UNIVERSITY OF COLOMBO, SRI LANKA

FACULTY OF SCIENCE

FIRST YEAR EXAMINATION IN SCIENCE – SEMESTER II – 2005/2006

PH 1003– WAVES & VIBRATIONS AND CIRCUIT THEORY

(Two Hours)

Answer ALL FOUR questions

Electronic calculators are allowed.

(This question paper consists of 04 questions in 06 pages.)

**Important Instructions to the Candidates**

- If a page or a part of this question paper is not printed, please inform the supervisor immediately.
- Enter Your Index Number on all pages of the answer script.
- MCQ TYPE: In each of these multiple choice questions, encircle the number of the correct response.
- ESSAY TYPE: Write the answers to these questions on writing papers provided.
- Electronic devices capable of storing and retrieving text, including electronic dictionaries and mobile phones are not allowed.
- In this question paper, questions 1, 2 & 3 are essay type questions. Question 4 consists of 15 Multiple Choice Questions.
- At the end of the time allowed for this paper, attach question 4 with the marked responses to your written answers to questions 1, 2 and 3 (answer book) and hand them over to the supervisor or invigilator as one answer script. Please make sure that you handover both English and Sinhala versions of the question 4 to the supervisor or invigilator.
- You are permitted to remove only questions 1, 2 and 3 of the question paper from the examination hall.

1. (a) Derive an expression for the voltage at time $t$, $V(t)$, of a charged capacitor with capacitance $C$ after it is being connected across a resistor, $R$ at time $t = 0$. Assume that the initial charge of the capacitor is $q_o$.

(b) What is the approximate value of current in the circuit in (a) after 05 time constants ?

(c) A resistance of 10 kΩ is used to discharge a 0.47 μF capacitor that is charged to a voltage of 2000 V. How long will it take for the voltage across the capacitor to falls to 100 V ?

(d) Show that $x = A\cos(\omega t + \phi)$ represents simple harmonic motion.

(e) A swing of length 3.0 m is pulled aside and released to go. By assuming a slight damping property of air, the motion of the swing can be represented by $\theta = \theta_o e^{-\gamma t}\cos\omega t$ where $\theta$ is the angular displacement from its equilibrium position. After 25 oscillations, the maximum angular displacement is found to be 1/3 of its original value ($\theta_o$).

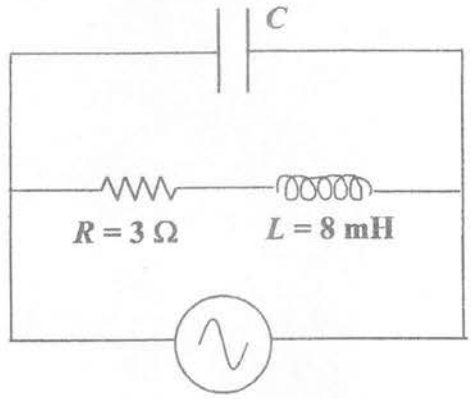
(i) Sketch how the angular displacement $\theta$ varies with time.
(ii) What is the value of $\gamma$ ?
(iii) What is the fraction of angular displacement that the swing will have after 40 oscillations with respect to its initial angular displacement ($\theta_o$) ?

2. (a) Consider two oscillations given below
$x = 20\sin(50t + \pi/3)$
$y = 30\sin(50t + 5\pi/6)$
Write down an expression for the resultant oscillation after the superposition of the above two oscillations took place and sketch the shape of the resultant oscillation.

(b) If $y = 100\sin(60t - 8x)$ represents a progressive wave, show that it can also be represented in the form of $\partial^2 y/\partial x^2 = (1/v^2)\partial^2 y/\partial t^2$ where all the symbols have their standard notation. Find the velocity of this propagation wave.

(c) If the wave given in above (b) meets a wave traveling in the opposite direction given by $y = 100\sin(60t + 8x)$
(i) Write down the equation of the resultant wave form.
(ii) Sketch the shape of the resultant wave showing its highest and lowest amplitudes.
(iii) Comment on the propagation of energy by the types of the wave you have drawn for (ii).

3. (a) Show that the resonant frequency ($f_o$) of the following circuit is given by $f_o = (1/2\pi)[1/LC - R^2/L^2]^{1/2}$




$V = 100 \sin(100\pi t)$

(b) Find the value of capacitance $C$ that will give resonance.

(c) Calculate the following at resonance
   (i) Total current (rms) in the circuit.
   (ii) Branch currents (rms) through $L$ and $C$ in the circuit.

(d) Comment on the magnitude of total current and branch currents found in above (c).

- Question 4 consists of 15 multiple choice questions.
- Encircle the number of the correct response on the question paper itself.
- Please note that there is **only one correct response** to each question.
- Enter your Index Number in all pages.
- **Please hand over both the Sinhala and English versions of the question 4 to the supervisor or invigilator along with the answer script of questions 1,2 & 3.**

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4. (i) What is **false** about simple harmonic motion

(a) Force is proportional to the negative of the displacement from the equilibrium position.
(b) The period of motion is independent of the amplitude.
(c) The amplitude of vibration is constant with time.
(d) The velocity is maximum at the equilibrium position.
(e) The acceleration is minimum at the maximum displacement.

(ii) Resonance of a mechanical vibration may occur when it is subjected to
(a) under damped vibrations.
(b) critically damped vibrations.
(c) over damped vibrations.
(d) forced vibrations.
(e) none of the above..

(iii) The number of beats produced per second by the vibrations, $x_1 = A\ sin(340\pi t)$ and $x_2 = A\ sin(346\pi t)$ is

(a) 2 (b) 3 (c) 4 (d) 5 (e) 6

(iv) Consider the equation $y = 60\ cos2xsin10t$.
This equation represents.
(a) simple harmonic vibration.
(b) longitudinal wave.
(c) transverse progressive wave.
(d) progressive wave.
(e) stationary wave.

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(v) The equation $y = 10\cos^3(4x - 0.8t)$ may represents a

(a) simple harmonic motion.
(b) standing wave.
(c) transverse wave.
(d) forced vibration.
(e) complex periodic wave.

(vi) A star emitting light of wave length 5000 Å is receding from an observer in the line of sight at a speed of $1/100^{th}$ of the speed of light. The wave length of the light observed by the observer is approximately

(a) 4500 Å (b) 4900 Å (c) 5000 Å (d) 5050 Å (e) 5100 Å

(vii) The intensity of a harmonic wave depends on
(a) its amplitude but not on frequency.
(b) its frequency but not on amplitude.
(c) both of its frequency and amplitude.
(d) neither frequency nor amplitude.
(e) only the density of its medium.

(viii) The power of sound coming out from a speaker of a radio is 30 mW. This power is increased up to 600 mW by turning the knob of the volume control of the radio.
The corresponding increase in the sound level is approximately

(a) 10 dB (b) 13 dB (c) 15 dB (d) 18 dB (e) 20 dB.

(ix) When charging a capacitor of 20 μF, it is connected in series with a resistor of 19 Ω and a battery with an emf of 12 V having an internal resistance of 1Ω. The time constant of the circuit is

(a) 0.10 ms (b) 0.20 ms (c) 0.30 ms (d) 0.38 ms (e) 0.40 ms

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(x) The current through an inductor connected across a voltage source

(a) is directly proportional to the frequency of the voltage source.
(b) is inversely proportional to the frequency of the voltage source.
(c) does not depend on the frequency of the voltage source.
(d) increases exponentially with frequency of the voltage source.
(e) decreases exponentially with frequency of the voltage source

(xi) A 10.0 V battery s connected in series with a resistor and an inductance coil. The time constant of the circuit s $2.0 \times 10^{-4}$ s and the steady current after a long time is 1.00 A. The value of the inductance is

(a) 0.5 mH (b) 1.0 mH (c) 2.0 mH (d) 4.0 mH (e) 6.0 mH

(xii) A series LCR circuit having R = 10 Ω, L = 0.1 H and C = 10 μF is at resonance when it is connected across a power supply given by $V = 200\ sin267t$. The rms value of the current in the circuit is approximately

(a) 10 A (b) 14 A (c) 20 A (d) 28 A (e) 40 mA .

(xiii) What is **not** an application of a CR circuit?

(a) An integrating circuit.
(b) A differentiating circuit.
(c) A camera flash bulb circuit.
(d) A blinker circuit.
(e) A radio aerial (antenna) circuit.

(xiv) At the resonance of a parallel LCR circuit

(a) impedance is minimum.
(b) current is maximum.
(c) impedance is real.
(d) impedance is always infinite.
(e) current is always zero.

(xv) A power supply of 100 V (rms), 50 Hz is connected across a variable inductor. What is the value of inductance to keep the peak current ($I_o$) in the circuit below 100 mA ?

(a) 3.18 H (b) 4.50 H (c) 4.49 H (d) 6.36 H (e) 17.82 H.

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