UNIVERSITI SAINS MALAYSIA

Second Semester Examination
Academic Session 2006/2007

April 2007

**ZCT 103/3 - Physics III (Vibrations, Waves and Optics)**
***[Fizik III (Getaran, Gelombang dan Optik]***

Duration: 3 hours
*[Masa : 3 jam]*

Please ensure that this examination paper contains **SIX** printed pages before you begin the examination.

*[Sila pastikan bahawa kertas peperiksaan ini mengandungi **ENAM** muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]*

**Instruction**: Answer any **FOUR** questions. Students are allowed to answer all questions in Bahasa Malaysia or in English.

*[**Arahan**: Jawab mana-mana **EMPAT** soalan. Pelajar dibenarkan menjawab semua soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.]*

1. (a) A spring is mounted horizontally, with its left end held stationary. A force of 6.0 N toward the right causes a displacement of 0.03 m of a 0.5 kg block. After removing the force the block oscillates with simple harmonic motion. Find

*[Suatu spring dipasang secara mengufuk dengan hujung sebelah kirinya dibiarkan pegun. Daya 6.0 N berarah ke kanan menyebabkan berlaku anjakan 0.03 m pada suatu blok 0.5 kg. Selepas daya dihentikan blok berayun dengan gerakan harmonik mudah. Hitung]*

(i) the spring constant (15/100)
*[pemalar spring]*

(ii) the angular frequency and (15/100)
*[frekuensi sudut dan]*

(iii) the period of the oscillation. (15/100)
*[tempoh bagi ayunan.]*

(b) For the similar system as in question (a) but this time we give the block an initial displacement of 0.015 m and an initial velocity of 0.4 m/s to the right. Find

*[Untuk sistem yang sama seperti dalam soalan (a) tetapi di sini kita berikan blok anjakan awal 0.015 m dan halaju awal 0.4 m/s. Hitung]*

(i) the period (15/100)
*[tempoh]*

(ii) the amplitude (15/100)
*[amplitud]*

(iii) the phase angle (15/100)
*[sudut fasa]*

(iv) write equations for the displacement, velocity and acceleration as functions of time.
*[tuliskan persamaan bagi sesaran, halaju dan cepatan sebagai fungsi masa.]*
(10/100)

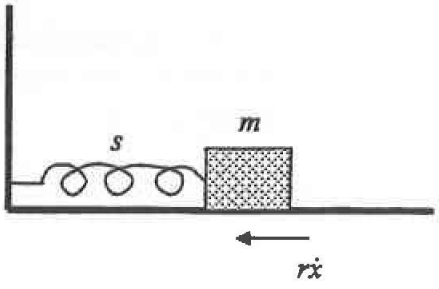



Figure 1 *[Rajah 1]*

2. Figure 1 shows a mass-spring system that oscillates on a horizontal plane. The oscillation of the mass $m$ at one end of the spring (with spring constant $s$) always experience a resistance force $r\dot{x}$ as shown where $r$ is a damping constant.
*[Rajah 1 menunjukkan satu sistem jisim-spring yang berayun pada satah mendatar. Ayunan jisim m pada hujung spring (dengan pemalar spring s) sentiasa mengalami daya rintangan $r\dot{x}$ seperti ditunjukkan di mana r ialah pemalar pelembapan.]*

(a) Show that $x = Ce^{\alpha t}$ is a solution for the equation of motion $m\ddot{x} + r\dot{x} + sx = 0$. Given $C$ and $\alpha$ are constant.
*[Tunjukkan bahawa $x = Ce^{\alpha t}$ merupakan penyelesaian kepada persamaan gerakan $m\ddot{x} + r\dot{x} + sx = 0$. Diberi C dan $\alpha$ ialah pemalar.]*

(55/100)

(b) Name the three cases of solution that can be obtained from (a).
*[Namakan tiga kes penyelesaian yang boleh diperolehi dari (a).]*

(c) Sketch (without using a graph paper) displacement $x$ versus time $t$ for the three cases mentioned in (b).
*[Lakarkan (tanpa menggunakan kertas geraf) sesaran x melawan masa t bagi ketiga-tiga kes yang dinyatakan dalam (b).]*

(30/100)

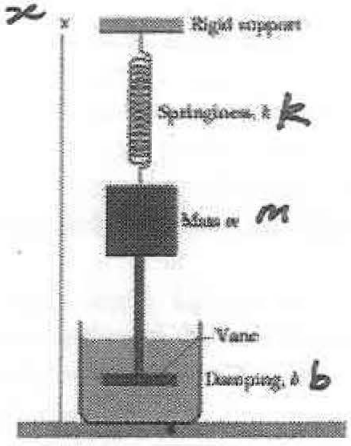
3. (a) For the system shown below, the block has a mass $m$ = 1.5 kg, the spring constant $s$ = 8 N/m and the damping $b$ = 230 g/s. Supposed that the block is initially pulled down a distance $x$ = 12 cm and then released.
*[Bagi sistem yang ditunjukkan di bawah, blok mempunyai jisim m = 1.5 kg, pemalar spring s = 8 N/m dan pelembapan b = 230 g/m. Katakan bahawa blok pada mulanya ditarik ke bawah dengan jarak x = 12 cm dan kemudian dibebaskan.]*

(i) Calculate the time interval required for the amplitude to fall to one-third of its initial amplitude value.
*[Hitung masa yang diperlukan bagi amplitud untuk jatuh kepada satu per tiga daripada nilai asal.]*

(30/100)

(ii) How many cycles would appear during this time interval?
*[Berapakah kitar yang terhasil semasa tempoh ini?]*

(20/100)




(b) A 1000 kg car carrying four people each weighing 62 kg travels over a rough road with corrugations 4.0 m apart, which cause the car to bounce vertically on its spring suspension. The car bounces with maximum amplitude when its speed is 16 km/hr. The car now stops and the four people get out. By how much does the car body rise on its suspension owing to this decrease in mass?
*[Sebuah kereta 1000 kg membawa 4 orang yang setiapnya 62 kg. Kereta tersebut bergerak di atas jalan yang tidak rata dan beralun dengan jarak pisahan 4.0 m yang menyebabkan kereta dilambung secara menegak di atas spring hentakan. Kereta melambung dengan amplitud maksimum semasa bergerak dengan halaju 16 km/j. Sekarang kereta diberhentikan dan 4 orang tersebut keluar. Sebanyak manakah badan kereta akan naik disebabkan berkurangnya jisim?]*

(50/100)

4. (a) A string oscillates according to the equation
*[Suatu tali berayun berdasarkan persamaan ]*

$$y = (0.5\text{ cm})\sin(\pi x/3)\cos(40\pi t)$$

What are
*[Hitung]*

(i) the speed of the two waves (identical except for direction of travel) whose superposition gives this oscillation?
*[laju dua gelombang (yang serupa kecuali arah gerakan) yang bersuperposisi menghasilkan gelombang di atas.]*
(10/100)

(ii) the distance between nodes?
*[jarak antara nod-nod]*
(10/100)

(iii) the speed of a particle of the string at the position x = 1.5 cm when t = 9/8 s? (10/100)
*[laju partikel tali pada kedudukan x = 1.5 cm apabila t = 9/8 s.]*
(10/100)

(b) A pulse moving to the right along the x axis is represented by the wave function
*[Suatu denyutan bergerak ke kanan sepanjang paksi x dan diwakili oleh fungsi gelombang]*

$$y(x,t) = \frac{2}{(x-3t)^2+1}$$

Where $x$ and $y$ are measured in centimeters and $t$ is measured in seconds. Plot the wave function at $t = 0$, $t = 1.0$ s and $t = 2.0$ s
*[Di mana x dan y diukur dalam sentimeter dan t diukur dalam saat. Plot fungsi gelombang pada = 0, t = 1.0 s dan t = 2.0 s.]*
(30/100)

$$y(x,t) = \frac{2}{(x-3t)^2+1}$$

(c) If $y(x, t) = (6\text{ mm})\sin(kx + (600\text{ rad/s})t + \Phi)$ describes a wave traveling along a string, how much time does any given point on the string take to move between displacements $y = +2$ mm and $y = -2$ mm?
*[Jika $y(x, t) = (6\text{ mm})\sin(kx + (600\text{ rad/s})t + \Phi)$ merakamkan suatu gelombang yang merambat di sepanjang suatu tali, hitung masa yang diambil oleh sebarang titik di atas tali untuk bergerak di antara sesaran $y = +2$ mm dan $y = -2$ mm? ]*

(40/100)

5. (a) Discuss briefly how we can measure electromagnetic wavelength using *[Bincangkan dengan ringkas kaedah mengukur gelombang elektromagnet menggunakan]*

(i) Young's double slit
*[Celah dubel Young]*
(ii) Newton's ring
*[Gegelang Newton]*

(30/100)

(b) Explain the basic structure of Michelson interferometer and how it can be used to observed circular and straight fringes.
*[Jelaskan struktur asas interferometer Michelson and bagaimana ia dapat digunakan untuk mencerap pinggir membulat dan pinggir lurus.]*

(30/100)

(c) A diffraction grating is made up of slits of width 300 nm with separation 900 nm. The grating is illuminated by monochromatic plane waves of wavelength $\lambda = 600$ nm at normal incidence.
*[Suatu parutan belauan mempunyai lebar celah 300 mm dan jarak pisahan 900nm.]*

(i) How many maxima are there in the full diffraction pattern? (20/100)
*[Berapakah bilangan maksimum apabila berlaku corak belauan penuh?]*

(ii) What is the angular width of a spectral line observed in the first order if the grating has 1000 slits?
*[Apakah lebar sudut bagi spektral garis yang dicerap pada peringkat pertama jikalau parutan mempunyai 1000 celah?]*

(20/100)

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