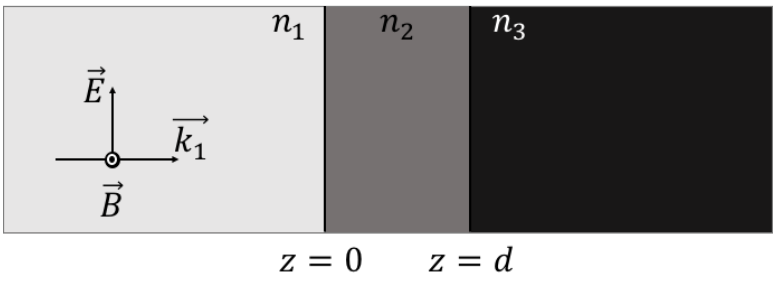
BIRZEIT UNIVERSITY
Faculty of Science كلية العلوم
Department of Physics دائرة الفيزياء

Phys332/midterm exam
Due on Saturday 28/11/2020 at 10:00 am

1. (20%) Find self-inductance per unit length of two straight parallel wires of the radii R_1 and R_2 with the distance $d > (R_1 + R_2)$ between their axes. The current I passing through the wires is oppositely directed.

2. If the electric field component of two electromagnetic waves is given by (i) $\vec{E} = E_0 e^{i(kz-\omega t)}\hat{x} + E_1 e^{i(kz-\omega t+\phi)}\hat{x}$ and (ii) $\vec{E} = E_0 e^{i(kz-\omega t)}\hat{x} + E_1 e^{i(kz-\omega t+\phi)}\hat{y}$.
   a. (8%) Find the magnetic field component of each wave.
   b. (8%) Calculate the Poynting vector for each electromagnetic wave.
   c. (8%) Calculate the Maxwell stress tensor for each electromagnetic wave.
   d. (8%) Calculate the average momentum density for each electromagnetic wave.

3. An electromagnetic plane wave is incident perpendicular to a layered interface as shown in the figure below. The indices of refraction of the three media is $n_1 = i_2, n_2 = 0.1(10i_1 + i_2)$ and $n_3 = 0.1(20i_1 + i_7)$, while the permeability of all three regions is μ_0. The thickness of the intermediate layer is d. Each of the other media is semi-infinite. i_1, i_2 *and* i_7 are obtained from your student id number: e.g. If ID #: 1101534, then $i_1 = 1, i_2 = 1, i_3 = 0, i_4 = 1, i_5 = 5, i_6 = 3$ *and* $i_7 = 4$.



   a. (20%) Compute $\left(\frac{E_{0T}}{E_{0I}}\right)^2$, the ratio between the incident electric field in medium 1 and the transmitted electric field in medium 3.
   b. (8%) For which value of d, $\left(\frac{E_{0T}}{E_{0I}}\right)^2$ is the smallest.

4. A constant current I is maintained within a circular wire of radius a that fixed in the xy-plane and centered at the origin. Another circular wire of radius b and resistance R is centered on and is normal to the z axis is moved by an applied force along the z-axis at constant velocity v such that its center is located at $z = vt$. Assuming $b << a$,
    a. (10%) estimate the current in the moving wire as function of time.
    b. (10%) estimate the force required to keep the ring moving at constant velocity as function of time.