Electromagnetism and Light **Name :** _____ [4*pts*]

Practice Exam 3

1) A tube with square cross-sectional area 0.20 $(\text{mm})^2$ carries a plane polarized electromagnetic wave. The wave travels in the positive x-direction. The electric component is polarized in the z-direction. The magnitude of the magnetic component is $\sqrt{\frac{4\pi}{3}}$ Tesla. The frequency of the wave is 25 kHz. [4 pts each]

a) Find E_{max}, B_{max}, S_{max}, λ, k, and ω.

b) Write out functions for $\overrightarrow{E}, \overrightarrow{B}$ and $\overrightarrow{S}$.

c) Determine the power of the light delivered by the tube.

d) Describe a way to generate the above wave using a capacitor.

e) Determine an LC circuit which would oscillate at the same frequency of said wave.

2) An infinite wire carries a current of 40 A. 20cm away a $0.10\text{cm} \times 0.10\text{cm}$ square loop has a resistance of 2.0 Ohms. The edge of the loop is parallel to the infinite wire. [5 pts each]

a) Determine the magnetic flux through the wire at the distance of 20cm.

b) Approximate the time in which to move the loop 1.0 cm away from the wire as to generate an EMF of 20 Volts.

c) Determine the current this would create in the loop.

d) Approximate the net force on the loop midway through this displacement.

3) A laser beam is incident on diffraction grating with 400 lines per millimeter. 75 cm away the diffraction pattern shows on a screen. The distance between the n=1 and n=2 diffraction peak is 4.0 centimeters. [5 pts each]

a) Determine the wavelength of the light.

b) Determine the total number of diffraction peaks on the screen.

c) Determine the angular distance between the two peaks with the (same) highest order.

d) Determine the location of the n=1 peak if the experiment were performed under water.

4) A circular wire has a circumference of 20 cm and a linear resistance of 100 Ohm/meter. The loop is placed in a uniform magnetic field as to maximize the flux. The circumference of the loop then grows at a rate of 1.0 cm/sec. [7 pts each]

a) Find the EMF in the loop as a function of time.

b) Find the current in the loop as a function of time.

c) Describe the magnetic force on the loop as the loop grows.

5) Consider a slab of glass with water on one side and air on the other. [7 pts each]

a) Find the critical angle which would keep light contained in the glass slab.

b) Determine the speed, wavelength and frequency of light that is 400 nm in vaccuum.

c) Determine the angle of incidence on the air side which would have light travel through the glass and into the water at an angle of 15 degrees.