VIT (Vellore Institute of Technology)

Reg. No. : 22BMH1100

Final Assessment Test (FAT) – January/February 2023

Programme	**B.Tech.**	Semester	**Fall Semester 2022-23**
Course Title	**ENGINEERING PHYSICS**	Course Code	**BPHY101L**
Faculty Name	**Prof. Caroline Ponraj**	Slot	**D2+TD2**
		Class Nbr	**CH2022231700409**
Time	**3 Hours**	Max. Marks	**100**

$h = 6.626 \times 10^{-34}$ Js; $e = 1.602 \times 10^{-19}$ C; $m_e = 9.109 \times 10^{-31}$ kg; $k_B = 1.3807 \times 10^{-23}$ J/K; $m_p = 1.67 \times 10^{-27}$ kg; $c = 3 \times 10^{8}$ m/s; $1eV = 1.602 \times 10^{-19}$ J;

Section-A (10 X 10 Marks)

Answer any 10 questions

1. What is a standing wave? Derive the equation for a standing wave in a stretched string. Obtain the frequency of the first two modes with necessary diagrams. **[10]**
2. a. Write down the Maxwell's equations in differential form and explain the significance of each. **[10]**

   b. Find the divergence and curl of the given vector $\overline{f}(x,y,z) = 2xy\hat{i} + 2zy^2\hat{j} + 2zx^3\hat{k}$
3. a. A monochromatic X- ray of wavelength 1.24Å is viewed at an angle of 60° with respect to the direction of incidence. Calculate the Compton shift in terms of wavelength. **[10]**

   b. With suitable experimental proof, show that electrons exhibit wave nature.
4. a. State deBroglie hypothesis. Give any two properties of matter waves. **[10]**

   b. The speed of the bullet (m = 0.060 kg) and the speed of an electron (m = 9.1×10^{-31}kg) are measured to be the same, namely 500 m/s, with an uncertainty of 0.02%. With what fundamental accuracy could we have located the position of each, if the position is measured simultaneously with the speed in the same experiment?
5. Consider a particle of mass *m* confined in a 1D infinite potential box of length *l*. Calculate the energy eigenvalues and the associated normalized wavefunction for the particle. **[10]**
6. a. Define quantum tunneling with appropriate diagrams. Write down the expression for the transmission probability. **[10]**

   b. What is meant by quantum confinement? Based on dimensions, briefly distinguish between any two structures obtained due to the confinement with suitable figures.
7. a. A laser system has three energy levels E_1, E_2 (Metastable) and E_3, at 0eV, 1.4 eV and 2.479 eV respectively. Evaluate the wavelengths of the optical pumping source and emitted laser? Write about the inherent problem of this kind of laser. **[10]**

   b. Write down any four properties of Lasers.
8. a. Consider a cavity of length 'L' bounded with mirrors M_1 and M_2 of reflectivities R_1 and R_2 respectively. Obtain the threshold gain coefficient for laser to emanate from such a structure. **[10]**

   b. If the emitted wavelength and output power of a given laser are 532 nm and 2mW respectively, calculate the number of photons emitted per second.
9. a. Explain the construction and working of a He-Ne laser with suitable energy level diagram. **[10]**

   b. What is population inversion? How do you achieve it?
10. a. Explain the principle of fiber optics communication. **[10]**

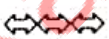
Satyaprakash Swain

b. In an optical fiber, the core and cladding refractive indices are 1.457 and 1.442 respectively. Calculate the (i) critical incident angle, (ii) critical propagation angle, (iii) acceptance angle and (iv) numerical aperture.

11. What is meant by pulse widening? How do you calculate the pulse widening in a step index fiber optic cable? Describe how graded index fiber is used to reduce dispersion in an optical fiber with suitable diagrams. [10]

12. a. Distinguish between (i) direct and indirect band gap semiconductors and (ii) LED and LASER based on their structure and performance for fiber optics application. [10]

b. Show that for a particular semiconductor, responsivity is directly proportional to the quantum efficiency of the photodiode.



Satyaprakash Swain

VIT

Reg. No. : 22BLC1392

Final Assessment Test (FAT) – January/February 2023

Programme	**B.Tech.**	Semester	**Fall Semester 2022-23**
Course Title	**ENGINEERING PHYSICS**	Course Code	**BPHY101L**
Faculty Name	**Prof. Sanjit Das**	Slot	**D1+TD1**
		Class Nbr	**CH2022231700337**
Time	**3 Hours**	Max. Marks	**100**

Physical constants: h = 6.626 x 10^{-34} Js; e = 1.602 x 10^{-19} C; m_e = 9.109 x 10^{-31} kg; k_B =1.3807×10^{-23}J/K; m_p=1.67 x 10^{-27} kg ; c= 3x 10^8 m/s; 1eV= 1.602 x 10^{-19}J;

Section A (10 X 10 Marks)
Answer any 10 questions

1. Using suitable diagram and assumptions, derive an equation for transverse wave motion in a stretched string with constant tension, 'T'. [10]
2. (a) Derive the plane electromagnetic wave (EM) equation for free space in terms of electric field vector using the Maxwell's equation. [10]
   (b) Find the curl and divergence of
   $\vec{A} = 3xyz\hat{i} + +5y\hat{j} + 4z^2\hat{k}$
3. (a) Find the kinetic energy of an electron whose de Broglie wavelength is the same as that of a 80 keV X-ray. [10]
   (b) State Heisenberg's uncertainty principle of space. An electron has a speed of 700 m/s with an accuracy of 0.004%. Calculate the uncertainty in it's location.
4. Derive the Schroedinger's time dependent and time independent equations for a free particle. [10]
5. (a) With suitable figures, b ased on dimensions, distinguish between the structures obtained due to q uantum confinement. [10]
   (b) If a proton confined to a one-dimensional infinitesimal potential box has an energy of approximately 250 keV in its second excited state, calculate the width of the box in picometers?
6. (a) An electron with total energy E strikes a finite potential barrier V (V>E). Interpret this situation classically and quantum mechanically with appropriate diagrams. [10]
   (b) Explain the principle and working of scanning tunnelling microscope including its different modes of operation.
7. (a) Derive the relations between Einstein's A and B coefficients for the fundamental processes involved in laser action . [10]
   (b) If levels 1 and 2 are separated by an energy $E_2 - E_1$, such that the corresponding output wavelength is 629 nm, calculate the ratio of the populations of two levels in the thermal equilibrium at room temperature.
8. (a) What is the temporal coherence length of a (i) sodium vapour lamp emitting in yellow region of the spectrum with a wavelength of 589 nm and emission bandwidth of $\Delta\upsilon$ = 4 x 10^8 Hz. (ii) Compare this with a Green laser of wavelength 532nm with emission width of $\Delta\upsilon$ = 10^6 Hz. [10]
   (b) Calculate the threshold gain coefficient for a He-Ne laser of volume loss of 1 cm^{-1}, tube length of 0.5 m and mirror reflectivities of 100% and 95%.

Satyaprakash Swain

9. What are the different modes of vibrations in a CO_2 molecule? Describe the construction and working of the CO_2 laser with suitable diagrams. [10]

10. (a) Considering light propagation in the optical fiber by total internal reflection, with a suitable diagram, derive the expressions for acceptance angle and numerical aperture. [10]

(b) How are optical fibers classified based on : (i) Number of modes and (ii) Refractive index profile?

11. (a) Discuss in brief the various losses in fiber optic communication. [10]

(b) Calculate the pulse widening caused due to intermodal dispersion in a fiber of length 2m with a core and cladding of refractive indices 1.451 and 1.433 respectively. Critical propagation angle is 9.03 °.

12. (a) Explain the principle & working of p-i-n diode, with suitable diagram. What are its advantages over p-n photodiode? [10]

(b) When 3.5×10^{12} photons generated by a laser source of wavelength 1.06 μm are incident on a photodiode, 1.5×10^{12} electrons on an average are collected at the outer terminal. Calculate the quantum efficiency and the responsitivity of the photodiode at the above wavelength.

Satyaprakash Swain

VIT

Reg. No. : 22BCE1351

Final Assessment Test (FAT) - JUNE/JULY 2023

Programme	**B.Tech.**	Semester	**Winter Semester 2022-23**
Course Title	**ENGINEERING PHYSICS**	Course Code	**BPHY101L**
Faculty Name	**Prof. M C Ramkumar**	Slot	E1+TE1
		Class Nbr	**CH2022232300040**
Time	**3 Hours**	Max. Marks	**100**

Useful constants:

$e = 1.6 \times 10^{-19}$ C; $m_e = 9.1 \times 10^{-31}$ kg; $h = 6.626 \times 10^{-34}$ Js; $k_B = 1.38 \times 10^{-23}$ J/K

Section A (10 X 10 Marks)
Answer any 10 questions

01. Derive the standard equation for wave propagation in a string fixed at one end, with appropriate diagram. [10]

02. (i) Calculate the wavelength of fundamental and the second harmonic for waves formed in a string of length 3 m fixed at both ends. [10]

(ii) A wave is allowed to propagate in a string made of aluminium of diameter 0.95 mm that is connected smoothly to another string of 1 mm diameter. What will happen to the wave as it moves from thinner to thicker region at the interface of different thickness strings? Write down the wave equations corresponding to the phenomena occurring at the interface.

03. (i) Find the curl and divergence of the following function: [10]

$$y = 2\,y\vec{i} + yz^2\vec{j} + x^2z^3\vec{k}$$

(ii) Write down the Maxwell's equations in a medium, explaining the terms therein.

Satyaprakash Swain

04. (i) Write down the formula for Compton shift and explain what happens when an X-ray photon hits a graphite target in Compton experiment. [10]

(ii) If you are given 2 particles each with corresponding masses and velocities ($m_1 = 9.1 \times 10^{-31}$ kg: $v_1 = 1.5 \times 10^5$ m/s and $m_2 = 5$ mg and $v_2 = 10$ m/s), then calculate and compare the significance of their de Broglie wavelengths.

05. Arrive at the energy Eigen values and the wavefunction of a quantum particle confined in a 1-D box of length 'l'. [10]

06. (i) The position and momentum of a 2 keV electron are simultaneously determined. If its position is located to within 0.2 nm, what is the percentage of uncertainty in its momentum? [10]

(ii) Explain briefly the effect of quantum confinement in obtaining different structures.

07. (i) Derive the threshold condition for achieving laser in a cavity. [10]

(ii) Consider a system with 2 energy levels E_1 and E_2 which are separated by energy of 3 eV. Calculate the temperature at which the ratio between the number of atoms in these levels (E_2:E_1) will be 0.003.

08. State different modes of vibration with diagrams in Carbon dioxide molecule? With neat energy level diagram, discuss the principle and working of the Carbon dioxide laser. [10]

09. (i) With neat figures, for a step index fiber, explain the (a) basic principle of fiber optic communication and (b) structure of an optical fiber. [10]

Satyaprakash Swain

(ii) A glass clad fiber is made with core glass of refractive index 1.495 and the cladding is doped to give a fractional index difference of $\Delta = 0.002$. Find the (a) cladding index (b) numerical aperture.

10. (i) Derive the expression for pulse broadening of a light pulse in a step index optical fiber. [10]
(ii) Briefly discuss about intramodal dispersion in an optical fiber.

11. Based on the electrical properties, identify which category of materials are more suitable for acting as optoelectronic devices. Why? Identify the charge carriers present in them. Also write down their types and explain the methods adopted to increase the charge carriers in them. [10]

12. (i) What is the operational difference in utilizing a semiconducting diode as a source and detector? Explain what happens during such process. Write down the significance of intrinsic region in *p-i-n* diode. [10]
(ii) The responsivity of a *p-i-n* photodiode is 0.6 A/W for photons of wavelength 1550 nm while incident at a rate of 2×10^9 s^{-1}. Calculate quantum efficiency of the photodiode.

⇔⇔⇔

Satyaprakash Swain

VIT

Final Assessment Test (FAT) – June 202

Programme	B.Tech	Semester	Winter Semester 2021-22
Course Title	ENGINEERING PHYSICS	Course Code	BPHY101L
Faculty Name	Prof. Navamathavan R	Slot	E2+TE2
Time	3 Hours	Class Nbr	CH2021222300565
		Max. Marks	100

Section A (10 X 10 Marks)
Answer any 10 questions

1. (a) The displacement of a plane progressive wave is represented by the equation: [10]

$f(x,t) = 0.6\sin(50\pi t - 10\pi x/3)$, where x is the distance from a fixed origin O.

Calculate (i) Frequency, (ii) Wavelength, and (iii) Speed of the wave.

(b) Is it possible to write the wave function $f(x,t) = A\cos(kx - \omega t)$ in different forms? If so, arrive at any 2 of the forms.

2. Compute the following: [10]

$div(grad\ f(x,y,z))$ where $f(x,y,z) = (2x^2 + y^2)/(x^2 - y^2)$.

3. (a) An electron with initial kinetic energy 30 eV encounters a square barrier with height 40 eV and width 0.25 nm. What is the probability that the electron will tunnel through the barrier? [10]

(b) A proton with the same kinetic energy encounters the same barrier. What is the probability that the proton will tunnel through the barrier?

4. Discuss the working of scanning tunneling microscopy with principle and schematic diagram. [10]
State and explain Heisenberg uncertainty principle of (i) space, and (ii) energy.

5. Explain the principle and working of He-Ne laser with neat energy level diagram? [10]
Describe the various pumping methods to achieve population inversion.

6. (i) Briefly discuss the dimensionality and applications of the following: [10]

(ii) Calculate the temporal coherence length of a laser emitting at the infrared region of the spectrum a wavelength of 1.08 μm with an emission bandwidth of $\Delta\upsilon = 8 \cdot 10^6$ Hz.

7. What is the principle of fiber optic communication? Using this principle, find out the acceptance angle and numerical aperture of a given fiber. [10]
Discuss the different types of fibers

8. Why are LED bulbs a better choice over incandescent bulbs? What types of applications are LED bulbs best suited for? Explain the reasons with diagram that direct bandgap semiconductors are suitable for the fabrication of LED. [1

Satyaprakash Swain

9. (a) Explain some important applications of fiber optic technology in biomedical and defense related purposes.

(b) In an optical fiber, the core refractive index is 1.40 and cladding refractive index is 1.30. Calculate the following: (i) Critical incident angle, (ii) Critical propagation angle, (iii) Acceptance angel and (iv) The numerical aperture.

10. What are the difference between light emitting diodes and laser diodes? Identify the properties required by the semiconductor to make a good laser diode. With necessary diagrams explain the principle and working of the same.

11. Discuss the various losses in a fiber optic cable. Explain the ways to reduce those losses. What are the differences between intramodal and intermodal dispersion?

12. Explain briefly about the working principle of a light emitting diode. How is p-i-n diode better that p-n diode? Explain the principle and working of such p-i-n diode

Satyaprakash Swain