**Department of Physics, Shiv Nadar Institution of Eminence**
**Spring 2025**
**PHY102: Introduction to Physics-II**
**Tutorial – 13**

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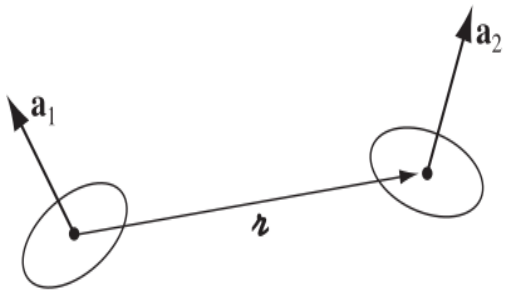
1. Two tiny wire loops, with areas $\mathbf{a_1}$ and $\mathbf{a_2}$, are situated as shown in the figure below.
(a) Find their mutual inductance.
[Hint: Treat them as magnetic dipoles]




(b) Suppose a current of magnitude $I_1$ is flowing in loop 1, and we propose to turn on a current of magnitude $I_2$ in loop 2. How much work must be done, against the mutually induced emf, to maintain the current magnitude $I_1$ flowing in loop 1?

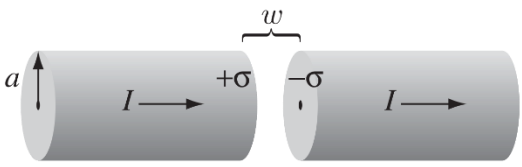
2. A sphere of radius *a* is so magnetized that its magnetization at any inside point (*x*,*y*,*z*) with respect to its Centre as origin is given by

$$\vec{M} = a_1 x^2 \hat{\imath} + (a_2 y^2 + b_2)\hat{\jmath}$$

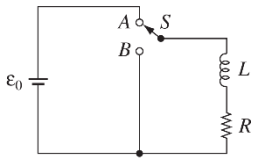
Find the magnetization current densities.

3. Suppose a long cylinder of radius *a* carries a magnetization $\vec{M} = Kr^2\hat{\theta}$, where *K* is a constant, $r$ is the distance from the axis and $\hat{\theta}$ is the usual unit vector in $(r, \theta, z)$ cylindrical coordinate system. Find the magnetic field due to $\vec{M}$ both inside and outside the cylinder.

4. A fat wire, radius a, carries a constant current *I*, uniformly distributed over its cross section. A narrow gap in the wire, of width $w \ll a$, forms a parallel-plate capacitor, as shown in the figure . Find the magnetic field in the gap, at a distance $s < a$ from the axis.




5. Suppose the circuit in the figure has been connected for a long time when suddenly, at time t = 0, switch S is thrown from A to B, bypassing the battery.




(a) What is the current at any subsequent time t?
(b) What is the total energy delivered to the resistor?
(c) Show that this is equal to the energy originally stored in the inductor.