Computational assignment 4

due on October 20, 2025

This week's assignment will implement a function to transfer the dose distribution of a photon beam in water to a dose distribution in the patient using radiological depth scaling.

For treatment plan optimization we will discretize the radiation field into beamlets of 5 mm in size. The matlab structure `beamletdose.mat` provides the dose distribution in water of a 5 mm wide photon beam. The fields are:

`dose`: Dose distribution as a two-dimensional array
`voxelsize`: Size of one voxel (0.5 mm)
`x`: Position of the voxels relative to the beam's central axis at $x = 0$
`z`: Position of the voxels in depth direction
`beamletsize`: Size of the photon field (5 mm)
`centralaxis_x`: Voxel index of the central axis in x-direction

Let us consider a voxel in the patient located x mm away from the beam's central axis and at radiological depth z_{rad}. The pencil beam algorithm assumes that the dose at that voxel can be approximated by the dose in water at geometric depth $z = z_{rad}$.

Write a function

`calculate_pencil_beam_dose(angle,latpos,raddepth)`

where the inputs are:

`angle` the angle of the incident beam,
`latpos` the lateral position of the beam's central axis relative to the isocenter (192 cm, 152 cm),
`raddepth` the radiological depth matrix for that beam angle,

and the function should return a dictionary named `pb` (for "pencil beam") with the following keys:

`'angle'` the beam angle,
`'latpos'` the lateral position of the beam's central axis,
`'dose'` the dose distribution of the beam in the patient. It should be a 2D array of the same size as the CT scan.