ADDITIONAL NUMERICAL PROBLEMS IN ENGINEERING PHYSICS

PHOTONICS

1. A laser beam has an average power of 10 mW. If 4.2×10^{16} photons are emitted per second, What is the wavelength of the emitted radiations?
   Ans: 834 nm

2. The ratio of the population of two energy levels in thermal equilibrium is 8.87×10^{-31} at 27°C. Calculate the wavelength of emitted radiation for a transition between them.
   Ans: 694.3 nm

3. Calculate the ratio of,
   a) Einstein's coefficients
   b) Stimulated to spontaneous emissions

   for a system in thermal equilibrium at 300 K in which the radiations of wavelength 1.39 μm are emitted.

   Ans: a) 6.2×10^{-15} b) 10^{-15}

4. The refractive index of the core and cladding of fibre are 1.465 and 1.460, respectively.
   a) If the light of wavelength 1 μm is used, what should be the diameter of the core for single-mode propagation?
   b) If the core diameter is given as 50 μm, how many modes can propagate through the fibre?

   Ans: a) 4.65 μm   b) 115 modes

5. A fibre with an attenuation coefficient of 1.19 dB/km has an input power of 8.6 mW. Calculate output power after 500m.
   Ans: 7.5 mW

QUANTUM MECHANICS

6. The de Broglie wavelength associated with an electron is 0.1 Å. Determine the potential difference by which the electron is accelerated.
   Ans: 15.05 kV

7. Calculate the energy in eV corresponding to a wavelength of 1 Å for
   a) Electron
   b) Neutron
   c) Photon

   Ans: a) 150.7 eV   b) 0.082 eV   c) 12.42 keV

8. The speed of an electron is measured to be 5×10^{3} m/s with an accuracy of 0.003%. Determine the uncertainty in the position of the electron.
   Ans: 3.86×10^{-4} m

9. Calculate the energy in eV for the first excited state of an electron confined in an infinite 1-D potential well of width 2 Å.
   Ans: 37.64 eV

10. A particle is confined to a 1-D infinite potential well of width L in its lowest energy state. What is the probability of finding the particle over an interval of L/2 marked symmetrically at the centre of the box?

Ans: 0.818

ELECTRICAL PROPERTIES OF MATERIALS AND THEIR APPLICATIONS

11. Calculate the probability of an electron occupying an energy level at 200 K for
    a) 0.02 eV above the Fermi level
    b) 0.02 eV below the Fermi level

    Ans: a) 0.24   b) 0.76

12. The Fermi level in silver is 5.5 eV. What is the energy for which the probability of occupancy at 300 K is
    a) 0.99
    b) 0.01

    Ans: a) 5.38 eV   b) 5.62 eV)

13. The Fermi level in Potassium is 2.1 eV. Calculate Fermi velocity and the number of free electrons per unit volume in Potassium.
    Ans: 8.59×10^5 m/s, 1.38×10^{28} m^{-3})

14. An elemental solid dielectric material has a polarizability of 7×10^{-40} Fm^2. The material has 3×10^{28} atoms/m^3. Assuming the internal field to be Lorentz field, calculate the dielectric constant of the material.
    Ans: 12.33)

15. The electronic polarizability of Krypton gas is 3.54×10^{-40} Fm^2. If the gas contains 2.7×10^{25} atoms/m^3 at NTP, calculate its dielectric constant.
    Ans: 1.00108)

16. At 5 K 6.5×10^3 Am^{-1} at absolute zero. What would be the critical magnetic field at 5K?

    Ans: 3.365x103 Am^{-1})

17. At 6 K critical magnetic field is 5×10^3 Am^{-1}. Calculate the transition temperature when a critical magnetic field is 2×10^4 Am^{-1} at 0K.
    Ans: 5.196K)

18. In a superconductor ring of radius 0.02 m, the critical magnetic field is 2×10^3 Am^{-1}. What is its critical current value?
    Ans: 251.2 A)

19. Calculate the critical current of a wire of Pb having a diameter of 3 mm at 5 K. The critical temperature for Pb is 8 K and the critical magnetic field at 0 K is 5×10^4 Am^{-1}.
    Ans: 286.9 A)

APPLICATIONS OF PHYSICS IN COMPUTING

20. The probability that a driver must stop at any one traffic light coming to the airport is 0.2. There are 15 sets of traffic lights on the journey. Assuming that his journey follows Binomial distribution, what is the probability that
    a) The driver must stop at exactly 2 of the 15 sets of traffic lights.
    b) The diver will be stopped at 1 or more of the 15 sets of traffic lights

    Ans: a) 0.2309   b) 0.9648

21. If a random variable X follows Poisson's distribution with a mean of 3.4, calculate P(X=6).
    Ans: 0.072

22. The number of industrial inquiries per working week in a particular factory is known to follow Poisson's distribution with a mean of 0.5. Find the probability that in a particular week
    a) Less than 2 accidents
    b) More than 2 accidents.

    Ans: a) 0.9098   b) 0.0144

23. A radioactive source emits 4 particles on average during a five-second period. If radioactive emission follows Poisson's distribution, calculate the probability that
    a) It emits exactly 3 particles during a 5-second period.
    b) It emits at least one particle during a 5- second period.

    Ans: a)0.1954   b) 0.9817

24. The download time of a resource web page is normally distributed with a mean of 6.5 seconds and a standard deviation of 2.3 seconds. What proportion of page downloads take less than 5 seconds?
    Ans: 0.2578