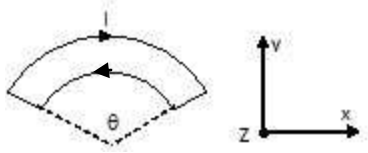
Q- Consider the circuit shown below which is composed of two concentric arcs, with radii R_1 = 1 cm and R_2 = 3.9 cm and connected by two radial arms. Each arc subtends an angle of 55 degrees. A current of 1.7 A flows clockwise in the loop. The loop lies in the x-y plane, and the +z direction is out of the page.



(a) What is the magnitude of the magnetic field at the center due to the arc of radius R_1 = 1 cm?
The magnetic field at the center of a circular ring of radius R carrying a current I is given by the formula

$$B = \frac{\mu_0 I}{2R}$$

The arc is subtending angle 55 degree at the center and hence the magnetic field at the center is reducing accordingly and is given by

$$B_1 = \frac{\mu_0 I}{2R_1} * \frac{55}{360} = \frac{4\pi * 10^{-7} * 1.7}{2 * 0.01} * \frac{55}{360} = 1.63 * 10^{-5}\,\mathrm{T}$$

(b) What is the magnitude of the magnetic field at the center due to a radial segment?

As the direction of current in radial segment is along the line joining the point to the wire the angle θ in Biot-Savart law is 180^0 and hence the field is zero.

(c) Indicate the direction of the magnetic field at the center by each arc.

According to the right hand rule if the extended thumb of the right hand is in the direction of the current than the direction of the magnetic flux (field) is given by the curled fingers of the right hand. Hence the direction of B_1 at the center is into the page, in negative z direction.

As the current in the inner arc is in opposite direction, the field due to it at the center will be in positive z direction.

(d)What is the magnitude and direction of the net magnetic field at the center of the arcs?

The magnetic field at the center due to the inner arc of radius R_2 is given by

$$B_2 = \frac{\mu_0 I}{2R_2} * \frac{55}{360} = \frac{4\pi * 10^{-7} * 1.7}{2 * 0.039} * \frac{55}{360} = 4.18 * 10^{-6}\,\mathrm{T}$$

As the magnitude of field due to the outer and inner wire is in opposite directions and the field due to both radial segments is zero, the net field will be given by

$$B_a = B_1 + B_2 = -1.63 * 10^{-5} + 4.18 * 10^{-6} = 1.212 * 10^{-5}$$

As the magnitude of the field due to inner arc is greater and it is in positive z direction, net field at the center will be in positive z direction i.e. out of the page.