Question Bank
Subject : Engineering Physics
Semester – I & II

Unit-1
CO:1 Students will be able to explain the basic concepts, theoretical principles and practical applications of interference, diffraction phenomena and their related optical devices in visible range.

Long Answer Type Questions:

1. Describe the construction and working of Michelson Interferometer and

   RTU 2014,15,16

   a) How do circular fringes originate in Michelson's interferometer?
   b) How it is used to find the wavelength of light?
   c) How shall you use to measure wavelength separation between two closely spaced spectral lines say D_1 and D_2 lines of sodium lamp?
   d) How does Michelson's ring differ from Newton's rings?

2. Explain the construction and working of the Newton's rings experiment in reflected light and
   a) Prove that the diameters of dark rings are proportional to the square root of the natural numbers in Newton's ring method.
   b) How will you determine wavelength of monochromatic light & the refractive index of a liquid with the help of Newton's ring apparatus?
   c) Why do we use a plano convex lens of large focal length in Newton's ring experiment?
   d) Why is the centre of the ring dark and how can we get a bright centre? **RTU 2010,11**

3. What will be effect on Newton's rings if :

   RTU 2008

   a) The Plano convex lens is raised by height Δh from the surface of plane glass plate?
   b) If both surfaces are curved.
   c) Oil is spreaded in between glass plat and plano convex lens?
   d) If mirror is used in place of plane glass plate.

4. Light containing two wavelengths λ_1 & λ_2 falls normally on a plano convex lens of radius of curvature R resting on a glass plate. If the n^{th} dark ring due to λ_1 coincides with the $(n+1)^{th}$ dark ring due to λ_2. Prove that the radius of n^{th} dark ring due to λ_1 is given by $r = \sqrt{\frac{\lambda_1 \lambda_2 R}{\lambda_1 - \lambda_2}}$
   RTU 2018

5. Discuss the phenomenon of Fraunhoffer's diffraction at a single slit and show that the relative intensities of successive maxima are nearly:-
   RTU 2015

$$1 : \frac{4}{9\pi^2} : \frac{4}{25\pi^2} : \frac{4}{49\pi^2} \cdots$$

6. Give theory of plane transmission diffraction grating and **RTU 2016**

a) Obtain an expression for intensity of light diffraction as under

$$\mathbf{I = I_0 (\sin\alpha/ \alpha)^2 (\sin N\beta / \sin\beta)^2}$$

b) How you determine wavelength of light.

c) How does plane diffraction grating forms a spectrum?

7. Explain Rayleigh's criterion of just resolution of two spectral lines of equal intensities giving suitable intensity distribution curves.

RTU 2018

Numerical Problems:-

1. Find the distance between two successive positions of a movable mirror of a Michelson interferometer giving distinct fringes in case of sodium having lines of wavelengths 5600 Å and 5610 Å

RTU 2016

2. In Michelson's interferometer the scale reading for two successive maxima of fringes were found to be 0.7854 mm and 0.8673 mm. If the mean wavelength of two components of light be 5600Å. Calculate the difference of the wavelength of the component.

3. Michelson interferometer is set to form circular fringes with light of wavelength 5000Å. By changing the path length of movable mirror slowly, 50 fringes cross the center of view. How much path length has been changed? **RTU 2007**

4. Michelson interferometer experiment is performed with a source which has two wavelengths 4882Å and 4886Å. By what distance does the mirror have to be moved between two positions of disappearance of fringes?

RTU 2012

5. Newton's rings are observed in reflected light of wavelength 5.9×10^{-5} cm. The diameter of the 10^{th} dark ring is 0.50 cm. Find the radius of curvature of lense & thickness of air film at the ring. **RTU 2018**
6. In Newton's ring experiment the diameter of n^{th} and $(n+1)^{th}$ ring are 4.2 mm and 5 mm. If the radius of curvature of lens is 3 m then find the wavelength of light used.
7. In Newton's rings experiment, the diameter of 10^{th} dark ring changes from 1.5 cm. to 1.27 cm, when liquid is introduced between lens & glass plate. Find out refractive index of the liquid.

8. In Newton's ring experiment, an air film is formed between two convex surfaces, each of radius of curvature 1m. Newton's rings are generated by using a light of wavelength 5000 Å. Find the distance between 16^{th} and 9^{th} dark rings.

9. The distance between the first and the sixth minima in the diffraction pattern of a single slit is 0.5 mm. The screen is 0.5 m away from the slit. If the wavelength of light used is 5000Å, determine the slit width.

RTU 2018

10. Fraunhofer diffraction due to a single slit is observed with the help of a lens of focal length 2.0 m. The slit width is 0.4 mm. Waves of two wavelengths λ_1 and λ_2 are present in the incident light. The forth minimum of λ_1 coincides with fifth minimum of λ_2 and they are formed at a distance of 1cm. from the central maximum. Determine the values of λ_1 and λ_2.

RTU 2009

11. How many lines per cm are there is a grating which gives an angle of diffraction of 30^0 in first order spectrum of light of wavelength $6x10^{-5}$cm. **RTU 2008**

12. A diffraction grating has total rules width 5 cm. for normal incidence. It is found that a line of wavelength 6000Å in a certain order superimposed on another line of wavelength 4500Å of the next higher order. If the angle of diffraction is 30^0, how many lines are there in the grating?

RTU 2009

13. A plane transmission grating has 6000 lines/cm. calculate:-
    (i) The highest order of spectrum which can be seen with light of wavelength 4000Å.
    (ii) The longest wavelength of light for which spectrum can be obtained. **RTU 2007**

Unit-2
CO2: Students will be able to acquire knowledge of fundamental concepts, principles of quantum mechanics to understand numerous atomic and molecular scale phenomena.

1. Derive the Schrödinger time dependent one dimensional wave equation. **RTU 2010,16**

2. Derive the Schrödinger time independent one dimensional wave equation. **RTU 2008,16**

3. Derive the Schrödinger time dependent three dimensional wave equation

4. Derive the Schrödinger time independent three dimensional wave equation.

5. Solve Schrödinger equation of a particle in a one-dimensional box for eigen values and

   eigen functions. Show that the particle takes discrete energies. **RTU 2014,15,16**

6. Find the probability that a particle in a box can be found between 0.45a and 0.55a where a is the width of the box and particles in the first excited sta **RTU 2018**

7. An electron confined to move in a one dimensional box of length 1A. Find the zero point energy and momentum of the electron in its ground state. **RTU 2008**

8. Find the probability that a particle in a box of width 'a' can be found between x=0 and x=a/n when it is in the n^{th} state. **RTU 2016**

9. Determine the expectation value of position of a particle trapped in one dimensional rigid box.

10. What is a wave function? Give its physical significance. **RTU 2010,11**

11. Explain the term Normalized wave function. **RTU 2014,15,16**

12. The wave function of a particle in its ground state in one dimensional box of length L is given by $\Psi=\sqrt{\frac{2}{L}}\sqrt{\frac{2}{L}}\ \sin\frac{\pi x}{L}\sin\frac{\pi x}{L}$. Calculate probability of finding the particle with in an interval of 1A° at the center of box of length L=10Å.

13. Determine the expectation value of momentum of a particle trapped in one dimensional rigid box.
14. Explain the term orthogonalized wave function

15. Explain the term Hamiltonian Operator **RTU 2017**

Unit-3
CO:3 Students will be able to learn all basic aspects of laser action, properties (coherence etc.), types of LASER devices and its applications in fibre optics, holography, medical science and industry etc.

Long Answer Type Questions:

1. Describe the construction and working of an Optical Fiber and **RTU 2009,11**
   e) Define acceptance angle and hence derive an expression for the maximum acceptance angle of an optical fiber .
   f) Define Numerical aperature and hence derive an expression for the Numerical aperature of an optical fiber .
   g) Write two applications of an optical fiber.
2. Explain the principle of LASER and

   RTU 2007,12,15

   (a) Describe Einstein's Coefficients and derive the relation between them
   (b) Threshold conditions for LASER action
   (c) Essential requirements of a LASER
   (d) Spontaneous emission and Stimulated emission
3. Explain the following: **RTU 2015,18,19**
   (a) Components (Active Medium , Pumping, Population Inversion and Optical resonator) of LASER
   (b) Applications of LASER
   (c) Properties (Highly Coherent, Monochromatic, Directional and Intense) of LASER
   (d) Metastable states
4. Explain the construction and working of He-Ne LASER. What is the role of He atoms in He-Ne LASER.

RTU 2007,13,15

Numerical Problems:-

1. Show that the numerical aperture of step index optical fiber is given by NA= $n_{core} \sqrt{2\Delta}$

   RTU 2018

2. Light of wavelength 4800 Å has wavetrain length of 25 waves. What is the coherent length, coherent time and quality factor **RTU 2008**

3. The spectral spread of red cadmium light of wave length 6943 Å is 0.001 mm. Calculate purity factor, coherence length and coherence time.

4. A LASER operates at wavelength of 6000 Å and its spectral line width is 10^2 Hz. For this LASER, calculate Quality factor, coherence length and coherence time. **RTU 2015**

5. Compare the maximum angle of acceptance and light gathering capacity (NA) of two fibers characterized by core and cladding indices n_1 and n_2 to be

   (a) $n_1 = 1.6$, $n_2 = 1.5$, (b) $n_1 = 2.1$, $n_2 = 1.5$ (assume $n_0 = 1$)

6. For a typical step index multimode fiber the core index is n_1=1.45 and the relative refractive index difference of core- cladding (n_1-n_2) is 0.01. Find the numerical aperture and the maximum acceptance angle?

7. Calculate the refractive indices of core and cladding materials of an optical fiber having NA = .22 and relative refractive index change is .012. Also find the critical angle and maximum acceptance angle. **RTU 2013,15**

8. What is the coherent length of a source of wavelength 6750 Å with a bandwidth of .40 Å.

9. Calculate the temporal coherence length for mercury vapour lamp emitting in green portion of spectrum at wavelength 5461 Å with emission bandwidth of $6x10^2$ Hz.

10. Two wavetrain overlaps 40% of their length . If the maxima in the resulting interfernce pattern receives 20 units of light , how much do the minima receive ?

11. A laser beam has a wave length of $8x10^{-7}$ m and aperture $5x10^{-3}$m. The laser beam is sent to moon. The distance of the moon from the earth is $4x10^5$ Km. Calculate (i) The angular spread of the beam (ii) The areal spread when it reaches the moon. **RTU 2016**

12. A laser beam has a power of 50 mW. It has an aperture of $5x10^{-3}$m and emits light of wavelength 7200 A. The beam is focused with a lens of focal length 0.1 m. Calculate the area and the intensity of the image. Find the intensity of a laser beam of 20mW power and having a diameter of 1.5 mm .

13. A LASER beam of wavelength 6000 Å on earth is focused by a lens of diameter 2 m on the surface of moon . How big is the moon .(Given distance of moon from earth = $4x10^5$ Km)

Unit-4
Students will be able to describe key concepts, fundamental laws of Hall effect, Fermi Dirac distribution, electrical conductivity, Fermi energy etc. to understand the Physics of semiconductors and materials. Students will also acquire basics of electrostatics.

Long Answer Type Questions:

1. Explain the formation of energy bands in solids and classify the materials into insulators, semiconductors and conductors. **RTU 2013,15**
2. Graphite is a good conductor of electricity while diamond is a bad conductor. Why? **RTU 2017**
3. Define semiconductors and obtain an expression for the conductivity of semiconductors. **RTU 2018**
4. Write short notes on : **RU 2013,15,18**
   (a) Intrinsic semiconductors
   (b) N-type semiconductors
   (c) P-type semiconductors
   (d) Fermi Distribution function
   (e) Fermi Energy
5. What is Hall Effect? Explain the significance and importance of Hall Effect. How Hall coefficient can be determined. **RTU 2014,16,18**
6. Explain the following with physical significance :
   (a) Gradient
   (b) Divergence **RTU 2018**
   (c) Curl
   (d) Gauss Divergence theorem
   (e) Stokes theorem
7. Write short notes on :
   (a) Biot-Savart's Law **RTU 2019**
   (b) Poisson's equation and Laplace equation **RTU 2019**

Numerical Problems:-

8. Find the resistance of an intrinsic Ge rod 1 cm lon , 1mm wide and 1mm thick at 300 K. For Ge n_i= 2.5x10^{19} /m^3. Mobility of electrons = .39 m^2/VS, Mobility of Holes = .19 m^2/VS.

9. The electron and hole mobilities in In-Sb semiconductor are 6 and 0.2 $m^2V^{-1}s^{-1}$ respectively. At room temperature, the resistivity of In-Sb semiconductor is $2x10^{-4}$ ohm meter. Assuming that material is intrinsic, determine its intrinsic carrier density at room temperature.

10. The electron mobility in a pure semiconductor is 50 $m^2v^{-1}s^{-1}$ at 4.2 K. What is its mobility at 300 K? The conductivity of semiconductor at 20^0 C is 250 mhos/m and at 100^0 C is 1100 mhos/m. What is its band gap E_g ?

11. A semiconducting crystal 12 mm long, 1 mm wide and 1mm thick has magnetic flux density of 0.5 wb/m^2, applied from front to back and perpendicular to target faces. When current of 20 mA flows lengthwise through the specimen, voltage measured across its width is found to be 37 microvolt. What is the hall coefficient of the semiconductor and density of charge carriers?

12. A rectangular n-type semiconductor specimen, 2mm wide and 1mm thick, gives a hall coefficient of 10^{-2} m^3/c. When a current of 1mA is passed through the sample, a hall voltage of 1mV is developed. Find the magnetic field and the hall field. **RTU 2017**

13. A n-type semiconductor sample has a hall coefficient $0.0125m^3c^{-1}$ and the mobility of majority charge carriers is 0.36 $m^2v^{-1}s^{-1}$ and a 100 v/m electric field apply on the sample of n-type semiconductor. Find the current density in the sample. **RTU 2018**

14. The Hall coefficient of a specimen of a doped silicon is found to be $3.66x10^{-4}$ m^3c^{-1}. The resistivity of the specimen is $8.93x10^{-3}$ ohm meter. Find the mobility and density of charge carriers.

15. In a semiconductor there are $5x10^{19}$electrons and $8x10^{20}$ holes per cube meter. If the mobilities of electrons and holes respectively 0.09 and 0.05 $m^2v^{-1}s^{-1}$ the determine the hall coefficient of semiconductor.

16.If E = 20i+10x^2 j + 4yk then find curl at (2,4,6).

17 .Calculate the amplitude of displacement current density in air near a car antenna where the $E=60 \cos(6.277x10^8t-2.092)a_z$ V/m **RTU 2018**

18. .For the material conductivity is 10^{-3} mho/m and relative permittivity = 3, determine conduction current density if E= $8x10^{-6}\sin(6x10^9t)$ V/m

19. .If A= 20x^2 i+10y^2j+4k then find divergence at point (0,1,0).