4.8 A 60 Hz single-phase, two-wire overhead line has solid cylindrical copper conductors with 1.5 cm diameter. The conductors are arranged in a horizontal configuration with 0.5 m spacing.

Calculate in mH/km:
   a) the inductance of each conductor due to internal flux linkages only,
   b) the inductances of each conductor due to both internal and external flux linkages, and
   c) the total inductance of the line.
4.9 Rework Problem 4.8 with the diameters of each conductor:

   a) increased by 20% to 1.8 cm,
   b) decreased by 20% to 1.2 cm, without changing the phase spacing.

   Compare the results with those of Problem 4.8.

   a)
b)
4.10 A 60 Hz three-phase, three-wire overhead line has solid cylindrical conductors arranged in the form of an equalateral triangle with 4 ft conductor spacing. Conductor diameter is 0.5 in.

Calculate:
   a) the positive-sequence inductance in H/m and
   b) the positive-sequence reactance in ohms/km

a)

b)
4.11 Rework Problem 4.10 with the spacing:

   a) increased by 20% to 4.8 ft and  
   b) decreased by 20% to 3.2 ft.

Compare the results with those of Problem 4.10.

   a) 

b)
4.12 Calculate the inductive reactance per mile of a single-phase overhead transmission line operating at 60 Hz, given the conductors to be Partridge and the spacing between centers to be 20 ft.

From Table A.4

Note that Table A.4 gives a conductor diameter of 0.642 in.

\[ e \left( \frac{1}{4} \right) \frac{0.642 \text{ in}}{2} = 0.635 \text{ cm} \]

The corresponding radius does not yield the GMR given in the table. It is a stranded conductor!
4.13 A single-phase overhead transmission line consists of two solid aluminum conductors having a radius of 2.5 cm, with a spacing of 3.6 m between centers.

a) Determine the total line inductance in mH/m.
b) Given the operating frequency of 60 Hz, find the total inductive reactance of the line in ohms/km and in ohms/mi.
c) If the spacing is doubled to 7.2 m, how does the reactance change?
4.15 Calculate the GMR of a stranded conductor consisting of six outer strands surrounding and touching one central strand, all strands having the same radius \( r \).

\[
R := 1
\]
\[
R = 1.000
\]
\[
D := \sqrt{(4R)^2 - (2R)^2}
\]
\[
D = 3.464 \cdot R
\]
\[
M := 7
\]