

BME 4400 Fall 2022

Assignment #2

Due: September 13, 2022 9:00 PM



1. Sketch a plot of the X-ray energy spectrum expected from an X-ray tube with a copper anode and filter, and a 45 kV tube voltage. Label the x-axis in energy (keV) and identify the approximate locations and approximate relative amplitudes of all the spectral components. Identify and explain the different physical interactions and X-ray tube characteristics which are responsible for the shape of the spectrum. If the copper filter went missing and you replaced it with a similarly sized silver filter, how would this affect the characteristics of the X-ray energy spectrum? Why this happen
2. Explain the trade-offs of X-ray intensifier screen thickness on image quality for a given exposure.
3. Assuming the same X-ray exposure, which exam would you expect to present a greater stochastic risk, a head X-ray or an abdominal X-ray? Explain your reasoning.
4. An X-ray beam of intensity I_0 is used to image a forearm. Crudely, consider that at one point in the plane transverse to the beam, the beam passes through 1.5 cm of soft tissue, then 2 cm of compact bone, then 2.5 cm of soft tissue. At another point, the beam passes through 6 cm of soft tissue only. Look up mass attenuation coefficients and densities here <https://www.nist.gov/pml/x-ray-mass-attenuation-coefficients> (Tables 2 and 4; use Tissue, Soft (ICRU-44) and Bone, Cortical (ICRU-44)) and then determine the following:
 - a. the X-Ray beam intensity (relative to I_0) incident on the detector at both points identified above, assuming a beam of 80 keV X-Ray photons (i.e., a mono-energetic beam). How much has the bone affected the intensity of the detected beam?
 - b. Repeat part a) assuming a 30 keV mono-energetic beam