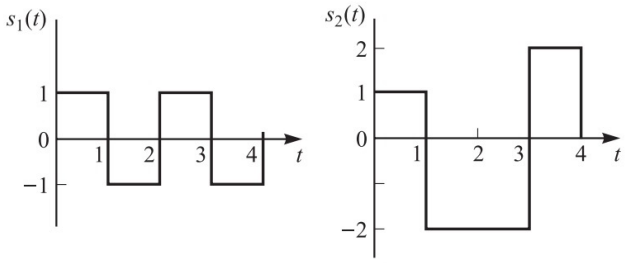
# ECE (435/535a) Spring 2016 Quiz 3
## March 31

**Name:** _____ **Signature:** _____

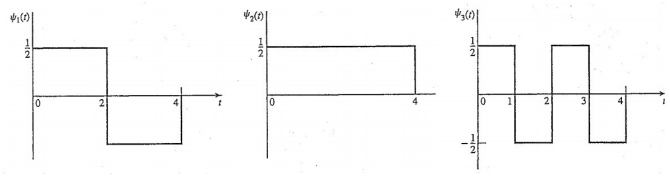
**Instructions:** Answer all questions and show all work. Answers which are not justified with appropriate work will receive 0 points. Students who cheat will receive zero points on the exam and will be subject to the university's disciplinary procedure for academic dishonesty. Cheating includes, but is not limited to, collaborating of conferring in any way with anyone. Use of the internet is strictly forbidden. Your signature above attests that you are in compliance with these rules.

1. Consider the two waveforms shown in the figure below.
   (a) (20 points) Determine the dimensionality of the waveforms and a set of basis functions.
   (b) (20 points) Use the basis functions to represent the waveforms by vectors $s_1$ and $s_2$.
   (c) (10 points) Determine the distance between the two vectors.



| Problem | Points | Student's Score |
|---|---|---|
| 1 | 50 | |
| 2 | 50 | |
| Total: | 100 | |

2. Use the orthonormal waveforms shown in the figure below to approximate the function $x(t) = sin(\frac{\pi t}{4})$, over the interval $0 \leq t \leq 4$ by the linear combination $\hat{x}(t) = \sum_{n=1}^{3} c_n \psi_n(t)$.




(a) (30 points) Determine the expansion coefficients $\{c_n\}$ that minimize the mean-square approximation error $\mathcal{E} = \int_0^4 (x(t) - \hat{x}(t))^2 dt$.

(b) (20 points) Determine the residual mean square error $\mathcal{E}_{\min}$.

(**Hints**: $\int \sin(x)dx = -\cos(x)$, $\int \cos(x)dx = \sin(x)$ and $\sin^2(x) = \frac{1-\cos(2x)}{2}$.)

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