Fayoum University

Faculty of Engineering

1ST Year Elect. Eng. Dept

Physics (Phys. 2) – Final Exam (January,21st 2009)

Allowed Time : 3 hours

Question (1):

- A switch is used to introduce a resistor of (0.052 Ohm) as a series element in an LC-circuit that is undergoing an oscillatory behavior (Fig.(1)) . The values of the inductance and the capacitor are (75 mH) and (16 μF) respectively. If the capacitor is initially charged with an electric charge "Q_0 ". (a) If the switch is in position (1), show that the charge in the Lc-circuit undergoes a simple harmonic oscillation whose maximum amplitude Q_0. (b) If the switch is switched to position (2), How much time passes between t=0, when the resistor is introduced in the circuit, and the moment when the charge amplitude has decreased to one half of its value at t=0. (c) How many oscillations does the circuit undergoes during this time. (d) If the resistor is replaced by one that is 10 times larger, what effect does this have on the number of oscillations?

- Consider the circuit shown in Fig.(2), The emf has an amplitude of V_0=4 volts, and the frequency Ω= 600 Hz, L = 70 μH, and C = 4 μF, and R = 1.0 Ohm. At steady state, find (a) the frequency of the charge oscillations, (b) the charge as a function of time Q(t), (c) the maximum current , and (d) the resonant frequency Ω_{res}

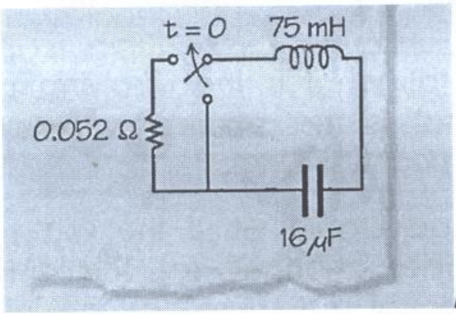

Fig.(1)

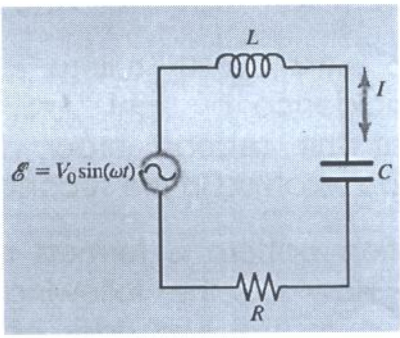

Fig.(2)

Question (2):

- Knowing that the sound intensity I is proportional to r^{-2}, where "r" stands for the distance between the sound source and the listener. (a) show that the difference between sound levels β_1 and β_2 of sound is related to the ratio of distances from sound sources r_1 and r_2 as follows $\beta_2 - \beta_1 = 20\log\left(\frac{r_1}{r_2}\right)$, (b) A loudspeaker is placed between two listeners who are 110.0m apart along the line connecting them. If one listener records a sound level of 60.0dB and the other records sound level of 80.0dB, how far is the speaker from each listener.

- A block with a speaker bolted to it is connected to a spring (K =20 N/m) as if Fig.(3). The total mass of the block and speaker is 5 kg, and the amplitude this unit's motion is 0.5m.(a) If the speaker emits sound waves of frequency 440 Hz, determine the highest and lowest frequencies heard by the person on the right of the speaker.

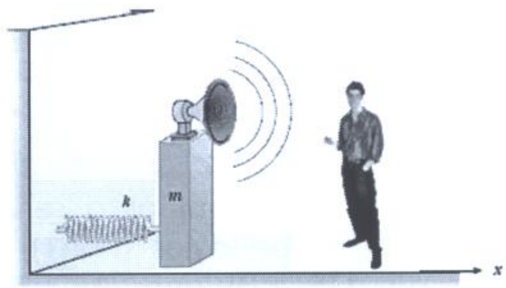

Fig.(3)

Question (3):

- A penny lies at the bottom of a pool filled with water, with depth "d" and index of refraction "n". S how that light rays are close to the normal appear to come from point that is a distance "D=d/n" below the water surface.

- Two thin flakes of mica whose thicknesses (2 μm, 2.44 μm), are used to cover the slits of the double-slit Young's experiment. The central point on the screen is then occupied by the first (m=1) bright fringe. If the wavelength (λ = 550 nm), what is the index of refraction of mica.

Question (4):

- An object 60cm away from and on the optical axis of a concave spherical mirror, produces an image 20cm away from the mirror. If the object is moved 35cm from the mirror, where will the image move?

- A grating with $2.0*10^4$ rulings spaced uniformly over 3.0cm is illuminated at normal incidence by light (λ=530nm). (a) What is the resolving power of the grating at the second order, (b) What is the smallest wavelength interval that can be resolved in the second order near λ=530nm.

- A diffraction pattern is formed by an adjustable slit. If the width of the slit is doubled. How do the following quantities change? (a) The distance of the first minima on the two sides of the central maximum, (b) the intensity of the central maximum.

Question (5):

- Ordinary light incident on one Polaroid sheet falls on a second Polaroid whose plane of polarization makes an angle of 30° with that of the first Polaroid. What the fraction of the original light transmitted through both sheets?. If the second Polaroid is rotated until the transmitted light is 10% of the incident one, what is the new angle?

- Given that the radii of two bright Newton's rings (2 mm, 2.4mm). If the successive order is not known, while there exist three dark rings between them. If the light wavelength is 700 nm, what is the radius of curvature "R"?.

GOOD LUCK, Dr. Maged Kassab

Fayoum University

Faculty of Engineering

1ST Year Elect. Eng. Dept

فيزيقا (الإجابة النموذجية)

Physics (Phys. 2) – Final Exam (January,21st 2009)- MODEL ANSWERS

Fayoum University

Question (1):

(1.1) (a) $L\frac{d^2q}{dt^2}+\frac{q}{C}=0, \Rightarrow q^{00}+\omega^2 q=0$ (SHM) with $\omega=\frac{1}{\sqrt{LC}}$ = 912.87 rad/s

(3) $q=A\sin(\omega t+\Phi)$ but at $t=0$, $q=Q_0$ and $i=0 \Rightarrow A=Q_0$ and $\Phi=\frac{\pi}{4}$

(2) (b) $RLC-circuit \Rightarrow \gamma=\frac{R}{2L}=\frac{0.052}{2*75*10^{-3}}=0.346\ rad/s$

$q(t)=Q_0\exp(-\gamma t)\sin(\omega_1 t+\Phi) \Rightarrow \frac{Q_0}{2}=Q_0\exp(-\gamma t) \Rightarrow t=2.0\ s)$

(2) (c) $\omega_1=\sqrt{\omega^2-\gamma^2}\cong\omega=912.87\ rad/s \Rightarrow T=\frac{2\pi}{\omega_1}=6.88*10^{-3}s$

$no.\ of\ oscillations=\frac{2}{T}=291\ cycle$

(1) (d) $R\to 10R \Rightarrow \gamma\to 10\gamma=3.46 rad/s \Rightarrow \omega_1=912.79 \Rightarrow T=6.88\times 10^{-3}s$

no change will happen

(1.2) (a) frequency =600 Hz
(1)

(3) (b) $Q(t)=Q_0\sin(\Omega t+\Phi)$ where $Q_0=\frac{V_0}{L\sqrt{(\omega^2-\Omega^2)^2+4\Omega^2\gamma^2}}$, $\omega=\frac{1}{\sqrt{LC}}=5.9761*10^4$

$\gamma=\frac{R}{2L}=7142.85\ rad/s$

(2) (c) $i(t)=\frac{dq}{dt}=Q_0\omega\cos(\omega t+\Phi)$

$i_{max}=\frac{\omega V_0}{L\sqrt{(\omega^2-\Omega^2)^2+4\Omega^2\gamma^2}}=0.956\ A$

(1) (d) $\Omega_{res}=\sqrt{\omega^2-2\gamma^2}=5.89\times 10^4$

Question (2):

(2.1) (a) $\beta_2-\beta_1=10\log\left(\frac{I_2}{I_0}\right)-10\log\left(\frac{I_1}{I_0}\right)=10\log\left(\frac{I_2}{I_1}\right)=20\log\left(\frac{r_1}{r_2}\right)$
(4)

(5) (b) $80-60=20\log\left(\frac{r_1}{110-r_1}\right), \Rightarrow \frac{r_1}{110-r_1}=10 \Rightarrow r_1=100m,\ r_2=10m$

(2.2) $\omega=\sqrt{\frac{k}{m}}=\sqrt{\frac{20}{5}}=2\ rad/s$ then $u_{max}=\omega A=2*0.5=1.0m/s$

$$f_0 = f_s * \frac{v}{v-u}, \quad \Rightarrow \quad f_{0,\max}(at\ u = u_{\max}) = 441.29\ Hz \quad f_{0,\min}(u = -u_{\max}) = 438.71 Hz$$
(3) (2) (2)

Question (3):

$$n_1 * \sin(\theta_1) = n_2 * \sin(\theta_2) \quad where \quad n_1 = n \quad and \quad n_2 = 1.0$$

(3.1) $for\ near\ normal \Rightarrow \quad \sin(\theta_1) \approx \tan(\theta_1) = \frac{L}{d}, \quad and \quad \sin(\theta_2) = \frac{L}{D}$ (8)

$$\therefore n * \frac{L}{d} = \frac{L}{D} \quad \Rightarrow \quad D = \frac{d}{n}$$

(3.2) $(n-1)(t_2 - t_1) = m\lambda, \quad where \quad m = 1, \quad t_1 = 2\mu m, \quad t_2 = 2.44\mu m, \quad \lambda = 550nm$

$\therefore n = 2.25$ (7)

Question (4):

$$\frac{1}{d_0} + \frac{1}{d_i} = \frac{1}{f}, \quad \Rightarrow \quad \frac{1}{f} = \frac{1}{60} + \frac{1}{20} \quad \Rightarrow f = 15cm$$ (3)

(4.1) $if \quad d_0 = 95 \Rightarrow \quad \therefore d_i = 17.815cm$ (2)

$if \quad d_0 = 25 \quad \Rightarrow \quad d_i = 37.5cm$ (2)

(4.2) (a) $R = Nm = 2 * 2 * 10^4 = 4 * 10^4$ (2)

(b) $\Delta\lambda = \frac{\lambda}{R} = \frac{530}{4 * 10^4} = 0.01325\ nm$ (2)

(4.3) (a) $dis\tan ce = y = \frac{\lambda D}{a} \quad if \quad a \Rightarrow 2a \quad then \quad y \Rightarrow \frac{y}{2}$ (2)

(b) I_0 *does not change* (2)

Question (5):

(5.1) **(a)** $\frac{I}{I_0} = \frac{\cos^2(30^0)}{2} = \frac{3}{8}$ (4)

(b) $\frac{I}{I_0} = \frac{1}{10} = \frac{\cos^2(\theta)}{2}, \quad \Rightarrow \theta = 63.435^0$ (4)

(5.2) $\frac{r_m^2}{R} = \left(m + \frac{1}{2}\right)\lambda, \quad \frac{r_{m+3}^2}{R} = \left(m + 3 + \frac{1}{2}\right)\lambda \quad \Rightarrow R = \frac{r_{m+3}^2 - r_m^2}{3\lambda} = 0.83\ m$ (7)