

Name _____
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EE 5345 Final Exam

1. The filtered backprojection algorithm in essence consists of the following two equations:

$$Q_q(t) = \int_{-\infty}^{\infty} S_q(\Omega) e^{j\Omega t} |\Omega| d\Omega \quad (1)$$

$$f(x, y) = \int_0^p Q_q(x \cos \mathbf{q} + y \sin \mathbf{q}) d\mathbf{q} \quad (2)$$

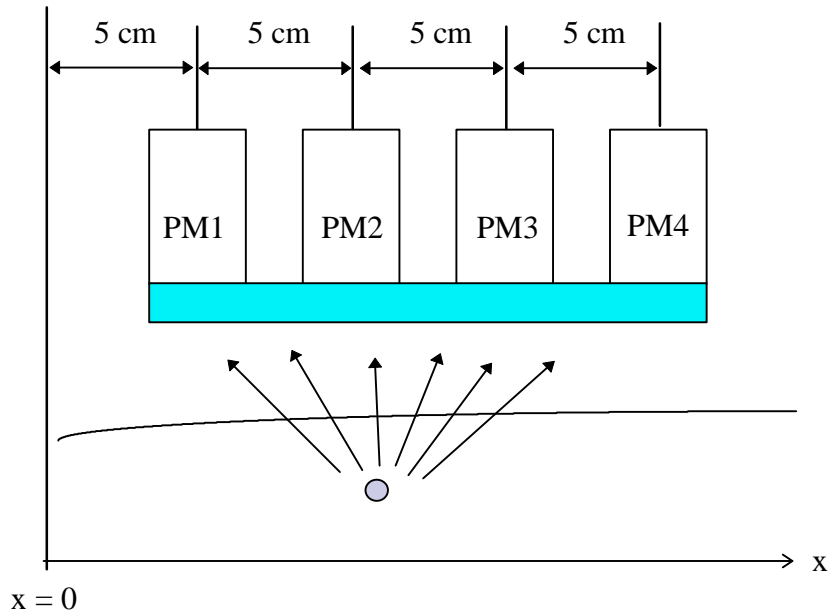
Describe what $Q_q(t)$ in (1) represents. Then describe what equation (2) does. Use sketches to augment your descriptions.

2. (a) In ultrasound imaging, reflected pulses should never encounter transmitted pulses, otherwise, what can happen?

(b) Suppose the speed of sound in tissue is 1500 m/s. What is the maximum pulse repetition rate in pulses per second for 5 MHz ultrasound if the maximum desired penetration depth is 10 cm?

(b) Describe some of the advantages of B-scan ultrasonic imaging derived via a phased array transducer versus a single element transducer.

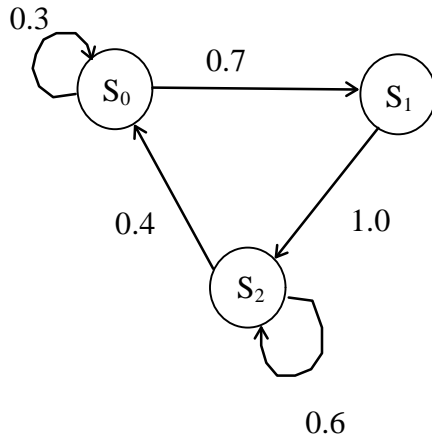
3. Consider an Anger camera consisting of a linear array of 4 photomultiplier tubes:



Suppose PM1, PM2, PM3, and PM4 generate 1000, 2000, 3000, and 2000 counts, respectively. What is the approximate location of the radiation source? Assume that the source is located directly beneath the array.

4. Assume that we wish to efficiently encode 4 symbols, “R”, “O”, “Y”, and “G”. The probability for each symbol is known to be: $\Pr(R) = 0.4$, $\Pr(O) = 0.3$, $\Pr(Y) = 0.2$, $\Pr(G) = 0.1$. (a) Find the Huffman binary codes for the four symbols, (b) determine the average length of each Huffman code word, (c) how does the average Huffman code word length compare with a straight binary code word length?

5. Consider the following Hidden Markov Model:



$$\begin{aligned}
 p_0 &= 0.5 \\
 p_1 &= 0.3 \\
 p_2 &= 0.2
 \end{aligned}$$

The output symbols are “U” and “D”, corresponding to the slope of the observed waveform. Each symbol occurs with a state-dependent probability given by:

state	U	D
S ₀	0.5	0.5
S ₁	0.8	0.2
S ₂	0.1	0.9

Suppose the symbol sequence, “D, U, D” is observed. Determine the most likely state sequence using the Viterbi algorithm.