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[22BSPH03]

# SECOND SEMESTER B.Tech EXAMINATION, JUNE - 2023

## COMPUTATIONAL PHYSICS

**Time: 3 Hours** **Maximum Marks: 100**

**Instructions: I.** Missing data may be suitably assumed.

**II.** Physical constants

- **i.** Mass of the electron $m_e = 9.1 \times 10^{-31} kg$
- **ii.** Mass of proton, neutron $m_n, m_p = 1.67 \times 10^{-27} kg$
- **iii.** Charge of the electron $e = 1.602 \times 10^{-19} C$
- **iv.** Planck's constant $h = 6.626 \times 10^{-34} Js$
- **v.** Velocity of light $c = 3 \times 10^{8} m/s$
- **vi.** Boltzmann's constant $k = 1.38 \times 10^{-23} J/K$
- **vii.** Acceleration due to gravity $g = 9.8\, m/s^2$

**ANSWER ALL QUESTIONS,**

**PART – A**

**5 X 2=10**

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|---|---|---|---|---|---|
| | a. | Give any two characteristics of simple harmonic motion. | L-1 | CO1 | 02 |
| | b. | State Heisenberg's uncertainty principle. | L-1 | CO2 | 02 |
| | c. | Explain the conditions for laser action. | L-2 | CO3 | 02 |
| | d. | Explain the propagation mechanism in an optical fiber. | L-2 | CO4 | 02 |
| | e. | Differentiate between digital and analog signals. | L-1 | CO5 | 02 |
| | | **PART - B** | | | **6 X 5=30** |
| 2. | a. | Derive an expression for effective force constant for two springs connected in series combination. | L-2 | CO1 | 05 |
| | | **OR** | | | |
| | b. | A free particle is executing simple harmonic motion in a straight line. The maximum velocity it attains during any oscillations is 52.8 m/s. Find the linear frequency of the oscillations, its amplitude is 0.4m. | L-3 | CO1 | 05 |
| | | | | | |
| 3. | a. | Compute the first 3 permitted energy values in eV for an electron in a box of width $2 \times 10^{-10} m$. | L-3 | CO2 | 05 |
| | | **OR** | | | |
| | b. | Discuss the properties of wavefunction. | L-2 | CO2 | 05 |
| | | | | | |
| 4. | a. | Discuss the three ways of interaction of radiation with matter. | L-2 | CO3 | 05 |
| | | **OR** | | | |
| | b. | A laser is emitting a laser beam with an average power if 2.5 mW. Find the number of photons emitted per second by the laser. The wavelength of the emitted radiation is 6328Å. | L-3 | CO3 | 05 |
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| 5. | a. | Discuss the application of optical fibers in point to point communication system. | L-2 | CO4 | 05 |
| | | **OR** | | | |

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| | **b.** | Find the attenuation in an optical fiber of length 500 m, when a light of power 100 mW emerges out of the fiber with a power of 95 mW. | L-3 | CO4 | **05** |
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| **6.** | **a.** | Explain NOT, AND, and OR gates with the help of truth table and gate symbol. | L-2 | CO5 | **05** |
| | | **OR** | | | |
| | **b.** | Explain NAND and NOR universal gates and show that they can be used to realize NOT, AND, and OR gates. | L-2 | CO5 | **05** |
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| **7.** | **a.** | A medium in thermal equilibrium at temperature 300K has two energy levels with wavelength separation of $1\mu m$. Find the ratio of population densities of the upper and lower levels. Write the python code for solving this problem. | L-3 | CO6 | **05** |
| | | **OR** | | | |
| | **b.** | The N.A of an optical fiber is 0.2 when surrounded by air. Determine the refractive index of its core given the refractive index of cladding as 1.59. Also find the acceptance angle when it is in a medium of refractive index 1.33. Write the python code to solve this problem. | L-3 | CO6 | **05** |
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| | | **PART - C** | | **6 X 10=60** | |
| **8.** | **a.** | Obtain differential equation for damped oscillations and hence solve to get displacement of damped oscillations. | L-3 | CO1 | **10** |
| | | **OR** | | | |
| | **b.** | Obtain the equations for amplitude and phase of the forced oscillations. | L-3 | CO1 | **10** |
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| **9.** | **a.** | Set up time-independent one-dimensional Schrodinger's wave equation. | L-3 | CO2 | **10** |
| | | **OR** | | | |
| | **b.** | Deduce time-independent Schrodinger's wave equation for a particle in one dimensional potential well of infinite height and discuss the solutions. | L-3 | CO2 | **10** |
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| **10.** | **a.** | Derive an expression for energy density in terms of Einstein coefficient. | L-3 | CO3 | **10** |
| | | **OR** | | | |
| | **b.** | Explain the requisites satisfied by a laser system and Describe the construction and working of CO2 laser using suitable diagrams. | L-3 | CO1 | **10** |
| | | | | | |
| **11.** | **a.** | What is numerical aperture? Derive an expression for numerical aperture in terms of refractive index of core and cladding and hence obtain the condition for propagation. | L-3 | CO4 | **10** |
| | | **OR** | | | |
| | **b.** | Explain the factors contributing to attenuation in an optical fiber. | L-3 | CO4 | **10** |

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| | | Derive an expression for attenuation coefficient of an optical fiber | | | |
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| **12.** | **a.** | Explain the realization of half adder using logic gates. | L-3 | CO5 | **10** |
| | | **OR** | | | |
| | **b.** | Explain the realization of full adder using logic gates. | L-3 | CO5 | **10** |
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| **13.** | **a.** | Describe the experimental approach for the determination of wavelength of given laser source. | L-4 | CO6 | **10** |
| | | **OR** | | | |
| | **b.** | Describe the determination of force constant of a mechanical spring using simulation method. | L-4 | CO6 | **10** |