# <u>PHYS306 Homework#5 (Due on 31Mar2022)</u>

**Q#1:** Suppose $V = 0$ and $A = A_o \sin(kx - \omega t)\hat{y}$ , where $A_o$ , $\omega$ , and $k$ are constants. Find $\vec{E}$ and $\vec{B}$, and check that they satisfy Maxwell's equations in vacuum. What condition must you impose on $\omega$ and $k$.

**Q#2:** A piece of wire bent into a loop, as shown in Fig.1, carries a current that increases linearly with time:

$$I(t) = kt$$

Calculate the retarded vector potential $\vec{A}$ at the center. Find the electric field at the center. Why does this (neutral) wire produce an electric field? Why can't you determine magnetic field from this expression of $\vec{A}$?

**Q#3:**

(a) Find the scalar and vector potentials of a point charge moving with a constant velocity $\vec{v}$ and check if these potentials satisfy Lorents gauge condition.
(b) Find the electric and magnetic fields of a point charge moving with a constant velocity and sketch them.

**Q#4:** A particle of charge q moves in a circle of radius a at constant angular velocity $\omega$ (assume that the circle lies in the xy-plane, centered at the origin, and at time t=0 the charge is at (a,0) on the positive x-axis. Find the Liénard-Wiechert potentials for point on the z-axis.

(a) Suppose some charge is glued on a plastic ring of radius $a$, so that the line charge density is $\lambda_o|\sin(\theta/2)|$. Then the ring was set to spin about its axis at an angular velocity $\omega$. Find the scalar and vector potentials at the center of the ring.

**Q#5:** A particle of charge q1 is held at rest at the origin and another particle of charge q2 approaches along the x-axis in hyperbolic motion:

$$x(t) = \sqrt{b^2 + (ct)^2}$$

It reaches the closest point b at time t=0, and then returns out to infinity.

(a) What is the force $F_2$ on $q_2$ due to $q_1$ at time t?
(b) What total impulse is delivered by $q_2$ to $q_1$?
(c) What is the force $F_1$ on $q_1$ due to $q_2$ at time t?
(d) What total impulse is delivered to $q_1$ by $q_2$?

**Q#6:** A particle of charge q is travelling at constant speed v along the x-axis. Calculate the total power passing through the plane $x = a$ , at the moment the particle itself is at the origin.