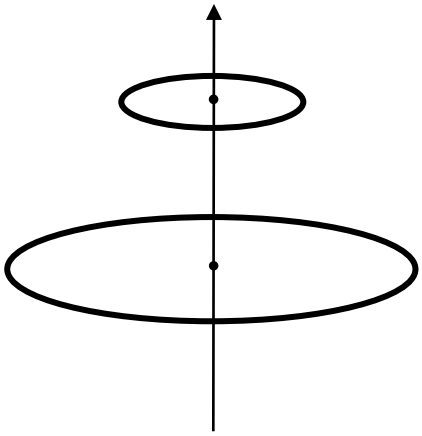
VP9 Mutual Inductance

There are two circular loops, with radii $R = 12$ cm on z = 0 cm plane and $r = 6$ cm on z = Height =10 cm plane. Find the mutual inductance between the two loops by (1) calculating the magnetic flux inside the small loop caused by the current on the large loop and (2) vice versa.



You can do this by your own method (especially by numpy array calculation, that would give the results much faster). If you have no clue, you may try the following steps:

For part (1):

1. Partition the area inside the small loop into *m* ring areas.

2. Assume the large loop has a current 1 A on it. Cut the large loop into *n* pieces, each with length *ds*.

3. Find the magnetic field at position *p* due to the current on each *ds* by Biot-Savart law.

4. Sum the magnetic field caused by the source from over all the *n* pieces *ds* along the large loop to get the total magnetic field at *p.*

5. Multiply the magnetic field with the area of the ring area to get the magnetic flux inside that ring area, and sum over all *m* rings to get the total flux inside the small loop due to the current on the large loop.

6. $M = \dfrac{N_s \phi_{sl}}{i_l} = \phi_{sl}$ for $N_s = 1$, and $i_l = 1\text{A}$

7. You can do similarly for part (2).

8. Check if the result of (1) = the result of (2).