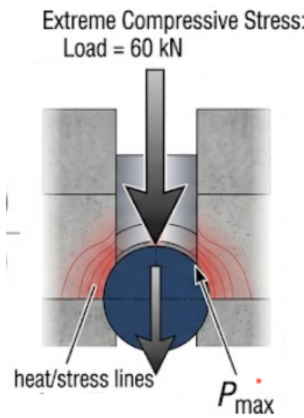
This question contains two mismatched sizing parameters: a bearing diameter given in **inches** (5-in) and a length given in **inches** (4-in), while the operating load is presented in **kiloNewtons** (kN) and the multiple-choice options are listed in **kilopascals** (kPa, which is kN/m^2).

Furthermore, to correctly calculate the stress developed in a sliding contact bearing, one must apply the concept of **projected bearing area** rather than traditional structural cross-sectional areas.

> **"Journal bearings support radial loads... The bearing stress is evaluated using the projected area of the journal, which is the product of the shaft diameter and the bearing length (A=DL)."**



To reconcile the Imperial dimensions with the Metric options, we must precisely convert the inches to meters using the standard conversion factor (1 in = 0.0254 m or 2.54 cm).

<u>Step 1:</u> Unit Conversion and Standardization

To ensure the resulting stress maps directly to kiloPascals (kPa), all geometric dimensions must be uniform in meters (m).

First, transform the journal diameter (D):

$$D = (5in)\left(\frac{0.0254\,m}{1\,in}\right) = 0.127\,m$$

Next, transform the active axial length of the bearing sleeve (L):

$$L = (4in)\left(\frac{0.0254\,m}{1\,in}\right) = 0.1016\,m$$

Step 2: Formulation of the Projected Bearing Area (A_p)

In journal bearing applications, the radial force is distributed across a semi-cylindrical surface. However, for design and stress analysis simplification, fluid-film and mechanical bearing pressures are evaluated against a flat 2D rectangle known as the *projected area*. This represents the shadow or profile area that directly opposes the radial load vector.

Mathematically, this area is expressed as:

$$A_p = DL = (0.127\,m)(0.1016\,m) = 0.0129032\,m^2$$

<u>Step 3:</u> Calculation of Induced Bearing Stress (S_b)

Bearing stress is defined as the crushing or compressive pressure developed at the contact interface between two bodies. It is calculated by dividing the total radial load (F) by the projected area (A_p):

$$S_b = \frac{F}{A_p}$$

$$S_b = \frac{60\,kN}{0.0129032\,m^2} = 4,649.999\,\frac{kN}{m^2} = 4,650\,kPa$$

The bearing has a length-to-diameter ratio (L/D) of 4/5 = 0.8. In rotating machinery design, an L/D ratio between 0.5 and 1.0 is the standard "sweet spot." If a bearing is designed too long (L/D > 2), shaft deflection will pinch the edges. If designed too short (L/D < 0.3), oil leaks out of the sides too quickly, preventing the formation of a sustainable hydrodynamic lift-off wedge.