July 21st 2023 European Summer Programm First name :

Last name :

Physics II (part 2)
Final exam

Without formula sheet
Calculator allowed

Useful or not that useful formula, maybe some formula are missing… :
$\frac{1}{p}+\frac{1}{i}=\frac{1}{f}$; $S=\frac{E\times B}{\mu_0}$; $I_{avg}=\frac{E_{max}^2}{2c\mu_0}$; $I_\theta = I_m cos^2\left(\frac{d\pi}{\lambda}sin\theta\right)\text{sinc}^2\left(\frac{a\pi}{\lambda}sin\theta\right)$; $\text{sinc}\,(x)=\frac{\sin x}{x}$

Constant values : $\mu_0 = 4\pi\times10^{-7}\,H/m$; $\epsilon_0 = 8.85\times10^{-12}F/m$ and $c = 3\times10^8\,m.s^{-1}$

I) Warm up /4pts

1) In a transformer electric power power is transferred from primary winding to secondary winding
   A – By electric flux B- By magnetic flux
   C – Through conductive medium D- none of the above
   Only one answer

2) In a step up-up transformer, the value of current in the secondary coil in comparison to primary coil is
   A – Equal B- More
   C – Less D- There is no relation
   Only one answer

3) What capacitance is needed in series with an 800μH inductor to form a circuit that radiates a wavelength of 196 m?

4) The wavelength of light from sodium source in vacuum is 5893Å.What are its (a) wavelength, (b) speed and (c) frequency when this light travels in water which has a refractive index of 1.33.

5) Schematically illustrate the intensity as a function of θ in a double-slit experiment. Provide commentary on the shape of the intensity profile.

II) Chapter 31 – EM oscillations and alternating current /5pts

A 240 V peak amplitude, 50 Hz AC supply is applied on a coil of 0.08 H inductance and 100 Ω resistance connected in series with a capacitor of 20 μF.

1) Draw a scheme of this circuit.
2) Calculate the impedance of the circuit.
3) Deduce the circuit maximum current.
4) Determine the phase angle between voltage and current.
5) Is current leading or lagging the voltage? Draw a phasor diagram to represent (approximately) the current and voltages across the different components as phasors.
6) What should be the change in capacitance, so that circuit is at resonance?

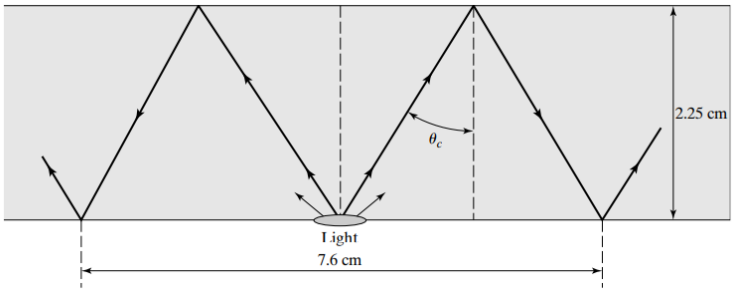
III) Chapter 33 – Electromagnetics waves /3pts

Suppose the maximum safe intensity of microwaves for human exposure is taken to be 1.00W/m².

1) If a radar unit leaks 10.0 W of microwaves uniformly in all directions, how far away must you be to be exposed to an intensity considered to be safe? Assume that the power spreads uniformly over the area of a sphere with no complications from absorption or reflection.
2) What is the maximum electric field strength at the safe intensity?

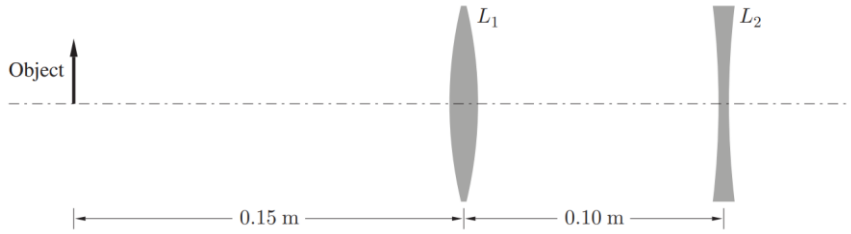
IV) Chapter 34 – Geometrical optics /5pts

A) A small source of light at the bottom face of a rectangular glass slab 2.25 cm thick is viewed from above. Rays of light totally internally reflected at the top surface outline a circle of 7.60 cm in diameter on the bottom surface.



Determine the refractive index of the glass.

B) An optical system consists of a biconvex lens (called L_1) of focal length $f_1 = 0.10\,m$ and a biconcave lens (called L_2) of focal length $f_2 = -0.20\,m$. The distance between the two lenses is $s = 0.10\,m$. An object in front of L_1 is at distance $p_1 = 0.15m$ away from it (sketch below).



1) In order to determine the image formed by these two lenses, we initially calculate the position of the image i_1 of the given object at p_1, considering only the lens L_1 and without taking into account the presence of L_2. Is this image real/virtual? Smaller/bigger than the object? Verify your calculation with a schematic drawing (without considering L_2).
2) Next, we can take into account the biconcave lens L_2 and utilize the first image formed by L_1 as an object located at position $p_2 = i_1 - s$ with respect to L_2, in order to determine the position of the second image i_2 formed by L_2, while disregarding the presence of L_1. Is the final image real or virtual, smaller or bigger than the original object? Verify your calculation with a schematic drawing.

Tips: You can make one or two different schematic drawings for clarity

V) Chapter 35-36 – Diffraction and interferences /3pts

Visible light of wavelength 550 nm falls on a single slit and produces its second diffraction minimum at an angle of 45.0° relative to the incident direction of the light. When the path length difference between two rays is equal to mλ, dark fringes can be observed.

1) In this experiment, are these minima and maxima related to interference or diffraction phenomenon? Justify
2) In your own words, describe how minima and maxima of intensity are produced when two waves originating from each edge of a slit reach point P on a screen.
3) What is the relationship between the width of the slit (a), the angle (θ) formed by point P on the screen and the slit, the integer (m), and the wavelength (λ) to explain the occurrence of dark fringes?
4) What is the width of the slit?
5) At what angle is the first minimum produced?