Kafr Elshiekh University
Faculty of Engineering
Department of
Physical and Mathematical Engineering
First Year

Engineering physics (2)

3 - 5 - 2018
3 hours
60 Marks
Final exam: 3 pages

Answer the following questions:

Question(1) : (ILOs: a1,b1) ***(12Marks)***

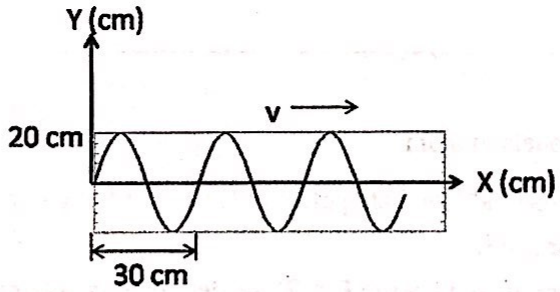
(a) A(0.8 Kg) block is attached to a horizontal spring with constant (k=180 N/m). If the total energy of the system is (E_t=2 j).

Find:
- The angular frequency.
- The amplitude of the motion.

(b) A mass of (2.5 Kg) is attached to a vertical spring that has a spring constant of (600 N/m). The value of the damping constant is (b=70 Kg/s)
- Which type of damping is produced?
- Determine the value of "b" that is required to produce critical damping.

Question(2) : (ILOs: c1) ***(18 Marks)***

(a) A wave travelling in the positive x direction has amplitude of 20 cm, a wavelength of 30 cm and a frequency of 10 Hz (as shown in figure).Write the general expression for the wave function



(b) A sound wave is sent from a ship to the ocean floor, where it is reflected and returned. If the sound trip takes (0.6 s), how deep is the ocean floor?
Consider the bulk modulus for sea water to be ($2.2*10^9$Pa) and its density to be (1030 Kg/m^3)

(c)Light wave is an Electromagnetic wave:
- Sketch an electromagnetic wave.
- What are the electromagnetic wave components?
- Compare between (sound wave) and (light wave).

Question(4) : (ILOs: a2) ***(10Marks)***

(a) Choose the best answer:

1-The de-Brglie wavelength of an electron whose speed is half that of light is: (a)3.6×10^{-12}m. (b) 4.2×10^{-12}m

(c)4.9×10^{-12}m (d) 1.2×10^{-11}m.

2-The units of the Planck constant h are those of: (a) Energy.

(b) Power. (c) Momentum. (d) Angular momentum. (e) Frequency.

3- When light is directed on a metal surface, the energies of the emitted electrons: (a) Vary with the intensity of the light.

(b) Vary with the frequency of the light.

(c) Vary with the speed of the light. (d) Are random.

4- The significance of $|\psi|^2$ is: (a) Probability. (b) Energy.

(c) Probability density. (d) Energy density. (e) Wavelength.

(b) Estimate how many visible light photons a 100-W light bulb emits per second. Assume the bulb has a typical efficiency of about 3% (that is, 97% of the energy goes to heat and the wavelength of visible light within range of 350nm to 650 nm approximately).

(c) Suppose a blackbody has a surface temperature of 3250 K. What color would this body appear?

Question(5) : (ILOs: b2) ***(10 Marks)***

(a) Discuss the different models of atom.

(b) 1- Sketch the one-dimensional "top hat" potential (1) $V = 0$ for $x < 0$; (2) $V = W =$ constant for $0 \leq x \leq L$; (3) $V = 0$ for $x > L$.

2- Consider particles, of mass m and energy $E < W$ incident on this potential barrier from the left ($x < 0$). Including possible reflections from the barrier boundaries, write down general expressions for the wave functions in these regions and the form the time-independent Schrodinger equation takes in each region. What ratio of wave function amplitudes is needed to determine the transmission coefficient?

3- Write down the boundary conditions for Ψ and $d\Psi/dx$ at $x = 0$ and $x = L$.

4- A full algebraic solution for these boundary conditions is time consuming. In the approximation for a tall or wide barrier, the transmission coefficient T is given by

$$T = 16\left(\frac{E}{W}\right)\left(1-\frac{E}{W}\right)e^{-2\alpha L}$$

where

$$\alpha^2 = 2m\left(\frac{W-E}{\hbar^2}\right)$$

Determine T for electrons of energy E = 2 eV, striking a potential of value W = 5 eV and width L = 0.3nm.

5- Describe two examples where quantum mechanical tunneling is observed.

(c) In case of Compton scattering consider the electron initially at rest. Prove that $\Delta\lambda = \lambda' - \lambda = (h/m_e c)(1 - \cos\phi)$

Question(6) : (ILOs: c2) ***(10 Marks)***

(a) Explain briefly the uncertainty principle.

(b) The state of a free particle is described by the following wave function

$\Psi(x) = 0$ for $x < -3a$

$= c\, e^x$ for $-3a < x < a$

$= 0$ for $x > a$

(i) Determine c using the normalization condition

(ii) Find the probability of finding the particle in the interval [0, a]

(c) Discuss the meaning of nanotechnology and two properties of its materials.

Useful data : $q_e = 1.6022 \times 10^{-19}$ C, $c = 3 \times 10^8$ m/s, $m_e = 9.1 \times 10^{-31}$ kg, $h = 6.63 \times 10^{-34}$ J.s, $K_B = 1.38 \times 10^{-23}$J/K, Wien's constant = 2.9 mm . K

$$\gamma = \frac{1}{\sqrt{1 - v^2/c^2}}$$

Assume any missing data

Best Wishes

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