HOMEWORK 2

Assigned 09/04/25

Due 09/11/25 on ELC before class.

Combine the gauss function from the lecture notes with the shape functions from Homework 1.

Using gauss quadrature, evaluate the integral below to produce a stiffness matrix. **Use linear shape functions**, assuming that the single element extends from x=0 to x=3 in the global domain. Remember that the shape functions from the previous homework are written with respect to ξ (parent domain), not x (global domain).

$$[K]^e = \int_0^3 [B]^{eT} AE [B]^e dx$$
$$A = 1 + 0.05x^2$$
$$E = 10^5$$

Based on the shape functions selected, the form of the polynomial you are integrating is $\alpha_0 + \alpha_1 x + \alpha_2 x^2$. This should only require two gauss points for exact evaluation.

Remember the following conversions. We can calculate the corresponding value of x for each gauss point ξ_{gp} using shape functions:

$$x(\xi_{gp}) = [N(\xi_{gp})][x]^e$$

This is a necessary step when evaluating the area A as a function of x.

This approach allows us to calculate the Jacobian by taking the derivative of the shape functions with respect to ξ:

$$J = \frac{dx}{d\xi} = \frac{d}{d\xi}\left([N(\xi_{gp})][x]^e\right) = [GN(\xi_{gp})][x]^e$$

Which then allows us to take the derivatives of our shape functions with respect to x:

$$[B(\xi_{gp})]^e = \frac{d}{dx}[N(\xi_{gp})]^e = \frac{d\xi}{dx}\frac{d}{d\xi}[N]^e = \frac{1}{J}[GN(\xi_{gp})]$$