# EECS 373 Final Exam Supplemental Practice Problems Winter 2015 

Name: $\qquad$ Uniquename: $\qquad$

NOTES:

- THESE ARE PRACTICE PROBLEMS. THEY WILL NOT BE GRADED.
- Suggestion: First, work through these problems on your own referencing class notes.
- After working through the problems, talk with classmates about your solutions.
- Solutions to these problems will be made available on Sunday, April 26, 2015.
- The final exam will include similar problems.
- These practice problems are not comprehensive. They cover only the additional material not on the midterm, however the final exam is cumulative and will look very similar to the midterm. You should also review this year's midterm and previously posted practice midterms.

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1) Student presentations. Fill-in-the-blank or circle the best answer.
a) Accelerometers / gyroscopes / magnetometers measure physical phenomenon via the Hall effect.
b) The Cortex M4 adds an MPU / a hardware multiplier / an FPU / DSP instructions.
c) Alkaline / Lithium / NiMH batteries are generally cheapest, but lowest energy density.
d) As quadcopters get physically larger, their payload carrying capacity increases / decreases / stays the same / varies and their flight time increases / decreases / stays the same / varies.
e) Shortening the BLE advertising interval will increase / decrease / increase or decrease the discovery latency.
f) Controlling a(n) AC motor / DC motor / stepper motor generally requires the most I/O pins.
g) A thermoelectric / photovoltaic / piezoelectric energy harvester can harvest the most energy per area.

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2) Consider the following 3-bit ADC. Draw the conversion transfer function (binary output vs input voltage) on the top graph. Draw the quantization error transfer function (error voltage vs input voltage) on the bottom graph. Make sure the transition points are clear. Assume Vref is 5 V . [15]


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3) Assume you have a 3-bit SAR ADC. The analog input is 0.65 V and the Vref is 1 V . Show how the SAR would approximate the analog input over three cycles. Label the cycles on the x -axis and show the approximation as a meandering stair-step line on the graph. [10]


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4) Data Converters. Consider the DAC and ADC converters found below. Assume Vref is 8 V for the DAC and 10 V for the ADC and that both converters have an absolute error of up to $+/-1 / 4$ LSB. The output of the ADC (Dout) is connected to the input of the DAC (Din). If 4.2 V is supplied as the input to the $\mathrm{ADC}(\mathrm{Vin})$, the range of values might you get on the output of the DAC (Vout) is $\qquad$ . Label every node/wire in the circuit with its value (analog or digital). Show your work. [15]

## DAC



ADC

5) Clock Generation. Assume you are designing a CMOS RC oscillator that must generate a 1 MHz clock ( $\mathrm{V}_{\text {Out }}$ ) using the circuit shown below. Assume that $\mathrm{V}_{\mathrm{CC}}$ is 5 V , and that the MM74C14's valid "high" input is $\geq 80 \%$ of $\mathrm{V}_{\mathrm{CC}}$ and valid "low" input is $\leq 20 \%$ of $\mathrm{V}_{\mathrm{CC}}$. Find a time constant, $\tau$, that will result in no more than $1 \%$ error in the generated frequency. [15]

(show your work)
$\tau=$ $\qquad$ (include units)

Give an example of reasonable resistor and capacitor values you might choose to implement this circuit.

$$
\begin{aligned}
& \mathbf{R}=\ldots \text { (include units) } \\
& \mathbf{C}=\ldots \text { (include units) }
\end{aligned}
$$

