Fayoum University – Faculty of Engineering
1st Year Dept. of Civil Engineering
Oscillations & Optics – PHYS102
First Semester Final Exam 2016/2017
Date: January, 10th 2017
Allowed Time: 3 hours  Total Score:60 points

B

**تعليمات الإمتحان:

عزيزي الطالب يرجى مراعاة الأتي عند الإجابة على الأسئلة الموضوعية في ورقة الإجابة الإلكترونية:

1. تظليل الدائرة الدالة على الإجابة الصحيحة في ورقة الإجابة الإلكترونية، بحيث يكون تظليل الإجابة في مركز الدائرة هكذا: (A) (B) (C) (D)
2. لايعتد بالإجابة عند اختيار إجابتين أو أكثر مالم يطلب منك غير ذلك.
3. ممنوع استخدام الكريكتور أو المزيل.
4. تكتب البيانات بالقلم الحبر الجاف في المكان المخصص الموجود اسفل الورقة.
5. يستخدم القلم الرصاص الثقيل في التظليل او استخدام القلم الجاف بعد التأكد من الإجابة الصحيحة.
6. ممنوع الكتابة أو الرسم علي ورقة الإجابة الإلكترونية.
7. بعد الإنتهاء من ال\الإمتحان توضع ورقة الإجابة الإلكترونية مع ورقة الأسئلة وتسلم معا للملاحظ.

| Security Code | | | |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 1 | 1 | 1 | 1 |
| 2 | 2 | 2 | 2 |
| 3 | 3 | 3 | 3 |
| 4 | 4 | 4 | 4 |
| 5 | 5 | 5 | 5 |
| 6 | 6 | 6 | 6 |
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| 8 | 8 | 8 | 8 |
| 9 | 9 | 9 | 9 |

**Solutions**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | A | **B** | C | D | 16 | A | B | C | **D** |
| 2 | A | **B** | C | D | 17 | A | B | C | **D** |
| 3 | A | B | **C** | D | 18 | **A** | B | C | D |
| 4 | A | B | C | **D** | 19 | **A** | B | C | D |
| 5 | A | B | **C** | D | 20 | A | B | **C** | D |
| 6 | **A** | B | C | D | 21 | A | B | **C** | D |
| 7 | A | **B** | C | D | 22 | A | **B** | C | D |
| 8 | A | B | **C** | D | 23 | A | B | **C** | D |
| 9 | A | B | **C** | D | 24 | A | B | **C** | D |
| 10 | A | B | C | **D** | 25 | **A** | B | C | D |
| 11 | A | B | **C** | D | 26 | A | B | C | **D** |
| 12 | A | B | **C** | D | 27 | A | **B** | C | D |
| 13 | **A** | B | C | D | 28 | A | B | C | **D** |
| 14 | A | B | **C** | D | 29 | A | B | **C** | D |
| 15 | A | B | **C** | D | 30 | A | B | **C** | D |

Name
Department
Course name
Academic Year: 2016-2017
Semester: First Semester
رقم الجلوس Seat number
Security Code

| Q. | answer | | | | Q. | answer |
|---|---|---|---|---|---|---|
| 1 | B | | | | 16 | D |
| 2 | B | | | | 17 | D |
| 3 | C | | | | 18 | A |
| 4 | D | | | | 19 | A |
| 5 | C | | | | 20 | C |
| 6 | A | | | | 21 | C |
| 7 | B | | | | 22 | B |
| 8 | C | | | | 23 | C |
| 9 | C | | | | 24 | C |
| 10 | D | | | | 25 | A |
| 11 | C | | | | 26 | D |
| 12 | C | | | | 27 | B |
| 13 | A | | | | 28 | D |
| 14 | C | | | | 29 | C |
| 15 | C | | | | 30 | C |

**QUESTION (2): (12 Points)**

**A block of mass m = 2 kg attached to a damped spring with k = 8 N .$m^{-1}$, and damping constant b = 8 kg. $s^{-1}$ is resting in equilibrium at time t = 0, when it receives an impulse that gives it an initial velocity of -3 m/s.**

**(a) Which kind of damping describes the subsequent motion of the block? Explain your answer. (2 Points)**

$$\omega_0 = \sqrt{\frac{k}{m}} = 2rad/s \quad , \beta = \frac{b}{2m} = 2\ s^{-1} \quad \Rightarrow \because \omega_0 = \beta \quad \Rightarrow \quad critical\ damping$$

**(b) Use the information given to determine the values of all constants in the appropriate x(t) equation, and thus specify the displacement of the block as functions of time. (6 points)**

$x(t) = (A + Bt)e^{-\beta t}$, *where* $A = x_0$, $B = v_0 + \beta x_0$

$x_0 = 0m$, *and* $v_0 = -3m/s \quad \Rightarrow \quad A = 0\ , B = -3 \quad \Rightarrow \therefore x(t) = -3te^{-2t}$

**(c) Find the time at which the block is farthest from its equilibrium position, and determine the displacement at this time. (4 points)**

$$\frac{dx}{dt} = (-3 + 6t)e^{-2t} = 0 \quad \Rightarrow \quad t = 0.5s \quad \Rightarrow \quad x(0.5) = -3(0.5)e^{-2(0.5)} = -0.55m$$

**QUESTION (3): (15 Points)**

**(3-1) A string of length L and total mass M is under a tension F. One end of it is fixed in place at x = 0, while the other end is free to move up and down at x = L.**

**(3-1a)** ***Starting from the standard form of*** $y(x,t) = 2A\sin(kx)\cos(\omega t)$***, for a harmonic standing wave, derive the wavelengths of the normal modes on this string:*** $\lambda_n = 4L/n$***. State clearly what values of n are allowed. [Hint: x = 0 is a node, i.e., y=0, but x = L is an antinode, i.e., y =±2A.] Obtain the normal-mode frequencies*** $f_n$ ***in terms of L, M, F, and n , and write the full wave functions in these terms. Sketch the first two allowed harmonics, indicating the positions of all nodes and antinodes. (6 Points)***

$$at \quad x = L \Rightarrow \quad \sin(kL) = \pm 1 \quad \Rightarrow \therefore \quad kL = \frac{2\pi}{\lambda_m} L = \frac{m\pi}{2} \ldots\ldots\ldots\ldots (m = \pm 1, \pm 3, \pm 5, \ldots.) \Rightarrow \quad \lambda_m = \frac{4L}{m}$$

$$f_m = \frac{v}{\lambda_m} = m\frac{\sqrt{F \cdot L / M}}{4L} = mf_1$$

$$y_m(t) = 2A\sin\left(\frac{m\pi}{2L}x\right)\cos\left(\frac{m\pi\sqrt{FL/M}}{2L}t\right)$$

**(3-1b)** ***With L = 2 m and M = 8 g, the string supports the standing wave, y(x, t) = 0.03 sin(3.25π x) cos(162.5π t), for x and y measured in metres and t in seconds. Find (i) the value of n for this particular harmonic ; (ii) the tension in the string. (6 points)***

$$3.25\pi = \frac{m\pi}{2L} \Rightarrow m = 2 * 3.25 * L = 2 * 3.25 * 2 = 13$$

$$162.5\pi = \frac{m\pi\sqrt{FL/M}}{2L} \quad \Rightarrow F = \frac{M}{L}\left(\frac{2L * 162.5}{m}\right)^2 = 10000\ N \times 10^{-3} = 10\ N$$

***(3-2) A siren radiates sound energy uniformly in all directions. When you stand a distance 100 m away from the siren you hear a sound level of 90 dB. If you move to a distance of 10 m from the siren, the sound level is given by .....(3 points)***

$$\beta_2 - \beta_1 = 20\log\left(\frac{r_1}{r_2}\right) \quad \Rightarrow \quad \beta_2 - 90 = 20\log\left(\frac{100}{10}\right) = 20 \quad \Rightarrow \quad \beta_2 = 110db$$

**QUESTION (4): (8 Points)**

***Monochromatic light illuminates two slits separated by 1.2 mm, creating a fringe pattern on a screen 3.6 m from the slits. The distance between the third and sixth dark fringes on the screen is 5.3 mm.***

***(a) What is the wavelength of the light? .....[5 points]***

$$y_6 - y_3 = 3\frac{L\lambda}{d} \quad \Rightarrow \quad \lambda = \frac{d \cdot \Delta y}{3L} = \frac{1.2 * 10^{-3} * 5.3 * 10^{-3}}{3 * 3.6} = 5.89 * 10^{-7}\ m$$

***(b) The width of each slit in part (a) is a = 0.15 mm. What is the width of the central diffraction maximum on the screen, and how many bright fringes (i.e., interference maxima) are contained within it?***

$$width = \frac{2L\lambda}{a} = \frac{2*3.6*5.89*10^{-7}}{0.15*10^{-3}} = 0.028m \quad \Rightarrow \quad N = 2\frac{d}{a} - 1 = 15 \quad bright\ fringes$$

***Good Luck***

***Dr. Maged M. Kassab***

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