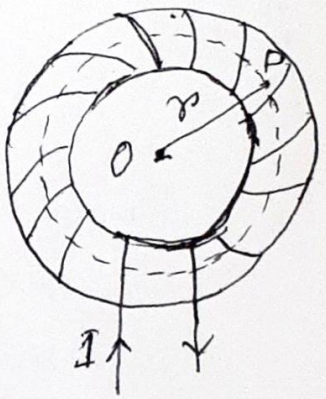
Magnetic field due to Toroid

An endless solenoid in the form of circular shape is called toroid. The magnetic field in such a toroid can be obtained by using Ampere's law.

Let P be a point on the concentric circular path at which magnetic field $\bar{B}$ is to be calculated. By symmetry the field will have equal magnitude at all points of this circle as shown in the figure. Let distance of P from center O is r.



The field is tangential at every point of the circle. Hence,

$$\oint \bar{B}.d\bar{l} = B\int dl = B \times 2\pi r = \mu_0 NI$$

where N is the total number of turns and I is the current through the wire.

$$\therefore \quad B = \frac{\mu_0 NI}{2\pi r}$$

Let $n = \frac{N}{2\pi r}$ is the number of turns per unit length.

$$\therefore \boxed{B = \mu_0 nI}$$