

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division

2079 Baishakh

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEL, BEX, BEL, BCT, BAM, BIE, BAG, BAS	Pass Marks	32
Year / Part	I / I	Time	3 hrs.

Subject: - Engineering Physics (SH 402)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ All questions carry equal marks.
- ✓ Assume suitable data if necessary.

- Derive a differential equation for damped oscillation. Write its solution and angular frequency. Hence discuss all three cases of damped angular frequency and corresponding motion.

OR

Derive a relation to determine the radius of gyration of a compound pendulum. Why determination of acceleration due to gravity is more accurate from a compound pendulum than a simple pendulum?

- A circuit has $L = 12 \text{ mH}$, $C = 1.6 \mu\text{F}$ and $R = 1.5 \Omega$
 - After what time t , will the amplitude of the charge oscillations drop to one half of its initial value?
 - To how many periods of oscillation does this correspond?
- What are particle velocity and wave velocity? Find the relation between them.
- What is chromatic aberration of a lens? Obtain the condition of achromatism in the case of combination of two lenses of the same material.
- What is diffraction of light? Explain how can you obtain the wavelength of light using a diffraction grating.

OR

Define interference of light. Analytically explain the condition for maximum and minimum intensity and hence show graphically the variation of intensity with phase angle.

- A screen is placed 2 m away from a narrow slit which is illuminated with light of wavelength 6000 \AA . If the first minimum lies 5 mm on either side of the central maximum, calculate the slit width.
- Find the specific rotation of a given sample of sugar solution if the plane of polarization is turned through an angle 25.2° . The length of the tube containing 15% sugar solution is 20 cm .
- Calculate the numerical aperture and acceptance angle of optical fiber in which refractive index of core is 1.62 and that of cladding is 1.52 .

9. Give the general method to calculate the electric field due to continuous charge distribution. Use it to calculate the electric field intensity at a perpendicular distance 'y' from the infinite rod having a linear charge density λ .

OR

What is electric field? Calculate the electric field at a distance x from the center of ring of charge. Show that if a negative charge $-q$ is placed near the center of charged ring, the motion of charge $-q$ will be simple harmonic.

10. A parallel plate capacitor has a capacitance of 110 pF, with a plate area of 90 cm^2 is filled with a substance of dielectric constant $k = 5.5$. A potential difference of 50 V is maintained between plates. Determine:
- The electric field strength in the dielectrics.
 - The magnitude of free charge on the plate.
 - The magnitude of induced surface charge.
 - The magnitude of polarization vector.
11. Discuss microscopic view of conduction. Show that resistivity and conductivity are independent of applied field and depends on nature of material.
12. Compare Biot-Savart law with Amper's law to calculate magnetic field due to current carrying conductor. Calculate the magnetic flux density at an axial distance 'x' from the centre of the coil of radius 'R' carrying a current 'i'.

OR

Describe the working mechanism of cyclotron. Find the expression for maximum energy of a rotating particles in a cyclotron. Write its limitation. How can you overcome its limitation?

13. A long circular coil consisting of 100 turns with diameter 1.2 m carries a current of 5A
- Calculate the magnetic field at a point along the axis 80 cm from the center.
 - At what distance from the center, along the axis, the magnitude of field is $1/8$ times its value at the center?
14. A uniform magnetic field of strength 8.0 T is applied perpendicularly on a rectangular metal strip of width 2.0 mm and thickness $15.0 \mu\text{m}$. A current of 1.5A is passed along the length of strip and a transverse voltage equal to $350 \mu\text{V}$ is measured across its width. Calculate
- The average velocity of the electron in the metal.
 - The number of conduction electron per unit volume in this metal.
15. Mention the Maxwell's electromagnetic equations in integral and differential form. Show that the electromagnetic wave propagate with the speed of light in free space.
16. A particle of mass M is confined in one dimensional infinitely deep potential well of width 'L'. Calculate the wave function and energy eigen value. Hence draw the wave function and its corresponding probability density for first three Quantum number.

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2078 Kartik

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Subject: - Engineering Physics (SH402)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
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- Derive the time period of physical pendulum. Show that its time period is minimum when length of pendulum is equal to radius of gyration.

OR

Derive a differential equation for LC oscillation. Show that the maximum values of electric and magnetic energies stored in LC circuit in equal.

- A solid sphere of mass 3kg and diameter 0.20m is suspended on a wire. Find the period of angular oscillation for small displacements if the torsional constant of the wire is $6 \times 10^{-3} \text{ Nm/rad}$.
- A string has linear mass density 530g/m and tension 50N. We send a sinusoidal wave with frequency 120Hz and amplitude 6.5mm along the string. At what average rate does the wave transport energy?
- What are Newton's rings? Give the necessary theory for the determination of refractive index of liquid using Newton's ring method.

OR

What is double refraction? Show that linearly and circularly polarized light are the special cases of elliptically polarized light.

- Light is incident normally on a grating 0.5cm wide with 2500 lines. Find the angular separation for the principle maxima of two sodium lines ($\lambda_1 = 589.0\text{nm}$ and $\lambda_2 = 589.6\text{nm}$) in the first order. Are the two lines resolved?
- Show that diameter of the circle of least confusion is independent of the focal length of lens in the case when object is at infinity.
- Two lenses of focal length +5.5cm and +4.5cm are separated by a finite distance. Find the position of principle points if the combination satisfies the condition of achromatism.
- Define optical fiber. Derive the expressions for acceptance angle and numerical aperture of optical fiber.
- Prove that the electric field due to a short dipole at a point on axial line is twice that on the equatorial line.

OR

Discuss Gauss's law in electrostatics. Find the electric field intensity at a point outside and inside the uniformly charged non-conducting sphere of radius R.

10. A capacitor of capacitance C is discharged through a resistor of resistance R . After how many time constants is the stored energy $\frac{1}{4}$ of its initial value.
11. Discuss a microscopic view of Ohm's law and show that resistivity of a conductor is independent of the external electric field.
12. Derive the expression of magnetic flux density at a point on the axis of a circular coil carrying current with N number of turns. Explain how the coil behaves for large distance.

OR

Show that the electrical energy density and the magnetic energy density are proportional to square of their corresponding fields.

13. Deuterons in cyclotron describe a circle of radius 0.32m just before emerging from dees. The frequency of the applied emf is 10 MHz . Find the flux density of the magnetic field and velocity of deuterons emerging out of the cyclotrons. (Mass of deuteron is $3.32 \times 10^{-27}\text{ kg}$)
14. Find an expression of the self inductance of a toroid having N number of turns, radius r and carrying current i .
15. The maximum electric field 20m from an isotropic point source is 1.5V/m . Determine:
 - a) the maximum value of magnetic field
 - b) average intensity of light
 - c) power of the source
16. Prove that the energy levels are quantized, when an electron is confined in an infinite potential well of width a .

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2078 Bhadra

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Year / Part	I / I	Time	3 hrs.

Subject: - Engineering Physics (SH 402)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
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1. Deduce the formula for the time period of compound pendulum and show that it is minimum when length of the pendulum is equal to radius of gyration.

Or,

Develop a differential equation of forced oscillations in LCR series circuit and find an expression for resonant frequency.

2. A string has linear density 525gm/m and tension 45N. When a sinusoidal wave of frequency 120Hz and amplitude 8.5mm is sent along the string, at what average rate does the wave transport energy.
3. What is meant by reverberation time. Derive the relation of sabine's formula. Also explain the growth and decay of sound in a hall.
4. What is chromatic aberration? Derive an expression for the condition of achromatism of two thin lenses in contact.
5. What do you mean by coherent sources? Derive necessary theory of interference due to wedge shape thin film.
6. The spacing of atomic planes in a crystal is 3.1×10^{-10} . When a monochromatic beam of X-ray is incident on them at incident angle $82^\circ 30'$ second order image is produced, calculate the glancing angle for the 4th order image.
7. A 200mm long glass tube is filled with a solution of sugar, containing 15 gram of sugar in 100ml of water. The plane of polarized light, passing through this solution, is rotated through $20^\circ 30'$. Find the specific rotation of sugar.
8. An optical fiber has numerical aperture 0.22 and refractive index change 0.012. What are the values of refractive index of core and cladding?
9. Define the term quadrupole. Derive the relation of the electric potential due to linear quadrupole along its axial line.

OR

Derive an expression for electric field intensity due to the non-conducting spherically symmetric charge distribution of radius R at point (i) inside sphere (ii) outside sphere by using Gauss law. Also write down the significance of Gaussian surface.

10. Two similar balls of mass m and charge q are hanging from silk thread of length l . These two balls are repelled by angle 2θ , prove that the separation of the balls as

$$x = \left(\frac{q^2 l}{2\pi\epsilon_0 mg} \right)^{1/3}, \text{ assuming } \theta \text{ is very small.}$$

11. An electron with kinetic energy 2.5 KeV circles in a plane perpendicular to a uniform magnetic field. The radius of the orbit is 25cm. Calculate (i) the speed of the electron (ii) the flux density of magnetic field (iii) the number of revolutions per second.
12. What is the average time between collisions of free electrons in copper wire? Given, atomic weight = 63 gm/mol, density = 9gm/cm³, resistivity = $1.7 \times 10^{-8} \Omega m$ and Avogadro's no = $6.02 \times 10^{23} \text{ mol}^{-1}$.
13. State and explain Biot and Savart's law. Derive an expression for magnetic field due to current carrying circular loop at axial line.

OR

Derive an expression for the growth and decay of current in LR circuit. Explain the meaning of inductive time constant.

14. A 10eV electron is circulating in a plane at right angles to a uniform field of magnetic induction of $1 \times 10^{-4} \text{ Wb/m}^2$. Calculate its orbital radius, cyclotron frequency and period of revolution.
15. Sun light just outside the earth in atmosphere has an intensity of 1.4 kW/m^2 . Calculate the maximum electric and magnetic fields for sun light, assuming it to be a plane wave. Given $c = 2.99 \times 10^8 \text{ m/s}$.
16. Show that energy of an electron that is confined in the infinite potential well is quantized and sketch that energy level and wave function diagram for $n=1, 2$ and 3 for that well.

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2076 Chaitra

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Year/Part	I/I	Time	3 hrs.

Subject: - Engineering Physics (SH 402)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
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- Define point of suspension & oscillation of bar pendulum & show that they are interchangeable. Also show that the time period will be minimum, when these points are equidistance from centre of gravity.

Or,

What is damped oscillation? Develop a relation for damped frequency in LCR oscillation. Hence discuss the underdamped, overdamped and critically damped oscillations.

- In an oscillation, the amplitude drops to $1/e$ of its original amplitude in 50sec. Find the relaxation time. Also, obtain the time required to drop the amplitude to $1/e^2$ of the original amplitude.
- The reverberation time for an empty hall is 1.5 sec. With 500 audiences present in the hall, the reverberation time falls to 1.4 secs. Find the number of persons present in the hall if the reverberation time falls to 1.312 sec.
- A coaxial lens system placed in air has two lens of focal length 36cm & 12cm separated by a distance 24cm. Find the position of the cardinal points.
- What is Newton's Ring? How can it be used to determine the refractive index of the liquid?

Or,

Discuss the similarities & difference of Young's double slit interference & single slit diffraction. Interrelate the discussion to explain the formation of spectra by diffraction in a single slit.

- Show the intensity in the first and second order in a single slit diffraction reduced approximately to 4.5% and 1.6% of its central maxima.
- Two polarizing sheets are placed together with their transmission axes crossed. A third sheet is inserted between them with its transmission axis at an angle of 45° with respect to each of the other axes. Find the fraction of incident unpolarised light intensity transmitted by the combination.
- What is the fiber optics? Discuss the physics behind the optical fiber transmission. Derive an expression for acceptance angle of an optical fiber.
- Define electric quadrupole and quadrupole moment. Hence, determine the expression for electric field intensity due to the quadrupole at axial line.

Or,

State and prove the Gauss's law in electrostatics. Apply this law to determine the electric field intensity at a point inside the uniformly charged non conducting solid sphere.

10. A parallel plate capacitor each of area 100cm^2 has potential difference of 50V and capacitance 100pF, if a mica of dielectric constant 5.4 is inserted between plate, find the magnitude of
- Electric field intensity
 - Displacement vector
 - Polarization vector
11. Define Faraday's laws of electromagnetic induction and Lenz's law. Obtain an expression for self inductance of toroid.
12. If the carrier density of intrinsic Germanium at 300K is $2.29 \times 10^{13}/\text{cm}^3$. Calculate the resistivity at the same temperature given that electron & hole mobilities are $0.39\text{m}^2\text{V}^{-1}\text{s}^{-1}$ & $0.19\text{m}^2\text{V}^{-1}\text{s}^{-1}$ respectively.
13. Compare Biot-Savart law with Amper's law. Calculate the magnetic field outside & inside due to a long, straight wire of radius R carrying a steady current 'I' that is uniformly distributed through the cross-section of the wire.
14. A long solenoid of radius 2cm has 1×10^3 turns per meter and carries a sinusoidally varying current $I = 5 \sin 100\pi t$, where I is in ampere & t is in second. Determine the magnitude of induced electric field at a radius $r = 1\text{ cm}$ & $r = 3\text{ cm}$ from its central axis.
15. What is Displacement current? Define and derive the relation of poynting vector in electromagnetism.
16. An electron with an energy of 8eV is incident on a potential barrier which is 9.2eV high & 0.2 nm wide.
- what is the maximum transmission coefficient that the electron will pass through the barrier?
 - what is the probability of transmission that the electron will pass through the barrier.

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2076 Ashwin

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Year / Part	I / I	Time	3 hrs.

Subject: - Engineering Physics (SH 402)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
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- ✓ Assume suitable data if necessary.

1. Derive an expression for the time period of a physical pendulum and establish the interchangeability of the center of oscillation and suspension.

OR

Give the necessary theory of forced electromagnetic oscillation and deduce the condition for resonance amplitude in LCR series circuit with ac source.

2. Write down the characteristics of simple harmonic progressive wave. Derive an expression of energy of a progressive wave.
3. A spring is stretched by 5 cm when a load of 1kg is suspended to the lower and (upper end of spring is fixed). What will be the maximum velocity of object if it is pulled down further by 5cm from equilibrium position and then released?
4. Two thin lenses of focal lengths f_1 and f_2 separated by a distance d have an equivalent focal length 0.3m and both lenses are of same material. The combination of lenses satisfies the condition of achromatism and minimization of spherical aberration. Find the value of f_1 and f_2 .
5. Explain the formation of Newton's ring in reflected system of monochromatic light. Prove that in reflected light diameters of the dark rings are proportional to the square root of natural numbers.

OR

What is double refraction of light? Using the concept of double refraction, show that the plane polarized light and circularly polarized light are the special cases of elliptically polarized light.

6. A plane transmission grating of width 6 cm has 5000 lines/cm. Find the resolving power of grating for second order spectrum and the smallest wavelength difference that can be resolved for light of wavelength 5000 Å.
7. A plano-convex lens of radius 300 cm is placed on an optically flat glass plate and is illuminated by monochromatic light. The diameter of the 8th dark ring in the transmitted system is 0.72 cm. Calculate the wavelength of light used.
8. Differentiate between LASER and white light. Why the light in He-Ne laser is produced from Neon and not from Helium?
9. A ring shaped conductor with radius R carries a charge q uniformly distributed around it. Find the electric field intensity at an axial point of ring at distance y from the centre.

OR

Define capacitance. Give a general method to calculate capacitance of a capacitor. Find expression for the capacitance of a cylindrical capacitor.

10. An electric dipole consists of charges $10\mu\text{C}$ and $-10\mu\text{C}$ separated by a distance of 1mm . What is the maximum torque experienced by the dipole if placed in the uniform electric field of intensity 400 V/cm ?
11. Calculate the (i) mean free time and (ii) mean free path between collisions for the conduction electrons in copper having electron density $8.5 \times 10^{28}/\text{m}^3$ and resistivity $1.7 \times 10^{-8}\ \Omega\text{m}$. Charge of electron $1.6 \times 10^{-19}\text{ C}$, mass of electron $9.1 \times 10^{-31}\text{ kg}$, effective speed of electron $1.6 \times 10^6\text{ m/s}$.
12. Using Ampere's law, calculate the magnetic field inside, outside and on the surface of a long current carrying conductor and hence plot a graph between the magnetic field and the distance from the center of the conductor.

OR

Show that the energy per unit volume in an electric field and magnetic field are proportional to the square of their fields.

13. A series circuit has $25\ \Omega$ resistance and 0.1 henry inductance. What will be initial rate of increase of current if the circuit contains a 12V steady source? What time is required for the current to attain a value of 100mA ?
14. A wire of length L carries a current I . If the wire is formed into a circular coil, then the maximum torque in a given magnetic field B developed for a single turn is $\tau = \left(\frac{1}{4\pi}\right) L^2 IB$.
15. Write Maxwell's equations in integral form. Convert them into differential form.
16. An electron is confined to an infinite potential well of size 8.5 nm . Calculate the ground state energy of the electron and radian frequency. Given: Planck's constant $= 6.62 \times 10^{-34}\text{ Js}$, mass of electron $= 9.1 \times 10^{-31}\text{ kg}$.

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1. Define torsional pendulum. Derive an expression for its time period. Explain why the time period of the torsional pendulum remains unaffected even if the amplitude is large.

OR

What is a damped EM oscillations? Which factor in the circuit is responsible to produce such a motion? Derive a differential equation for this motion and write its solution. What will be the remedy of such motion to make it smooth?

2. A meter stick swings as a compound pendulum when suspended from one of its end. Calculate (a) period of the oscillations and (b) equivalent length of the simple pendulum that would have the same period.
3. Mention the conditions for good acoustics of a hall and derive an expression for reverberation time.
4. Why Newton's interference fringes are circular? Derive an expression for radius of the Newton's ring due to the transmitted light.

OR

Define dispersive and resolving power of a diffraction grating. Derive an expression for the resolving power of the grating having N slits.

5. A plane transmission grating having 5000 lines/cm is used to obtain a spectrum of light from a sodium lamp in the second order. Calculate the angular separation between the two sodium lines whose wavelengths are 589 nm and 589.6 nm.
6. Calculate the specific rotation if the plane of polarization is turned through 30.5° traversing 25 cm length of 10% sugar solution.
7. Define an optical fiber and mention its types. Explain the numerical aperture and acceptance angle for the optical fiber and derive the expression to establish a relationship between them.
8. Dispersive powers for crown and flint glass lenses are 0.015 and 0.030 respectively. How can you design an achromatic contact of the lenses of focal length 50 cm?
9. What is an electric Quadrupole? Derive an expression for the electric potential at any point on the axial line at a distance ' r ' from the centre of a short Quadrupole. Also, show that the electric potential at that point is inversely proportional to r^3 .

OR

Discuss the modification of Gauss law due to the presence of the dielectrics and derive a relation among displacement vector, polarization vector and the electric field.

10. A particle of charge $-q$ and mass m is placed midway between two equal positive charges q_0 of separation d . If the negative charge executes SHM between the positive charges, then derive an expression for the time period of the oscillations.
11. Calculate the mean free time and mean free path between the collisions for the free electrons in copper with number density of the electron $8.5 \times 10^{28} \text{ m}^{-3}$ and resistivity $1.7 \times 10^{-8} \text{ ohm-m}$. ($e = 1.6 \times 10^{-19} \text{ C}$, $m_e = 9.1 \times 10^{-31} \text{ kg}$ and effective speed of the electron $= 1.6 \times 10^6 \text{ m/s}$)
12. Define the cyclotron and cyclotron frequency. show that energy of a charged particle in a cyclotron is independent to the oscillating electric field.

OR

State Ampere's law in magnetism. Calculate the magnetic field outside and inside a current carrying long straight conductor.

13. An inductance of an inductor L connected to a battery of emf ε through a resistor of resistance R . Show that the p.d. across the inductor after time t is $V_L = \varepsilon e^{-(R/L)t}$. At what time the p.d. across the inductor is equal to the p.d. across the resistor such that $i = i_0/2$.
14. What is magnetic flux density at the center of a circular coil of radius 2 cm and with 20 turns carrying current of 10 A?
15. Write Maxwell equations in differential form. State and explain the pointing vector and theorem.
16. What is the physical significance of wave function? Derive the relation of Schrodinger wave equation in time dependent form.

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1) Deduce the time period of a simple harmonic vibration. Explain why a loaded bus is more comfortable than an empty bus. (3+2)

2) Explain forced oscillation with its differential equation. Write the relation for the frequency dependent amplitude and hence give a rough sketch of the resonance curve. (3+2)

Or

Calculate the average amplitude of a sinusoidal sound wave in air of a frequency of 1.5 KHz and average intensity 10^{-5} W/cm^2 , where density of air is 1.29 kg/m^3 . (5)

3) Give an account of bad acoustic properties of a hall and discuss the method to improve these defects. (5)

4) Explain the physical meaning of Dispersive and resolving powers of a Grating. Two spectral lines have wavelengths λ and $\lambda + \Delta\lambda$ respectively where $\Delta\lambda \ll \lambda$. Show that their angular separation $\Delta\theta$ in a grating spectrometer is $\Delta\theta = \frac{\Delta\lambda}{\sqrt{\left(\frac{d}{m}\right)^2 - \lambda^2}}$, where 'd' and 'm' are grating elements and no. of order respectively. (2+3)

Or

In newton's ring experiment, "Central spot is dark in reflected system" and "Fringes get closer as the no. of order increased" explain. Is it possible to make central spot bright in reflected system? If so how? (3+2)

5) A soap film $5 \times 10^{-5} \text{ cm}$ thick is viewed at an angle of 35° to the normal. Find the wavelength of the visible light which will be absent from the reflected light. (5)

6) Light of wavelength 580 nm falls on a calcite crystal of certain thickness. The emerging light is circularly polarized. What must be the thickness of such crystal? (5)

7) Calculate the focal length of combination of two thin lenses of focal length f_1 and f_2 separated by a distance 'd'. Find the position of two principal points. (5)

8) Trace the ray diagram that shows the propagation of light through the step and graded index optical fiber. Write the importance of self-focusing in an optical fiber. (3+2)

- 9) Charge of uniform density $\rho = 3.2 \mu\text{C}/\text{m}^2$ fills a non-conducting solid sphere of radius of 5.0 cm. What is the magnitude of the electric field a) at 3.5 cm b) 8.0 cm from the sphere's center (5)

Or

Two large parallel plates are separated by a distance of 5cm. The plates have equal but opposite charges that create an electric field in the region between the plates. An alpha particle ($q = 3.2 \times 10^{-19} \text{ C}$, $m = 6.68 \times 10^{-27} \text{ kg}$) is released from the positively charged plate, and it strikes the negatively charged plate $2 \times 10^{-6} \text{ sec}$ later. Assuming that the electric field between plates is uniform and perpendicular to the plates, what is the strength of electric field? (5)

- 10) Calculate the potential at a point due to a uniform line of charge of length L at a distance D from its one end which lies in the perpendicular line. (5)

- 11) Explain how electric energy is stored in a capacitor and derive an expression for energy density of electric field. (2+3)

- 12) Explain super conductivity and its types with examples. Write the difference(s) between super conductor and perfect conductor. (3+2)

- 13) If a test charge revolves round a circular path of radius 8.5cm where the magnetic field increases at steady rate 0.13 T/s , calculate the magnitude of induced electric field at a point 12.5 cm? (5)

- 14) Derive expression for inductances of a solenoid and toroid. Then show that inductance is the property of the coil. (5)

Or

What is Hall Effect? Write its importance. Show that the hall coefficient $R_H = -1/ne$, where the symbols have their own meanings. (1+1+3)

- 15) The Sun delivers about 10^3 W/m^2 of energy to the earth's surface through EM radiation calculate a) the total power incident on a roof of dimensions $8\text{m} \times 20\text{m}$. b) Radiation pressure and force exerted on the roof, assuming roof is perfect absorber. (2+3)

- 16) A beam of electrons having energy of each 3eV is incident on a potential barrier of height 4eV . If the width of the barrier is 20nm , calculate the percentage transmission of the beam through the barrier. (5)

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1. Describe L.C oscillation qualitatively by using necessary circuits and graph.

OR

Define the terms sharpness of resonance and quality factor. Derive the relation of quality factor in terms of band width.

2. Define transverse wave. Develop a differential equation of the wave in a stretched string and then find the velocity of transverse wave.
3. A reverberation time of 2.3 sec is observed in a hall of volume 5500 m^3 . The sound absorbing surface of the hall has an area of 750 m^2 . Calculate the average absorption coefficient.
4. What are constructive and destructive interference? Prove that the path difference for constructive interference is integer multiple of λ and that for destructive interference is odd integer multiple of $\lambda/2$.

OR

How can you distinguish the plane, circularly and elliptically polarized light by using nicol prised and wave plate?

5. What is diffraction of light? Explain the dispersive power and resolving power of a diffraction grating. Derive the relation and also relate them.
6. A 30 cm long polarimeter tube containing 50 cm^3 of sugar solution produces an optical rotation 14.5° when placed on a polarimeter tube. If the specific rotation of sugar solution is 65° , calculate the quantity of sugar contained in the tube.
7. Two thin converging lenses of focal lengths 30 cm and 40 cm respectively are placed co-oxially in air separated by a distance of 20 cm. An object is placed 40 cm in front of the first lens. Find the position and nature of the image.
8. What is optical fiber? Explain numerical aperture and acceptance angle. Also compare the attenuation property efficiency and cost of single mode and multimode optical fibers.
9. What is electrical dipole and dipole moment? Derive an expression of the electric field intensity at a point due to dipole at equatorial line?

10. Define the three electric vectors E,P,D and develop a relation between them.

OR

A cylindrical capacitor has radii 'a' and 'b'. Show that half the energy stored lies within the cylinder whose radius is $r = \sqrt{ab}$.

11. What will be the conductivity of sodium metal having atomic weight 22.9 and density 1.013 gm/cm^3 ? The relaxation time of sodium metal is $3 \times 10^{-14} \text{ sec}$.
12. What type of particles can be accelerated by a cyclotron? Explain the working of cyclotron and synchrotron with their differences.

OR

Differentiate between electromagnetic induction and self-induction. Develop an expression for self-inductance of a toroid.

13. Using Ampere's law, calculate the magnetic field inside, outside and on the surface of a long current carrying conductor and hence plot a graph between the magnetic field versus distance from the center of the conductor.
14. Determine the energy stored in an inductor. Also, determine the energy density in magnetic field.
15. A radio wave transmits 25 W/m^2 of power per unit area. The flat surface area is perpendicular to the direction of propagation of the wave. Calculate the radiation pressure on it and maximum electric and magnetic field associated with the wave.
16. What are the significances of wave-function? Using the wave function derive an expression for the time dependent Schrodinger wave equation.

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEL, BEX, BAME, BCT, BIE, B.Agric.	Pass Marks	32
Year / Part	1 / 1	Time	3 hrs.

Subject: - Engineering Physics (SH402)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ All questions carry equal marks.
- ✓ Assume suitable data if necessary.

1. Define centers of suspension and oscillation of a compound pendulum and show that they are interchangeable. What length of the pendulum has its minimum time period?

OR

Define SHM. Derive the expression for energy of SHM. Show that the KE and PE of simple harmonically oscillating object changes with time however the total energy is invariant.

2. What is LC oscillation? Derive the differential equation of free oscillation and compare its solution with mass spring system.
3. What is piezoelectric effect? Describe the construction of a piezoelectric oscillator for the production of ultrasonic waves.
4. Explain how interference fringes are formed by a thin wedge shaped film examining by normally reflected light. Derive a relation for the fringe width on such system of interference fringes.

OR

What is double refraction? Explain how would you use the phenomenon to produce linear polarized light and circularly polarized light.

5. A diffraction grating used at normal incidence gives a line (540 nm) in a certain order superposed on the violet line (405 nm) of the next higher order. How many lines per cm are there in the grating if the angle of diffraction is 30° ?
6. In Ramsden's eyepiece a coaxial lens system is used. There are two lenses in air and are of equal focal length of separated by a distance $2f/3$. Find positions of the cardinal points.
7. Discuss the physical significance of numerical aperture (NA). How does it depend on refractive index of core and cladding?
8. Calculate the thickness of doubly refracting plate capable of producing a path differences of $\frac{\lambda}{4}$ between extraordinary and ordinary rays of wavelength 5890 Å. (Use $\mu_o = 1.53$; and $\mu_e = 1.54$)
9. What is an electric dipole and dipole moment? Show that electric field for a short dipole drops inversely to cube of the distance at any point from the dipole on an axial line.

OR

What is an electric quadrupole? Calculate potential for points on the axis of the quadrupole.

10. Two point charges $6\mu\text{C}$ and $-24\mu\text{C}$ are 18 cm apart in air. Locate the positions of zero potential on the line joining the charges.
11. Two capacitors having capacitance $25\mu\text{F}$ and $5\mu\text{F}$ are connected in parallel and charged with a 100V power supply. Calculate the total energy stored in the two capacitors.
12. What is superconductor? Explain critical magnetic field. Describe the characteristics of superconductor.

OR

Explain Biot-Savart law. Show that a current carrying circular coil behaves as a magnetic dipole for a large distance.

13. Explain meaning of self induction. Calculate inductance for a solenoid and Toroid.
14. Deuterons in a cyclotron describe a circle of radius 0.32 m just before emerging from dees. The frequency of the applied emf's 10 MHz. Find the flux density of the magnetic field and the energy of deuterons emerging out of the cyclotron. (mass of deuterons = 3.32×10^{-27} kg.)
15. What are Maxwell's equations? Using Maxwell equations derive electromagnetic (em) wave equation in dielectric medium. Prove that em wave travels with velocity less than velocity of light in such medium.
16. A non relativistic particle is moving three times as fast as an electron. The ratio of the de-Broglie wavelength of the particle to that of the electron is 1.813×10^{-4} . Calculate the mass of the particle.

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BAME, BEL, BEX, BCT, BIE, B. Agri.	Pass Marks	32
Year / Part	I / I	Time	3 hrs.

Subject: - Engineering Physics (SH402)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ All questions carry equal marks.
- ✓ Assume suitable data if necessary.

1. Write the differences between mechanical oscillation and e.m. oscillation. Set up the differential equation of damped harmonic mechanical oscillation. Obtain the relation for frequency of such oscillation. Hence explain the conditions for different types of damped oscillation

OR

Define sharpness of resonance. Derive the relation for current amplitude of forced e-m oscillation.

2. What are the measures of good acoustic building? Show that the reverberation time decrease with increase in absorbing factors in a hall.
3. Two thin lenses of focal length f_1 and f_2 separated by a distance having an equivalent focal length 50 cm. The combination satisfies the condition for no chromatic aberration and minimum spherical aberration. Find the separation between the two lenses if both lenses are of same materials.
4. Prove that the intensity of first maxima is 4.54% of the central maxima in Fraunhofer's single slit diffraction.

OR

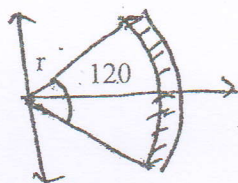
Write the physical meaning of dispersive power and resolving power of grating. Show that resolving power is directly proportional to the total number of rulings on the grating.

5. Newton's Rings arrangement is used with a source emitting two wavelength λ_1 and λ_2 . It is found that the n^{th} dark ring due to λ_1 coincides with $(n+1)^{\text{th}}$ dark ring to λ_2 . Find the diameter of n^{th} dark ring. ($\lambda_1 = 6 \times 10^{-5}$ cm, $\lambda_2 = 5.9 \times 10^{-5}$ cm radius of curvature of the lens $R = 90$ cm).
6. A quartz crystal has refractive indices 1.553 and 1.544. Calculate the thickness of a quarter wave plate for sodium light of wavelength 5890 \AA .
7. Explain the terms stimulated emission, population inversion, optical pumping and metastable. Explain working principle of He-Nellaser.
8. A heavy circular ring of radius R oscillates in a vertical plane about a horizontal axis at a distance x from the center. Show that the time period is minimum when $x = R$

9. Derive the relation for potential at any point due to an electric dipole and show that no work is done in bringing a charge from infinity to dipole along the perpendicular bisector of the dipole.

OR

A plastic rod contains uniformly distributed Q charge. The rod has been bent in 120° circular arc of radius ' r ' as shown in figure below. Prove that the electric field intensity at the center of bent rod is $E = \frac{0.83Q}{4\pi\epsilon_0 r^2}$.



10. Derive the relation for rise and fall of current in charging and discharging of capacitor through resistor. Plot graphs between current and time and explain the figures.
11. The space between two concentric conducting spherical shells of radii $b = 1.70$ cm and $a = 1.20$ cm is filled with a substance of dielectric constant $k = 23.5$. A potential difference $V = 73$ V is applied across the inner and outer shells. Determine (a) the capacitance of the device (b) the free charge q on the inner shell.
12. What is Hall-effect? Derive an expression for the Hall coefficient and established the relation between mobility of charge carrier and conductivity of material of wire.

OR

Derive a relation resistivity of a conductor using microscopic view. From your result, explain why resistivity of a conductor increase with necessary with increasing temperature.

13. Explain the phenomenon of self induction. Calculate the value of inductance for (a) long solenoid and (b) Toroid.
14. What is Ampere's law? Derive the expression for magnetic flux density outside and inside a long straight conductor carrying current I .
15. Define Poynting vector. Prove that $\vec{S} = (\vec{E} \times \vec{B}) / \mu_0$, where the symbols have their usual meanings.
16. Discuss the significance of the wave function and deduce the time independent Schrodinger's wave equation.

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT BAME, BIE, B Agri.	Pass Marks	32
Year / Part	I / I	Time	3 hrs.

Subject: - Engineering Physics (SH402)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ All questions carry equal marks.
- ✓ Assume suitable data if necessary.

1. Differentiate between bar pendulum and torsional pendulum. Prove that there exists four collinear points in bar pendulum.

OR

Prove that LC circuit is an analogy of simple harmonic motion and hence prove that maximum energy stored in electric field is equal to maximum energy stored in magnetic field.

2. In simple harmonic motion, when the displacement is one-half the amplitude, what fraction of the total energy is KE and what fraction is PE? At what displacement is the energy half KE and half PE?
3. A source of sound has a frequency of 256 Hz and amplitude of 0.50 cm, calculate the energy flow across a square cm per sec. The velocity of sound in air is 330 m/s and density of air is 1.29 kg/m³.
4. Prove that interference in thin film of reflected and transmitted light are complementary to each other.

OR

What is diffraction of light? Discuss the intensity distribution with special reference to diffraction of light in a single slit.

5. Two thin converging lenses of focal lengths 30 cm and 40 cm respectively are placed co-axially in air separated by a distance of 20 cm. An object is placed 40 cm in front of the first lens. Find the position and nature of the image.
6. A 200 mm long tube and containing 48 cm³ of sugar solution produces an optical rotation of 11° when placed in a saccharimeter. If the specific rotation of sugar solution is 66°, calculate the quantity of sugar contained in the tube in the form of a solution.
7. In a Newton's ring experiment the diameter of the 10th ring changes from 1.40 cm to 1.27 cm when a liquid is introduced between the lens and the plate. Calculate the refractive index of the liquid.
8. What is an optical fiber? Show that Numerical aperture of an optical fiber is given by the expression, $NA = \mu \sqrt{2\Delta}$, where the symbols carry their usual meanings.
9. Determine the electric field at a distance z on the central axis from the center of a charged ring. Also, find the maximum value of electric field.

OR

Calculate the potential at any point due to an electric dipole. Also, find the potential on the axial line.

10. Over certain region of space the electric potential is $v = 15x - 3x^2y + 12yz^2$. Find the expression for the x, y and z components of the electric field over this region. What is the magnitude of the field at the point P that has coordinates (1, 0, -2) m?
11. Write the general methods to calculate the capacitance of a capacitor and hence determine the capacitance of a cylindrical capacitor of inner and outer radii 'a' and 'b' respectively.
12. Calculate the drift speed of electrons when 20 A current is supplied through a copper wire of cross-sectional area 1 mm^2 and electron density 10^{28} m^{-3} .
13. Determine the energy stored in an inductor. Hence, prove that the energy density in magnetic field is directly proportional to square of magnetic field.

OR

Obtain an expression for magnetic field intensity due to a circular coil carrying current at its axial point

14. A copper strip 3.0 cm wide and 2.0 mm thick is placed in a magnetic field 1.75T. If a current of 150 A is setup in the strip, calculate (i) Hall voltage and (ii) Hall mobility if the number of electrons per unit volume is $8.4 \times 10^{28} \text{ m}^{-3}$ and resistivity is $1.72 \times 10^{-8} \text{ ohm-m}$.
15. Define poynting vector. Prove that $\vec{S} = \frac{1}{\mu} (\vec{E} \times \vec{B})$
16. A beam of electrons having energy of 3eV is incident on a potential barrier of height 4 eV. If the width of the barrier is 20 \AA , calculate the percentage transmission of the beam through the barrier.

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT, BIE, B.Agr.	Pass Marks	32
Year / Part	I / I	Time	3 hrs.

Subject: - Engineering Physics (SH402)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ All questions carry equal marks.
- ✓ Assume suitable data if necessary.

1. Differentiate between bar pendulum and torsional pendulum. Using a torsional pendulum, derive a relation for modulus of rigidity of the metallic wire.

OR

Compare the damped and forced LCR oscillation. Derive the differential equation of forced em-oscillation and compare it with driven mechanical oscillation

2. Show that in a bar pendulum, minimum time period is achieved if radius of gyration is equal to the distance of point of suspension or point of oscillation from center of gravity.
3. Write some features of acoustically good auditorium. Derive Sabine's formula.
4. Two thin converging lenses of focal lengths 3 cm and 4 cm respectively are placed coaxially in air separated by a distance of 2 cm. An object is placed at 4 cm in front of first lens. Locate the positions of the principal points and final image.
5. What is polarization? Derive the relation for plane, elliptical and circular polarized light.

OR

What are the coherent sources of light? How such sources develop in lab? Show that the square of diameters of the n^{th} dark ring by the reflected light of Newton's ring is directly proportional to the natural number.

6. Define acceptance angle and numerical aperture. In an optical fiber, show that Numerical Aperture (NA) = $\mu_{\text{core}} \sqrt{2\Delta}$, symbols have their usual meanings.
7. In a Fraunhofer Single slit diffraction, a convex lens of focal length 20 cm is placed just after a slit of width 0.6 mm. If a plane wave of wavelength 6000\AA falls on slit normally, calculate the separation between the second minima on either side of central maximum.
8. Calculate the minimum no of lines per cm in a 2.5 cm wide grating which will just resolve the sodium lines 5890\AA and 5896\AA in second order spectrum.
9. A thin ring made of plastic of radius R is uniformly charged with linear charge density λ . Calculate the electric field intensity at any point at an axial distance y from the center. If electron is constrained to be in axial line of the same ring, show that the motion of electron is SHM.

OR

Discuss the behavior of dielectrics in a parallel plate capacitor. Based on Gauss law of electrostatic in dielectric, show that $\vec{D} = \epsilon_0 \vec{E} + \vec{P}$, where symbols have their usual meaning.

10. The potential in a region between $x = 0\text{m}$ and $x = 6\text{m}$ is $V = a + bx^2$ where $a = 10$ and $b = -7\text{V/m}$. Determine (i) the potentials at $x = 0\text{m}$, 3m and 6m and (ii) the magnitude and direction of electric fields at $x = 0\text{m}$, 3m and 6m .
11. What are the current density and mobility? Explain the atomic view of the resistivity and show that $\rho = \{m/ne^2\tau\}$, where symbols have their usual meanings.
12. Give general method of calculating capacitance of a capacitor. Use the method to calculate the capacitance of a spherical capacitor.
13. A toroid has number of turns 1250, internal radius 52 mm, external radius 95 mm and thickness of the ring 13 mm, calculate the inductance.

OR

- A solenoid having an inductance of $6.3\ \mu\text{H}$ is connected in series with a $1.2\ \text{k}\Omega$ resistance. If a $14\ \text{V}$ battery is connected across the pair, how long will it take for the current through the resistor to reach 80% of its final value?
14. Explain Hall effect. What results you can draw from Hall experiment? Obtain an expression for the Hall voltage in a current carrying specimen placed in a magnetic field.
 15. State Maxwell equation in integral form. Convert them into differential form. Explain each of these equations.
 16. A free particle is confined in a box of width L . Using Schrodinger wave equation find an expression for energy eigen value.

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT, BIE, B.Agr.	Pass Marks	32
Year / Part	1 / 1	Time	3 hrs.

Subject: - Engineering Physics (SH402)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ All questions carry equal marks.
- ✓ Assume suitable data if necessary.

1. Derive a relation to find the moment of inertia of a rigid body about an axis passing through its center of gravity using the torsional pendulum.

OR

What is resonance? Formulate the differential equation of forced electromagnetic oscillation. Then determine the expression for resonant frequency.

2. A string has a linear density of 625 gm/m and is stretched with a tension 50N. A wave, whose frequency and amplitude are 160Hz and 10mm respectively, is travelling along the string. At what average rate is the wave transporting energy along the string?
3. Why is it important to study the reverberation time, before the construction of a Cinema Hall? Derive a relation for reverberation time based on absorption coefficient, volume and surface area of the hall.
4. What happens to the energy when waves perfectly cancel to each other in interference? Derive the relations for thin film interference by reflected light.

OR

Show that the diameters of the Newton's rings when two surfaces of radii R_1 and R_2 are placed in contact are related by the relation $(1/R_1) - (1/R_2) = (4n\lambda/d^2)_n$, where n is the integer number of the fringes.

5. A grating with 250 grooves/mm is used with an incandescent light source. Assume the visible spectrum to range in wavelength from 400 to 700 nm. In how many orders can one see the entire visible spectrum?
6. Define the polarization of light. Write its importance in different optical instruments. Derive the relation for the thickness of quarter wave plate and half wave plate.
7. Two thin converging lenses of focal length 3cm and 4cm respectively are placed coaxially in air and separated by distance of 2cm. An object is placed 4cm in front of the first lens. Find the position of the nature of the image and its lateral magnification.
8. A glass-clad fiber is made with a core glass of refractive index 1.55 and the cladding is doped to give a fractional index difference of 5.5×10^{-4} . Determine (i) Cladding index (ii) the critical internal reflection angle (iii) the external critical acceptance angle and (iv) numerical aperture (NA).
9. A particle of charge $-q$ and mass m is placed midway between two equal positive charges q_0 of separation d . If the negative charge $-q$ is displaced in perpendicular direction to the line joining them and released. Show that the particle describes a SHM with a period.

$$T = \sqrt{\frac{\epsilon_0 m \pi^3 d^3}{q q_0}}$$

OR

Calculate electric field at any point is axial distance due to a dipole and a quadrapole. What conclusion you can draw from your results.

10. Charges are uniformly distributed through out the volume of an infinitely large cylinder of radius 'a'. Show that the electric field at a distance 'r' from the cylinder axis $r < a$ is given by $E = \frac{\rho r}{2\epsilon_0}$ where ρ is the volume charge density.
11. A cylindrical capacitor has radii a and b. Show that half the stored electric potential energy lies within a cylinder whose radius is $r = \sqrt{ab}$
12. Explain Hall Effect. Derive a relation for hall resistance. From this relation explain the meaning of quantization of hall resistance.
13. The current density in a cylindrical wire of radius $R = 2 \text{ mm}$ and uniform cross-sectional area is given by $J = 2 \times 10^5 \text{ Am}^2$. What is the current through the outer portion of the wire between radial distances $R/2$ and R ?
14. Explain the phenomenon of "self-induction". Find an expression for the self-induction of a toroid having N numbers of turns, radius r and carrying current i.

OR

- State Ampere's law. Find the expressions for magnetic field outside and inside the long straight wire by using this law.
15. Write down the Maxwell's equations for non conducting medium. Find the equation of propagation of plane electromagnetic wave for E-field and B-field for such medium. Show that electromagnetic wave travels with velocity less than velocity of light in such medium.
 16. Derive Schrodinger time independent wave equation. A particle is moving in one dimensional potential well of infinite height and width 'a'. Find the expression for energy of the particle.

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT, BIE, B.Agri.	Pass Marks	32
Year / Part	I / I	Time	3 hrs.

Subject: - Engineering Physics (SH402)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ All questions carry equal marks.
- ✓ Assume suitable data if necessary.

1. Distinguish between free and forced vibrations. Write the differential equation of forced oscillation. Determine the amplitude of oscillation for forced oscillation and hence explain sharpness of the resonance.

OR

Define simple harmonic motion. Show the average kinetic energy is half of the total energy of a particle executing simple harmonic motion.

2. A $2\mu\text{F}$ capacitor is charged upto 50V. The battery is disconnected and 50mH coil is connected across the capacitor so that LC oscillation to occur. Calculate the maximum value of the current in the circuit.
3. The elastic limit of steel forming a piece of wire is equal to 2.70×10^8 Pa. What is the maximum speed at which transverse wave pulses can propagate along this wire without exceeding this stress? (density of steel = $7.89 \times 10^3 \text{ kg/m}^3$)
4. What are Newton's rings? How can you use these rings to determine the refractive index of a given liquid?

OR

Discuss the phenomenon of Fraunhofer diffraction at a single slit. Show that the relative intensities of the successive maxima are $1 : \frac{4}{9\pi^2} : \frac{4}{25\pi^2} : \dots$

5. Light of wavelength 6000 Å falls normally on a thin wedge shaped film of refractive index 1.4, forming fringes that are 2 mm apart. Find the angle of the wedge.
6. If the plane of vibration of the incident beam makes an angle of 30° with the optic axis, compare the intensities of extraordinary and ordinary light.
7. Show that the diameter of circle of least confusion depends on the diameter of lens aperture and dispersive power of the material of the lens but is independent of the focal length of the lens.
8. An optical fiber has a numerical aperture of 0.22 and core refractive index 1.62. Determine the acceptance angle for the fiber in a liquid which has a refractive index of 1.25. Also, determine the fractional refractive index change.

9. Prove that electric field due to a short dipole at axial point is twice that at equatorial point.
10. A capacitor of capacitance C is discharging through a resistor of resistance R . After how many time constants is the stored energy $1/8$ of its initial value?
11. Give a general method to calculate electric field and potential due to continuous charge distribution. Using your method, calculate electric field at an equatorial distance y due to a long charged rod having linear charge density λ .
12. Consider a circular coil of radius R carrying current I . Find the magnetic field at any point on the axis of the loop at a distance z from the center of the loop. Show that the circular current carrying coil behaves as a magnetic dipole for large distance.
13. In a Hall Effect experiment, a current of 3.2A lengthwise in a conductor 1.2 cm wide, 4.0 cm long and $9.5\mu\text{m}$ thick produces a transverse Hall voltage (across the width) of $40\mu\text{V}$ when a magnetic field of 1.4T is passed perpendicularly through the thin conductor. From this data, find (a) the drift velocity of the charge carriers and (b) the number density of charge carriers.
14. Derive an expression for growth and decay of current in LR circuit. Explain inductive time constant by sketching graph between current and time for both cases.

OR

Derive expressions for inductance of a Solenoid and Toroid. Then show that inductance is the property of the coil.

15. Write and explain Ampere's law in magnetism. How Maxwell modified it. Based on this modified equation, explain the term displacement current. Prove displacement current is equal to conduction current.
16. Explain Schrodinger's wave equation. Derive time independent Schrodinger wave equation. Use this equation to find energy for a particle in a box of infinite square well potential.

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INSTITUTE OF ENGINEERING
Examination Control Division
2069 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT, BIE, B.Agric.	Pass Marks	32
Year / Part	I / I	Time	3 hrs.

Subject: - Engineering Physics (SH402)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt **All** questions.
- ✓ **All** questions carry equal marks.
- ✓ Assume suitable data if necessary.

- Point out the similarities and dissimilarities between the oscillations of bar pendulum and torsional pendulum. Show that the radius of gyration is equal to distance from center of suspension to center of gravity of compound pendulum, when time period is minimum.
- Derive a differential equation for LC Oscillation. Show that the maximum value of electric and magnetic energies stored in LC circuit is equal.

OR

Prove that if a transverse wave is travelling along a string, then the slope at any point of the string is numerically equal to the ratio of the particle speed to the wave speed at that point.

- The time of reverberation of an empty hall is 1.5 sec with 500 audiences present in the hall; the reverberation time falls to 1.4 sec. Find the no. of persons present in the hall if the reverberation time falls down to 1.32 sec.
- Show that the intensity of the first subsidiary maxima of Fraunhofer's diffraction at a single slit is 4.5% of that of principal maxima.

OR

What is double diffraction? Explain how Nicol prism can be used as polarizer and analyzer?

- In a Newton's ring experiment, the radius of curvature of the lens is 5cm and the lens diameter is 20mm. (a) How many bright rings are produced? Assume that $\lambda=589\text{nm}$ (b) How many bright rings would be produced if the arrangement were immersed in water ($\mu=1.33$)?
- A diffraction grating 3cm wide produces the second order at 33° with light of wavelength 600nm. What is the total number of lines on the grating.
- What is population inversion? Explain why laser action cannot occur without population inversion between atomic levels?
- What are cardinal points of an optical system? Determine the equivalent focal length of a combination of two thin lenses separated by a finite distance.
- A ring has a charge q uniformly distributed in it. Derive an expression for the electric field at any point on the axial line of the ring. Extend your result to find the potential.

OR

Write an expression for electric field at any point in the axial line of a charged ring. Using this equation, calculate the electric field at any point in the axial line of a charged disk.

10. What is the magnitude of the electric field at the point (3,2) m if the electric potential is given by $V = 2x + 5xy + 3y^2$ volts. What acceleration does an electron experiences in the x-direction.
11. Derive an equation $\vec{J} = \sigma \vec{E}$. Explain why resistivity of a conductor increases with increasing temperature plot a graph between R_θ (Resistance at any temperature θ) and temperature. Based on the graph, explain what are superconductor? How they differ from perfect conductor? Describe the characteristics of superconductor.
12. Derive an expression for energy stored in magnetic field. Show that the energy stored per unit volume is directly proportional to the square of the magnetic flux density. Compare this result with electric energy density.

OR

What is self induction? Define inductance of a coil. Show by calculation inductance of a coil depends on the permeability of a medium and the geometry of the coil.

13. A long circuit coil consisting of 50 turns with diameter 1.2m carries a current of 10Amp. (a) Find the magnetic field at a point along the axis 90cm from the center. (b) At what distance from the center, along the axis, the field is $1/8$ greater as at the center.
14. Describe the principal and working of Cyclotron. Show that the time taken by the ion in a Dee to travel a semicircle is exactly same whatever be its radius and velocity.
15. Write Maxwell's equations in free space and dielectric medium. With the help of Maxwell's equations, Derive charge conservation theorem.
16. A beam of electrons having energy of each 3eV is incident on a potential barrier of height 4eV. If the width of the barrier is 20\AA , calculate the transmission coefficient of the beam through the barrier.

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INSTITUTE OF ENGINEERING
Examination Control Division.

2069 Ashad

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT, BIE, B.Agric.	Pass Marks	32
Year / Part	I / I	Time	3 hrs.

Subject: - Engineering Physics (SH 402)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ All questions carry equal marks.
- ✓ Assume suitable data if necessary.

1. Obtain an expression for the time period of a compound pendulum and show that its time period is unaffected by the fixing of a small additional mass to it at its centre of suspension.

OR

What is electromagnetic oscillation? Derive differential equation of damped LCR oscillation and find its frequency.

2. A particle is moving with simple harmonic motion in a straight line. If it has a speed v_1 when the displacement is x_1 and speed v_2 when the displacement is x_2 then show that the

amplitude of the motion is, $a = \left[\frac{v_2^2 x_1^2 - v_1^2 x_2^2}{v_2^2 - v_1^2} \right]^{\frac{1}{2}}$.

3. In the progressive wave, show that the potential energy and kinetic energy of every particle will change with time but the average K.E. per unit volume and P.E. per unit volume remains constant.
4. Two coherent sources having constant phase δ but different amplitudes A_1 and A_2 superimpose, prove that the intensity of superimposed beam is $I = A_1^2 + A_2^2 + 2A_1 A_2 \cos \delta$.

OR

Explain the phenomenon of double refraction. Describe the construction and action of Nicol prism.

5. White light is incident on a soap film at an angle $\sin^{-1}\left(\frac{4}{5}\right)$ and the reflected light on examination by a spectrometer shows dark bands. The consecutive dark bands correspond to wavelength $6.1 \times 10^{-5} \text{ cm}$ and $6.0 \times 10^{-5} \text{ cm}$. If $\mu = 1.33$ for the film, calculate its thickness.
6. Light of wavelength 600 nm is incident normally on a slit of width 0.1 mm . Calculate the intensity at $\theta = 0.2^\circ$.
7. Two lenses of focal lengths 8 cm and 4 cm are placed at a certain distance apart. Calculate the position of principal points if they form an achromatic combination.

8. An optical fiber has a NA of 0.2 and a cladding refractive index of 1.59. Determine acceptance angle for the fiber in water which has a refractive index of 1.33.
9. A ring has a charge q uniformly distributed in it. Find the expression for the electric field at any point on the axial line of the ring. Locate the point at which the field is maximum.

OR

Prove that electric field due to a short dipole at axial point is twice that at equatorial point.

10. A particle of charge $-q$ and a mass m is placed midway between two equal positive charges q_0 of separation d . If the negative charge $-q$ is displaced in perpendicular direction to the line joining them and released, show that the particle describes a SHM with

$$\text{a period } T = \left[\frac{\epsilon_0 m \pi^3 d^3}{q q_0} \right]^{\frac{1}{2}}.$$

11. A cylindrical capacitor has radii a and b . Show that half the stored electric potential energy lies within a cylinder of radius $r = \sqrt{ab}$.
12. A flat silver strip of width 1.5cm and thickness 1.5mm carries a current of 150A. a magnetic field of 2.0 Tesla is applied perpendicular to the flat face of the strip. The emf developed across the width of strip is measured to be $17.9\mu\text{V}$. Estimate the number density of free electrons in the metal.
13. A straight wire segment of length l carries current I . Show that the magnetic field B produced by that segment at a distance y from it along a perpendicular bisector is $B = (\mu_0 / 2\pi y) [l / (l^2 + 4y^2)]$.
14. Find the inductance of a toroid having N number of turns and radius R .

OR

Show that the energy per unit volume in electric field and magnetic field are proportional to the square of their fields.

15. State and explain Maxwell's equations. Derive the continuity equation: $\nabla \cdot \vec{J} = -\frac{\partial \rho}{\partial t}$.
16. Determine the total energy of a particle using Schrodinger equation, when the potential energy has value $V=0$ for $0 < x < a$, and $V=\alpha$ for $x \leq 0$ and $x \geq a$.

Exam.	Regular		
Level	BE	Full Marks	80
Programme	All	Pass Marks	32
Year / Part	I / I	Time	3 hrs.

Subject: - Engineering Physics (SH 402)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ All questions carry equal marks.
- ✓ Assume suitable data if necessary.

1. Differentiate between linear and angular harmonic motion. Show that the motion of torsion pendulum is angular harmonic motion. Also find its time period.

OR

Derive the differential equation of the forced oscillation of LCR circuit with an AC source and find the expression for the current amplitude. Hence explain the condition of current resonance in such circuit.

2. A 750g block oscillates on the end of a spring whose force constant, $k=56\text{N/m}$. The mass moves in a fluid which offers a resistive force $F = -bv$, where $b = 0.162\text{Ns/m}$. What is the period of the oscillation?
3. A room has dimensions $6\text{m} \times 4\text{m} \times 5\text{m}$. Find:
 - i) Mean free path of sound wave in the room
 - ii) The number of reflections made persecond by the sound wave with the walls of the room. (Take velocity of sound in air $= 350\text{ms}^{-1}$).
4. Define interference. Show that interference in thin film due to reflected and transmitted lights are complementary.

OR

What are Newton's rings? How can you determine the refractive index of given liquid using Newton's rings experiment?

5. Explain the dispersive and resolving power of a diffraction grating. Derive expressions and develop a relation between them.
6. A 200mm long tube containing 48cm^3 of sugar solution produces an optical rotation of 11° when placed on a saccharimeter. If the specific rotation of sugar solution is 66° , calculate the quantity of sugar contained in the tube in the form of solution.
7. Prove that the condition for achromatism for the combination of two lenses of focal length f_1 and f_2 having dispersive power ω_1 and ω_2 placed at a separate distance x is $(\omega_1/f_1) + (\omega_2/f_2) = (x/f_1 f_2) (\omega_1 + \omega_2)$.
8. Differentiate between spontaneous and stimulated emission of radiation. Explain the construction and working of He-Ne laser with a suitable energy level diagram.
9. Derive an expression for the electric field at a point P at a distance X from a circular plastic disc of radius a along its central axis. Does this expression for E reduces to an expected result for $x \gg a$?

10. A capacitor of capacitance 'C' is discharged through a resistor of resistance 'R'. After how many time constants is the energy stored becomes one fourth of initial value?

11. Calculate the electric field due to a uniformly charged rod of length l at a point along its long axis at a distance 'a' from its nearest end.

12. Explain the principle and working of cyclotron. Show that the time spent by the particle in a Dees is independent of its speed and radius of its circular path.

OR

Use Biot-Savart Law to calculate magnetic field on the axial line of a current carrying circular loop. Explain how the coil behaves for a large distance point.

13. A copper strip $150\mu\text{m}$ thick is placed in a magnetic field of strength 0.65T perpendicular to the plane of the strip and current of 23Amp is set up in the strip. Calculate: (i) the Hall voltage (ii) Hall coefficient and (iii) Hall mobility, if the number of electrons per unit volume is $8.5 \times 10^{28}/\text{m}^3$ and resistivity is $1.72 \times 10^{-8} \text{ Ohm-m}$.

14. A parallel plate capacitor with circular plates of 10cm radius is charged producing uniform displacement current of magnitude $20\text{A}/\text{m}^2$. Calculate (i) dE/dt in the region (ii) Displacement current density and (iii) Induced magnetic field.

15. Obtain an expression for energy transfer rate by electromagnetic wave. From your result show that $I \propto E_{\text{rms}}^2$. Where I is the intensity em wave and E_{rms} is root mean square value of electric field.

16. Derive the schrodinger time independent wave equation. Also what do you mean by a potential barrier?

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INSTITUTE OF ENGINEERING
Examination Control Division

2067 Ashadh

Exam.	Regular/Back		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT, BIE, B.Agr.	Pass Marks	32
Year / Part	I / I	Time	3 hrs.

Subject: - Engineering Physics

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ All questions carry equal marks.
- ✓ Assume suitable data if necessary.

1. Show that there are four collinear points within compound pendulum having same time period. Give their physical significance.

OR

Derive the differential equation of damped harmonic oscillation in LCR circuit. Solving the equation find the damped frequency of the oscillation and explain its significance.

2. A uniform circular disk whose radius R is 12.6cm is suspended as a physical pendulum from a point on its rim. (a) What is its period? (b) At what radial distance $r < R$. Is there a pivot point that gives the same period?
3. Define absorption coefficient of sound. Derive a relation between reverberation time and absorption coefficient for acoustically good hall.
4. Explain how interference fringes are formed by a thin wedge shaped film, when examined by normally reflected light. How will you estimate the difference of film thickness between two points?

OR

Show that the intensity of second order maxima of Fraunhofer's single slit diffraction is

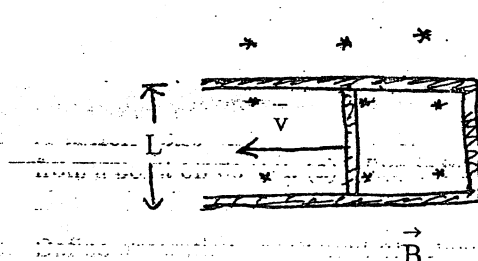
$\frac{2}{5\pi}$ times the intensity of central maxima.

5. In Newton's ring arrangement a source emitting two wavelengths $6 \times 10^{-7} \text{m}$ and $5.9 \times 10^{-7} \text{m}$ is used. It is found that n^{th} dark ring due to one wavelength coincides with $(n+1)^{\text{th}}$ dark ring due to other. Find the diameter of the n^{th} dark ring if radius of curvature of lens is 0.9m.
6. Calculate the thickness of quarter wave plate for light of wavelength 5893\AA . Given refractive indices of ordinary and extraordinary ray are 1.544 and 1.553 respectively.
7. Define acceptance angle of an optical fiber. Derive the relation for Numerical Aperture (NA) of the optical fiber. Also write down its significance.
8. Two thin converging lenses of focal lengths 0.2m and 0.3m are placed coaxially 0.10m apart in air. An object is located 0.6m in front of the lens of smaller focal length. Find the position of the two principal points and that of image.
9. Derive an expression for the electric potential at any point on the axis of the uniformly charged disk. Extend your result to calculate electric field.

OR

Derive an expression for the electric field at any point on the axis of the short linear quadrupole.

10. A copper slab of thickness b is inserted into a parallel plate capacitor exactly half way between the plates. If the separation of the plate is d and the area of each plate is A , show that the change in capacitance is equal to $\frac{\epsilon_0 Ab}{(d-b)d}$.
11. What is the drift speed of the conduction electrons in a copper wire (molecular mass = 63.54 g/mol, density 8.96 g/cm³) with radius 900 μ m when it has a uniform current 17mA flowing in the wire?
12. A long straight wire of radius R carries a uniformly distributed current I . Calculate magnetic fields at any points inside and outside the wire.
13. The conducting rod shown in figure has length L and is being pulled along horizontal, frictionless conducting rails at a constant velocity \vec{v} . The rails are connected at one end with a metal strip. A uniform magnetic field \vec{B} , directed out of the page, fills the region in which the rod moves. Derive an expression for the rate of thermal energy being generated in the rod.



14. A coil has an inductance of 53 mH and a resistance of 0.35 Ω . If a 12V emf is applied across the coil, how much energy is stored in the magnetic field after the current has built up to its equilibrium value? After how many time constants will half this equilibrium be stored in the magnetic field?

OR

In a certain cyclotron a proton moves in a circle of radius 0.5m. The magnitude of the magnetic field is 1.20T. What is the oscillator frequency? What is the kinetic energy of the proton in eV?

15. Define poynting vector. Prove that $\vec{S} = \frac{1}{\mu_0} (\vec{E} \times \vec{B})$, where the symbols have their usual meanings.

16. An electron is trapped in an one dimensional infinite potential well of width 'a' such that

$$V = \infty \quad \text{for } 0 \leq x \text{ and } x \geq a$$

$$V = 0 \quad \text{for } 0 < x < a$$

Using boundary condition, prove that the total energy of the system is

$$E = \frac{\pi^2 n^2 \hbar^2}{2ma^2}$$

Where symbols carry their usual meanings.

Examination Control Division

2067 Ashwin

Exam.	New Back (2066 Batch)		
Level	BE	Full Marks	80
Programme	BEL, BEX, BCT, BIE, B.Agric.	Pass Marks	32
Year / Part	I / I	Time	3 hrs.

Subject: - Engineering Physics

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ All questions carry equal marks.
- ✓ Assume suitable data if necessary.

1. Define forced oscillation. Show that the total energy of the damped oscillation decreases with increasing time.

OR

Derive a differential equation for LC oscillation. Solve the equation and show that the maximum value of electric and magnetic energies stored in L.C. circuit are equal.

12. A meter stick swings about pivot point at one end, at distance 'h' from the stick's center of mass. Calculate the period of oscillation using parallel axis theorem.
13. Give an account of bad acoustic properties of a hall. Derive the expression for reverberation time in a good acoustics of a hall.
4. What are coherent sources? Describe a method for determining the refractive index of transparent liquid film using the interference phenomenon.

OR

Describe the construction of Nicol Prism. Explain how it can be used as polarizer and analyzer.

5. A diffraction grating is used at normal incidence. In such arrangement a green line ($\lambda = 5400\text{\AA}$) of certain order is superimposed on the violet line ($\lambda = 4050\text{\AA}$) of the next order. If the angle of diffraction is 30° , how many lines are there in 1 centimeter?

16. A light source emits light of two wavelengths 4300\AA and 5100\AA . The source is used in a double slit experiment. The distance between the sources and the screen is 1.5m and the distance between the slits is 0.025mm. Calculate the separation between the third order bright fringes due to these two wavelengths.

17. A thin convex and thin concave lens, each of focal length 50cm, are coaxially situated and separated by 10cm. Find the position and nature of the final image formed of an object placed 20cm from the convex lens.

8. What is population inversion? Explain the lasing action of a gas laser with necessary energy level diagram.

9. Consider a circular plastic disk of radius R that has a positive surface charge of uniform density on its upper surface. Find the electric field at any point at a distance x from the centre of the disk along its central axis.

OR

✓ Define electric quadrupole. Calculate the electric potential of linear quadrupole of separation $2a$ at an axial distance r from its centre.

10. As a parallel plate capacitor with circular plates 20cm in diameter is being charged, the current density of the displacement current in the region between the plates is uniform and has a magnitude of 20A/m^2 . Calculate the magnitude of magnetic field (B) at a distance $r = 50\text{mm}$ from the axis of symmetry of this region. Also calculate $\frac{dE}{dt}$ in this region.

11. Assuming that each atom of copper contributes one free electrons, calculate the drift velocity of free electrons in copper conductor of cross sectional area 10^{-4}m^2 carrying a current of 200A. Given:

Atomic weight of copper = 63.5 g/mol

Density of copper = $8.94 \times 10^3 \text{kg/m}^3$

Charge of an electron = $1.6 \times 10^{-19}\text{C}$

✓ 12. State Ampere's law. Use this law to find magnetic field that a current produces inside and outside a long straight wire of circular cross section.

OR

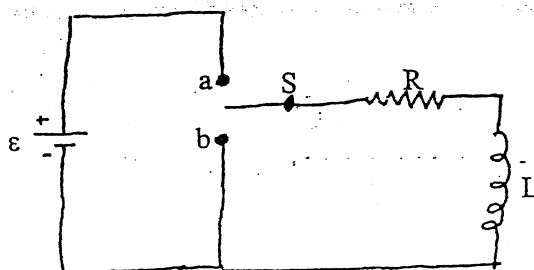
Derive an expression for energy stored in an inductor. Show that the magnetic energy density is directly proportional to the square of the magnetic flux density. How can you compare electric energy density with this result?

✓ 13. A cyclotron which has the dees of radius 42cm and magnetic field of flux density 0.5 weber/m^2 is employed to accelerate protons. If the final velocity of the proton is $2.02 \times 10^7 \text{m/sec}$, calculate the charge to mass ratio for the proton and the frequency of the alternating potential between the dees.

✓ 14. In the given figure, when switch S is closed on a , the current rises and approaches a limiting value $\frac{\epsilon}{R}$.

a) Find the current through the inductor as a function of time.

b) When the switch is closed on b , the current reduces to zero. Find the rate of decay of current through the inductor.



✓ 15. State Maxwell equations in integral form. Convert them into differential form. Explain each of these equations.

16. Discuss the significance of the wave function and deduce the time independent Schrodinger equation.

Exam	Regular		
Level	B.E.	Full Marks	80
Programme	All	Pass Marks	32
Year / Part	I / I	Time	3 hrs

Subject: Physics

Attempt ALL questions. Each question carries equal mark.

1. Define physical pendulum show that point of Suspension and point of oscillation are interchangeable.

OR

Define damped harmonic oscillator; find time period and frequency for under damping oscillation.

2. Define interference. Show that interference in thin film due to reflected and transmitted light are complementary.

OR

What is double refraction? Obtain the mathematical relation for linearly, circularly and elliptically polarized light.

3. Define diffraction. Derive the intensity distribution pattern of single slit due to diffraction.
4. What is the importance of laser? Discuss the laser action of He-Ne laser with labeled diagram.
5. The maximum Pressure Variation that the ear can tolerate in loud Sound is about 20 N/m^2 . If normal atmospheric pressure is about 10^5 Pascal what is the corresponding maximum displacement for sound wave in air of frequency 1000Hz. (density of air 1.3 kg/m^3 and velocity of sound in air is 343 m/sec).
6. Two thin converging lenses of focal length 20 cm and 40 cm respectively are placed Coaxially 10 cm apart. An object is located at a distance 48 cm from the first lens. Find (a) Position of image (b) Position of principal point and (c) position of focal points.
7. Light is incident normally on a grating 0.5 cm wide having 2500 lines? Find the angle of diffraction for the principal maxima of two sodium line in first order spectrum. ($\lambda_1 = 5890 \text{ \AA}$, $\lambda_2 = 5896 \text{ \AA}$). Are the two lines resolved?
8. A circuit has $L = 10 \text{ mH}$ and $C = 1 \mu\text{F}$, How much resistance must be inserted in the circuit to reduce the (undamped) resonance frequency by 0.01%?
9. Design an electric- quadrupole. Derive the electric field intensity at point on the axial line of the quadrupole.

OR

Derive an expression for the potential at any point due to an electric dipole.

10. An air filled parallel plates Capacitor has a Capacitance of 1.3 pF. The separation of the plates is doubled and wax is inserted between them. The new Capacitance is 2.6 pF. Find the dielectric constant of the wax.

11. Define resistivity. Discuss Atomic view of resistivity and show that $\sigma = m/ne^2\tau$. Where symbols carry to their usual meaning.
12. What is the magnitude of magnetic field needed to be accelerated in the cyclotron? ($m_d = 3.34 \times 10^{-27} \text{ kg}$)
13. State & explain Hall Effect. Derive an expression for Hall coefficient for an Electron.
14. A circular loop of wire 10 cm in radius carries a current 100 Amp. What is the energy density at the center of the loop?
15. Prove that the speed of electromagnetic wave is equal to velocity of light in free space.
16. Derive an expression for one dimensional time independent Schrodinger wave equation.

OR

Define tunneling effect and derive the expression for transmission coefficient for a barrier of width a and potential of height V_0 .