GEOL 5690 Homework 3 2024
Due 1 March 2024

Let's play a little with solutions for flexure of an elastic plate.

1. The equation below (from the flexure notes) has the deflection as a function of position:

$$w = w_0 e^{-x/\alpha}\left(\cos\frac{x}{\alpha} + \sin\frac{x}{\alpha}\right) \quad (1)$$

Where w_0 is

$$w_0 = \frac{V_0\alpha^3}{8D} \quad (2)$$

Where V_0 is the load at x=0, D is the flexural rigidity and the flexural parameter α is defined as

$$\alpha = \left(\frac{4D}{g(\rho_a - \rho_w)}\right)^{1/4} \quad (3)$$

Where ρ_w is the density of fill to the w=0 level (this can be air, water, or sediment). As we discussed in class, the zero crossings (nodes) are where w=0; the first such node is at $x = 0.75\pi\alpha$.

Please determine the position of the forebulge in this system analytically. It should help to remember that the slope is zero at the forebulge.

For the following problems, assume the lithosphere has a flexural rigidity *D* of 10^{22} Nm and the asthenospheric density is 3200 kg m^{-3}.

2. A load is placed at x=0 and the flexural basin is initially filled with water. Determine the distance to the forebulge from the point load. We'll call this distance X_{water}.
3. In this initial state, the maximum deflection w_0 is 1200m. What then is V_0?
4. Without any change the the flexural rigidity or the magnitude of the point load, the basin is now filled with sediment with a density of 2350 kg m^{-3}. Where is the forebulge? We'll call this distance X_{sed}.
5. Calculate the deflection w at both X_{water} and X_{sed} for both the original water-filled foredeep and then the sediment filled foredeep. Note that w_0 is not constant.
6. From your answer to #5, which location, X_{water} or X_{sed}, will best record the change in foredeep fill, assuming sediments are deposited and preserved only up to the top of the then-current forebulge (yes, we are ignoring any additional subsidence from this extra layer of sediments.) Justify your choice.