^{-6}$ $\varepsilon_0 := 8.85 \cdot 10^{-12}$ $r := 4$

$$E = \frac{Q}{4 \cdot \pi \cdot \varepsilon_0 \cdot r^2}$$

$$E := \frac{Q}{4 \cdot \pi \cdot \varepsilon_0 \cdot r^2} \qquad E = 5.62 \times 10^3$$

3. what is the electric field intensity (V/m) at a distance $R = 0.75a$ due to a spherical cloud of electrons with charge density $\rho_v = 6\varepsilon_0$ C/m^3 and radius a?



a) $2a\varepsilon_o \hat{R}$
b) $a/4 \hat{R}$
c) $3a/2 \hat{R}$
d) $4\pi a^2 \hat{R}$
e) $6a \hat{R}$

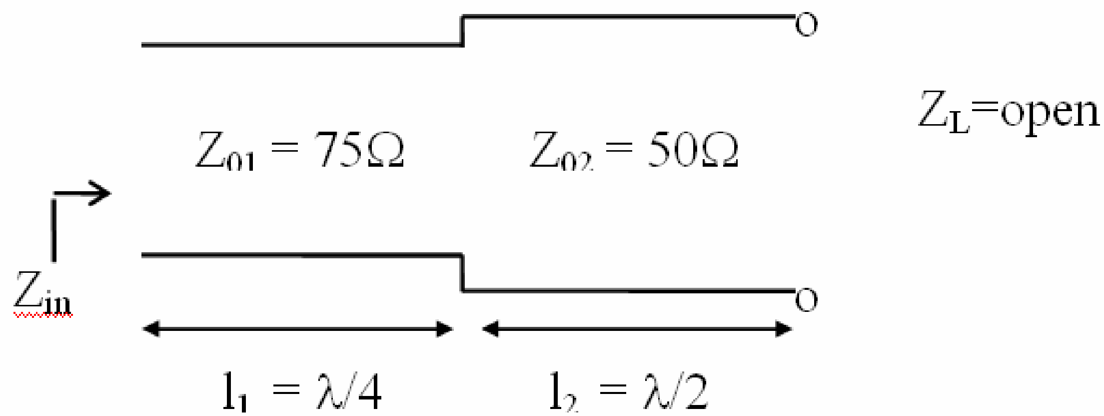
$$6\cdot\varepsilon_0 \int_0^{\pi}\int_0^{2\pi}\int_0^{a} r^2\cdot\sin(\theta)\, dr\, d\phi\, d\theta \rightarrow 8\cdot\varepsilon_0\cdot\pi\cdot a^3$$

$$\frac{8\cdot\pi\cdot a^3\cdot\varepsilon_0\cdot r}{4\cdot\pi\cdot\varepsilon_0\cdot a^3} \rightarrow 2\cdot r$$

$$2\cdot\frac{3}{4}\cdot a \rightarrow \frac{3}{2}\cdot a$$

$$E = \frac{\rho_V\cdot r}{3\cdot\varepsilon_0} \qquad \frac{6\cdot\varepsilon_0\cdot\frac{3}{4}\cdot a}{3\cdot\varepsilon_0} \rightarrow \frac{3}{2}\cdot a$$

4. Find the input impedance Z_{in} to the cascaded lossless transmission lines as shown. (25 points)



a) $Z_{in} = 0.0$
b) $Z_{in} = 50\Omega$
c) $Z_{in} = 75\Omega$
d) $Z_{in} = \infty$
e) $Z_{in} = 125\Omega$

5. A student observes the envelope of the voltage standing-wave on the transmission line simulator TLS, as shown. What is the impedance of the load?

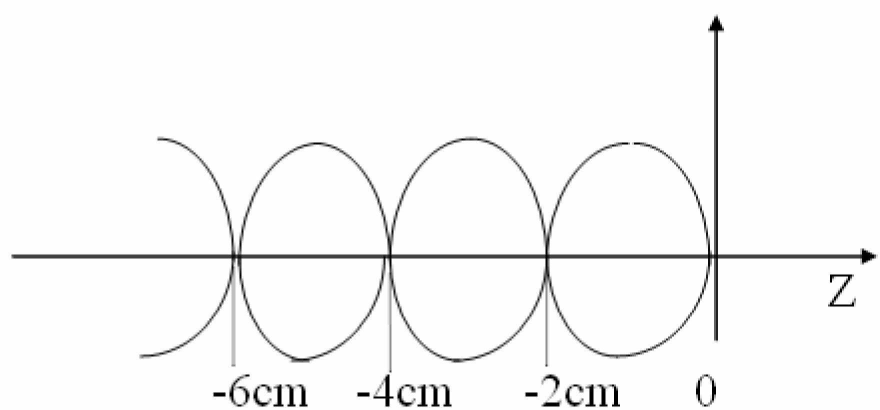
a) 0
b) ∞
c) 50
d) 75

6. A student observes the envelope of the voltage standing-wave on the transmission line simulator TLS, as shown. What is the standing-wave ratio?

a) 0
b) ∞
c) 1
d) 6

7. A student observes the envelope of the voltage standing-wave on the transmission line simulator TLS, as shown. What is the wavelength?

a) 2 cm
b) 4 cm
c) 6 cm
d) ¼ cm



Digital Circuits and Systems

- Digital products are easier to design fabricate and verify do to the fact that the on/off signal has a range of voltage values that track to on or off.
- Digital signals can even have parity generators that can detect/fix errors

Sample Questions

- Binary, Hex, 2’s complement number systems
- Ripple vs. Carry look ahead adders
- CMOS circuits (invert, nand nor)
- Latches (setup and hold times)
- DeMorgan’s theorem

Systems

- The systems analysis tools can be used to study/model almost any kind of system you will come across in your lifetime
  - Mass/spring/friction
  - Neurons
  - Heart

Sample Questions

- Thevenin equivalent of a battery
- Uses for Inductors
- Voltage Current definitions
- Definitions of high pass, low pass, notch filters
- Definitions of critically, under and over sampled systems.

More sample questions

- Step Response

Device Physics

- You need to understand how the diodes, BJTS, and MOSFETs work so that you may use them to design circuits.
- You use this knowledge to prevent or analyze circuit failures
  - Some times it is ok to use a data sheet!

Sample Questions

- DC IC curves for diode, BJT, MOSFET
- Threshold Voltage as a function of oxide thickness, doping
- How to measure VT of a MOSFET?
- What is punch through?
- What is latchup?
- Draw a cross section of a MOSFET and BJT
- Gain in a BJT
- Dimensions of a BJT
- Dimensions of a MOSFET

Analog Circuits

- Signal processing is faster.
- Structures are simpler.

$$I = I_O \cdot \left(e^{\frac{V \cdot q}{n \cdot k \cdot T}} - 1 \right)$$

If e(Vq/nkT) >>1

$$I = I_O \cdot \left(e^{\frac{V \cdot q}{n \cdot k \cdot T}} \right)$$

$$V = \ln\left(\frac{I}{Io} \right) \cdot \frac{n \cdot k \cdot T}{q}$$

A Diode can be used to calculate the natural Log or e raised to a value!
One Device!

Sample Questions

- Identify
  - Inverting OPAMP configuration
  - Non Inverting OPAMP configuration
  - Low pass OPAMP configuration
  - Band pass OPAMP configuration
  - High pass OPAMP configuration
- Given a MOSFET circuit determine if the MOSFET is in cutoff, linear, or saturation mode.
- Design an OPAMP circuit to implement the following function: 10 x (A +B). A and B are signals.

Sample Questions

- If the CMRR of an amplifier is low, what error signal will be more present at the output?
  - common-mode input
  - gm
  - noise coupled into both inputs
  - common-mode output
  - a and c
  - a and b
- If you need to raise the CMRR of an amplifier, what design parameters must you improve?
  - Gm
  - Current
  - Power
  - Output resistance of current source
  - Neither of the above
  - All of the above
- Can an amplifier be unstable in an open-loop configuration?
  - Maybe. (It depends on the feedback.)
  - Yes.
  - No.
  - Maybe. (It depends on the open loop gain.)
- What is the result of increasing the size of the compensation capacitor?
  - larger area
  - smaller area
  - lower dominant pole
  - higher dominant pole
  - better gain/phase margin
  - worse gain/phase margin
  - a and c and e
  - b and d and f
- An active load is used to
  - save area on an IC
  - maximize gain of differential pair stage
  - neither (a) nor (b)
  - both (a) and (b)