

TRIBHUVAN UNIVERSITY  
INSTITUTE OF ENGINEERING  
Examination Control Division  
2079 Ashwin

Exam.	Back		
Level	BE	Full Marks	80
Programme	BCE, BME, BGE, BCH	Pass Marks	32
Year / Part	I/II	Time	3 hrs.

**Subject:** - Engineering Physics (SH 452)

- ✓ 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. What is physical pendulum? Derive its time period. Show that in the case of compound pendulum, the points of suspension and oscillation are interchangeable.

OR

Define the quality factor. Derive a relation of quality factor from the damped harmonic motion and show that quality is inversely proportional to damped constant.

2. Define transverse wave. Develop a differential equation of the wave in a stretched string and then find the velocity of transverse wave.
3. The volume of a room is  $600 \text{ m}^3$ , wall area of room is  $220 \text{ m}^2$ , the floor and ceiling area is  $120 \text{ m}^2$ . If average absorption coefficients for walls is 0.03, for ceiling is 0.80 and for floor is 0.06, calculate average absorption coefficient and reverberation time for this hall.
4. What is interference? Discuss the interference in thin wedge-shaped films and determine the fringe width for this case.

OR

Prove that the ratio of dispersive power to resolving is equal to the ratio of half width of peak and wavelength of incident light.

5. A beam of monochromatic light of wavelength  $5.82 \times 10^{-7} \text{ m}$  falls normally on a glass wedge with the wedge angle of 20 sec of an arc. If the refractive index of glass is 1.5, find the numbers of interference fringes per cm of the wedge length.
6. A 200 mm long glass tube is filled with a solution of sugar, containing 15 gm of sugar in 100 ml of water. The plane of polarized light passing through this solution is rotated through  $25^\circ 16'$ . Find the specific rotation.
7. An achromatic doublet of focal length 90 cm is to be made of two lenses, the material of one having 1.5 times the dispersive power of the other. The doublet is a converging type. Find the focal length of each lens.
8. Show that, Numerical Aperture (NA) =  $\mu_1 \sqrt{2\Delta}$ ; where  $\mu_1$  is refractive index of core of optical fiber,  $\Delta$  is fractional change in refractive index. Also write the physical significance of NA.
9. Define quadrupole moment. Determine the expression for electric field intensity due to quadrupole in axial line.

OR

Prove the relations  $q_i = q \left(1 - \frac{1}{k}\right)$  and  $\bar{D} = \epsilon_0 \bar{E} + \bar{P}$ , where symbol carry their usual meanings.

10. An air filled parallel plate capacitor has a capacitance of 1.32pF. The separation of the plates is double and wax is inserted between them. The new capacitance is 2.57pF. Find the dielectric constant of wax.

11. The super conducting state of a lead specimen has critical temperature  $6.2^{\circ}\text{K}$ . at zero magnetic field and the critical field is  $0.064 \times 10^6 \text{ A/m}$  at  $0^{\circ}\text{K}$ . Estimate the critical field at  $5^{\circ}\text{K}$ .

12. Describe the principle and working of cyclotron. What are the limitations of cyclotron and explain how synchrotron satisfies the limitations of cyclotron?

*OR*

Determine the energy stored in an inductor and prove that energy density due to magnetic field is directly proportional to square of field strength.

13. Derive an expression for energy stored in magnetic field. Show that the energy stored per unit volume is directly proportional to the square of magnetic field density. Compare this result with electric field density.

14. A solenoid having an inductance of  $6.3 \mu\text{H}$  is connected in series with a  $1.2 \text{ k}\Omega$  resistor. If a  $12 \text{ V}$  battery is connected across the pair, how long will it take for the current through the resistor to reach 80% of its final value?

15. Define Poynting vector. Prove that 
$$\vec{S} = \frac{1}{\mu_0} (\vec{E} \times \vec{B}).$$

16. A beam of electrons having energy of each  $6\text{eV}$  is incident on a potential barrier of height  $12\text{eV}$ . If the width of the barrier is  $1\text{\AA}$ . Calculate the percentage transmission of the beam through the barrier.

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1. Derive the time period of torsional pendulum and explain why it is not affected by 'g'. Determine the modulus of rigidity of metallic wire using torsional pendulum. [3+2]

OR

Establish the differential equation of motion for a driven harmonic oscillator and write the expression for Resonance condition. Explain the resonance and quality factor with appropriate graphs. [2+3]

2. A condenser of capacity  $1 \mu\text{F}$ , an inductance of  $0.2 \text{ H}$  and a resistance of  $800 \Omega$  are connected in series. Calculate the frequency and quality factor of the circuit. [2.5+2.5]
3. Derive the expression for the velocity of longitudinal wave in isotropic thin rod. [5]

OR

What is ultrasonic wave? Describe the methods for producing ultrasonic waves. [1+4]

4. A crown-glass convex lens has radii of curvature  $20 \text{ cm}$  and  $30 \text{ cm}$ . If  $\mu_b = 1.523$  and  $\mu_r = 1.513$ , find the longitudinal chromatic aberration produced by the lens. [5]
5. Explain the term division of amplitude. Show that the fringe width of interference pattern in wedge shaped thin film is inversely proportional to the refractive index of the medium. [1+4]
6. A diffraction grating is just able to resolve two lines of wavelengths  $5140.34 \text{ \AA}$  and  $5140.85 \text{ \AA}$  in the first order. Will it resolve two lines  $8037.2 \text{ \AA}$  and  $8037.5 \text{ \AA}$  in second order? [5]
7. What is double refraction? Explain how Nicol prism can be used as polarizer and analyzer. [1+4]

OR

Explain dispersive power and resolving power. Establish the relationship between them. [2+3]

8. What is stimulated power and resolving power? Explain why laser action can't occur without population inversion. How laser action is achieved in semiconductor? [1+2+2]
9. Show that electric field due to dipole across the axial line is half of the along the axial line. [5]
10. A particle of charge  $(-q)$  and mass  $m$  is placed midway between two equal positive charges  $q'$  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 time period

$$T = (\epsilon_0 \pi^3 d^3 m / q'q)^{1/2} \quad [5]$$

11. When a dielectric slab of thickness  $0.5 \text{ cm}$  and dielectric constant  $2.5$  is inserted between the plates of a parallel plate capacitor of area  $100 \text{ cm}^2$  and separation  $1.5 \text{ cm}$ . Calculate the resultant capacitance. [5]

12. Write the difference between super conductor and perfect conductor on the basis of Meissner's effect. Write the application of super conductor.
13. Write the limitations of Ampere's law. Derive an expression for magnetic flux density due to a current carrying loop at its axial point.

OR

- Determine the energy stored in an inductor. Show that the magnetic energy density is directly proportional to the square of magnetic field.
14. An LR circuit having inductance 4 H, resistance 1  $\Omega$  and applied D.C. e.m.f. of 6 V is switched at  $t=0$ . Find the power dissipated in the circuit at  $t = 4$  sec.
15. The maximum electric field 10 m from an isotropic point source of light is 10 V/m. What are (a) the maximum value of the magnetic field (b) what is the power of source. [2.5+1]
16. A beam of electrons having energy of each 4 eV is incident on a potential barrier of height 4 eV. If the width of the barrier is 10  $\text{\AA}$ , calculate the probability of reflection and interpret your result. [4]

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**Subject:** - Engineering Physics (SH 452)

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1. What is physical pendulum? Show that time period of physical pendulum is minimum when length of pendulum is equal to radius of gyration.

OR

Prove that LC circuit is an analog of simple harmonic motion and hence show that maximum energy in capacitor is equal to maximum energy in inductor.

2. If the relaxation time of a damped harmonic oscillator is 50 sec, find the time for which  
(i) the amplitude falls to  $\frac{1}{e}$  times the initial value and (ii) energy falls to  $\frac{1}{e^2}$  times the initial value.
3. What is reverberation time? Derive Sabine's relation for reverberation time.
4. What are Newton's rings? Give the necessary theory for the determination of the wavelength of monochromatic light using Newton's rings method.

OR

What are dispersive power and resolving power of a diffraction grating? Show that the resolving power of a grating is proportional to the number of order.

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. If the plane of vibration of the incident beam makes an angle of  $30^\circ$  with the optic axis, compare the intensities of extraordinary and ordinary light.
7. Two waves of the same frequency have amplitudes  $A_1$  units and  $A_2$  units. They interfere at a point where their phase difference is  $\phi$ . What is the resultant amplitude?
8. Calculate the refractive indices of the core and cladding materials of a fiber from following data.  $NA = 0.22$  and fractional refractive index change = 0.012.
9. Define electric dipole. Determine the electric field at a point along the axial line due to short dipole.

OR

At what distance along the central axis of a uniform charged plastic disc of radius 'a' is the electric field strength equal to half the value of field at the center of the surface of the disc?

10. Mention the steps to calculate the capacitance of a capacitor. Derive the capacitance of a cylindrical capacitor having inner radius a and outer radius b.

11. The current density in the cylindrical wire of radius  $R = 2.00$  mm is uniform across a cross section of the wire and is  $J = 2.0 \times 10^5$  Am<sup>-2</sup>. What is the current through the outer portion of the wire between radial distance  $R/2$  and  $R$ ?
12. Explain Ampere's circuital law. Calculate the magnetic field inside and outside a long straight wire carrying current  $I$ .

OR

- Obtain an expression for magnetic field intensity due to a circular coil carrying current at its axial point.
13. A strip of copper  $200$   $\mu\text{m}$  thick is placed in a magnetic field  $0.7$  T perpendicular to the plane of the strip and a current of  $20$  A is setup in the strip, calculate (i) Hall voltage (ii) Hall coefficient if the number of electrons per unit volume is  $8.5 \times 10^{28}$  m<sup>-3</sup>.
14. The induced magnetic field at radial distance  $6$  mm from the central axis of a circular parallel plate capacitor is  $2 \times 10^{-7}$  T. The plates have radius  $3$  mm. At what rate is the electric field between the plates changing?
15. What are contributions made by Maxwell to set up Maxwell's equations? Explain with suitable reasons.
16. An electron is confined to one dimensional region in which its ground state energy is  $3\text{eV}$ . (a) What is the length of the region? (b) How much energy is required to promote the electron to its first excited state?

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1. With appropriate graphs and equations, show that there are four collinear points in a bar pendulum. Also write the similarity between Torsional pendulum and Bar pendulum. [4+1]

OR

How does an LC circuit produce oscillations? Derive an expression for the frequency of LC oscillation. [3+2]

2. A wave of frequency 500 cycles/sec has a phase velocity of 350m/s (i) How far apart are two points  $60^\circ$  out of phase? (ii) What is the phase difference between two displacements at a certain point at times  $10^{-3}$  sec apart? [2.5+2.5]
3. Explain the formation of Newton's rings in reflected light. Prove that in reflected light the diameters of bright rings are directly proportional to the square root of odd natural numbers. [5]

OR

How can you produce and detect a beam of circularly and elliptically polarized light? Explain. [5]

4. A plane polarized light is incident perpendicularly on a quartz plate cut with faces parallel to the optic axis. Find the thickness of the quartz plate, which introduces a phase difference of  $60^\circ$  between E and O-rays. [5]
5. Discuss the characteristic features of various types of optical fiber. Point out the advantages of an optical fiber communication system. [3+2]
6. A wire has a torsional constant of 2Nm/radian. A disc of radius 5cm and mass 100gm is suspended at its center. What is the frequency of torsional oscillations? [5]
7. The ratio between maximum and minimum intensities is 36:1 in an interference pattern. Find the ratio of intensity at this point to that at the center of a bright fringe. [5]
8. A 200mm long tube containing a sugar solution rotates the plane of polarization by  $10^\circ$ . If the specific rotation of sugar is  $66^\circ$ , calculate the strength of the solution. [5]
9. Show that electric field intensity is the negative gradient of electric potential. Derive an expression for the electric potential at any point in space due to an electric dipole. [2+3]

OR

State Gauss' Theorem for electric field in the presence of dielectrics and derive the relation,  $D = \epsilon_0 E + P$ . [1+4]

10. A parallel plate capacitor with each plate of area  $100\text{cm}^2$  has a potential difference of 50V and a capacitance of  $100\mu\text{F}$ . If a mica of dielectric constant 5.4 is inserted between the plates, find the magnitude of (i) electric field in mica, (ii) displacement vector and (iii) polarization vector. [5]

11. What are the main causes behind the appearance of resistance in a conductor? Explain Meissner's effect and using it make the difference between perfect conductor and superconductor.

[1+2+2]

12. Write the limitations of Cyclotron? Show that maximum kinetic energy of charge particles coming out of Dees of cyclotron is directly proportional to square of frequency of oscillator.

[2+3]

OR

What conclusions can be drawn from the Hall effect? Derive an expression for number density of charge carrier in terms of Hall voltage.

[2+3]

13. Deuterons of mass  $3.3 \times 10^{-27}$  kg are accelerated in a cyclotron. If the magnetic field is 0.5 T (a) find the cyclotron radius for the particles which leave the cyclotron with a kinetic energy of 16 MeV and (b) how many times does the deuteron cross between dees if potential difference is 50 kV.

[5]

14. Calculate the displacement current density between the capacitor plates of area  $1.5 \times 10^{-2} \text{ m}^2$  and rate of change of electric field is  $1.5 \times 10^{12} \text{ V/ms}$ .

[5]

15. Using Maxwell's equations, prove that  $\nabla \cdot \vec{j} + \frac{\partial \rho}{\partial t} = 0$ . Where the symbols have their usual meanings.

[5]

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

$V = \infty$  for  $0 \leq x$  and  $x \geq a$

$V = 0$  for  $0 < x < a$

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

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

[5]

Where symbols carry their usual meanings.

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1. Define Restoring force. Determine the time period of oscillation in torsion pendulum. Hence explain, how can you determine the modulus of elasticity of a wire.

**OR**

Prove that LC oscillation is an analogy of spring mass system. Hence prove that maximum energy stored in the capacitor is equal to maximum energy stored in the inductor.

2. The energy of a guitar string of frequency 512 Hz reduces to half its initial value in 2 seconds. What is the Q value of the string?
3. The volume of a room is  $650 \text{ m}^3$ , wall area of room is  $220 \text{ m}^2$ , the floor and ceiling area each is  $130 \text{ m}^2$ . If average absorption coefficients for walls is 0.04, for ceiling is 0.85 and for floor is 0.05, calculate average absorption coefficient and reverberation time for this hall.
4. Define interference. Show that interference in thin film due to reflected and transmitted lights are complementary.

**OR**

Describe how will you produce linearly, circularly and elliptically polarized light. Explain with mathematical calculation.

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 50 cm in front of the first lens. Find the position and nature of the image.
6. Light of wavelength  $5000 \text{ \AA}$  is incident normally on a plane transmission grating. Find the difference in the angles of deviation in the first and third order spectra if the number of lines per cm on the grating surface is 6000.
7. What is Nicol Prism? Explain its construction. Write down some of its applications.
8. What is LASER? Define the terms: optical pumping and population inversion. Why the light in He-Ne laser is from Neon and not from Helium?
9. Define electric quadrupole. Determine the electric field at a point along the axial line due to quadrupole.

**OR**

At what distance along the central axis of a uniform charged plastic disc of radius 'a' is the electric field strength equal to half the value of field at the center of the surface of the disc?

- 10. An electric dipole consists of charges +2e and -2e separated by 0.75 nm. It is in electric field of strength  $3.4 \times 10^6 \text{ N/C}$ . Calculate the magnitude of the torque on the dipole when the dipole moment is (a) parallel, (b) at right angle and (c) opposite to the electric field.
- 11. A fully charged capacitor stores energy  $U_0$ . How much energy remains when its charge has decrease to  $1/2$  its original value?
- 12. Define resistivity. Explain the atomic view of resistivity and show that the resistivity  $\rho = \frac{m}{ne^2 \tau}$  where each symbol carries its usual meaning.
- 13. Obtain an expression for magnetic field intensity due to a circular coil carrying current at its axial point

OR

- Derive the expression for the growth and decay of current in LR circuit. Explain the meaning of inductive time constant.
- 14. A strip of copper 150  $\mu\text{m}$  thick is placed in a magnetic field  $B = 0.65 \text{ T}$  perpendicular to the plane of the strip, and a current  $i = 23 \text{ A}$  is set up in the strip. What hall potential difference  $V$  would appear across the width of the strip if there was one charge carrier per atom?
- 15. Define Poynting vector. Prove that  $\vec{S} = \vec{E} \times \vec{H}$  where each symbol carries its usual meaning.
- 16. Prove that the energy levels are quantized, when the electron is confined in an infinite potential well of width  $a$ .

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	I / II		

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1. Write down the difference between compound pendulum and torsion pendulum. Show that motion of torsion pendulum is angular harmonic in nature and hence find its time period.

OR

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

2. A meter stick swings about a pivot point at one of its end. What is the time period of oscillation? What is the distance of the pivot point from the centre of oscillation of the stick?
3. What is piezo-electric effect? How is it used for the production of ultrasonic?
4. What are Newton's rings? Give the necessary theory for the determination of the wavelength of monochromatic light using Newton's rings method.

OR

What are dispersive power and resolving power of a diffraction grating? Show that the resolving power of a grating is proportional to the number of order.

5. Interference fringes are produced with monochromatic light falling normally on a wedge shaped film of cellophane with refractive index 1.4. The angle of the wedge is 40 seconds of an arc and the distance between the successive fringes is 0.125 cm. Calculate the wavelength of light.
6. The refractive indices for o-ray and e-ray are 1.65 and 1.55 when incident on retardation plate. Calculate the thickness such that (i) the emergent ray is plane polarized. (ii) emergent ray is elliptically polarized. (wavelength of light is  $5893\text{\AA}$ )
7. How optical fibres are classified? Discuss their characteristics features. Point out the advantages of an optical fibre communication system.
8. A thin convex lens of focal length 15cm and a thin concave lens of focal length 10cm are arranged on a common axis at a distance of 10cm apart. Find the focal length of combination and position of principle point.
9. Prove that electric field due to a short dipole at axial point is twice that at equatorial point.

OR

Derive an expression for the electric field intensity at a point on the axis of a positively charged plastic ring. Also locate the point where the field is maximum.

10. Mention the steps to calculate the capacitance of a capacitor. Derive the capacitance per unit length of a cylindrical capacitor having inner radius  $a$  and outer radius  $b$ .

11. A copper wire of cross-sectional area  $5 \times 10^{-6} \text{ m}^2$  carries a steady current of 50A. Assuming one free electron per atom, calculate (i) Free electron density and (ii) average drift velocity. Given, Density of copper =  $8.9 \times 10^3 \text{ kgm}^{-3}$ , Molar mass of copper = 64 gm and Avogadro's number =  $6.02 \times 10^{23} \text{ mole}^{-1}$ .

12. Compare Amperere's law with Biot-Savart's law. Calculate the magnetic field inside and outside a long straight wire carrying current I using Amperere's law.

OR

Derive an expression for energy stored in magnetic field. Show that the magnetic energy density is proportional to square of magnetic field.

13. A strip of copper 150 $\mu\text{m}$  thick is placed in a magnetic field of strength 0.65T perpendicular to the plane of strip and a current of 23A is set up in the strip. Calculate the Hall voltage and Hall coefficient if the electron density is  $8.5 \times 10^{28} \text{ m}^{-3}$ .

14. The induced magnetic field at radial distance 6mm from the central axis of a circular parallel plate capacitor is  $2 \times 10^{-7} \text{ T}$ . The plates have radius 3mm. At what rate is the electric field between the plates changing?

15. Using Maxwell's equations show that the speed of electromagnetic waves in a medium is given by  $v = \frac{c}{\sqrt{\epsilon_r \mu_r}}$ , where symbols have their usual meanings.

$$v = \frac{c}{\sqrt{\epsilon_r \mu_r}}$$

16. The Position and momentum of a 1 keV electron are simultaneously determined. If its position is located to within  $1\text{\AA}$ . What is the % of uncertainty in its momentum?

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1. Give a theory of forced vibration and write the condition for amplitude resonance. Also include a note on sharpness of resonance. [3+1+1]
2. A 0.5 kg body oscillates in SHM on a spring that, when extended 2mm from its equilibrium position, has an 8N restoring force. What are the angular frequency of oscillation and the capacitance of an LC circuit with the same period if Inductor is 5 H? [3+2]
3. Distinguish between the particle velocity and wave velocity. Show that the function  $y = A \sin kx \cos \omega t$  satisfies the wave equation. [2+3]
4. Light containing two wavelengths  $\lambda_1$  and  $\lambda_2$  falls normally on a plano-convex lens of radius of curvature R resting on a glass plate. If the  $n^{\text{th}}$  dark ring due to  $\lambda_1$  coincides with  $(n-1)^{\text{th}}$  dark ring due to  $\lambda_2$ , prove that the radius of the  $n^{\text{th}}$  ring of  $\lambda_1$  is  $\sqrt{\frac{\lambda_1 \lambda_2 R}{\lambda_1 - \lambda_2}}$ . [5]

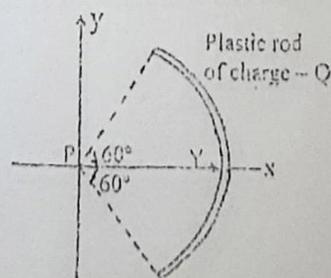
OR

Discuss the Fraunhofer diffraction pattern at a double slit and explain the condition for diffraction maxima and minima.

5. Light of wavelength 624nm is incident perpendicularly on a soap film ( $\mu = 1.33$ ) suspended in air. What are the non-zero a) least and b) second least thickness of the film for which the reflections from the film undergo fully constructive interference? [2.5+2.5]
6. What is Nicol Prism? How is it constructed? Write some of its applications. [1+3+1]
7. Explain Chromatic Aberration with suitable sketches? Show that longitudinal chromatic aberration is equal to  $\omega \times f$ , when object is at infinite, where symbols have their usual meanings. [5]
8. What is the principle behind the functioning of an optical fibre? Point out the advantages of optical fiber communication over conventional communication system? [2+3]
9. How much work is required to turn an electric dipole  $180^\circ$  in a uniform electric field of magnitude 46.0N/C if dipole moment is  $3.02 \times 10^{-25}$  C-m and the initial angle is  $64^\circ$ . [5]
10. Prove that the electric intensity at any point within the charged dielectric sphere is directly proportional to the distance of point from the Centre if the charge is uniformly distributed within the sphere. [5]

OR

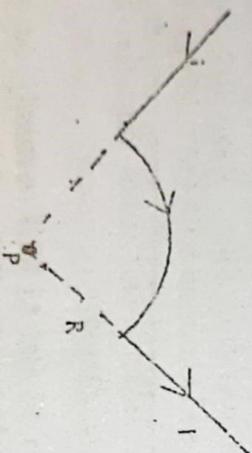
Figure below shows a plastic rod having a uniformly distributed charge  $-Q$ . The rod has been bent in a  $120^\circ$  circular arc of radius  $r$ . We place coordinate axes such that the axis of symmetry of the rod lies along the x axis and the origin is at the center of curvature P of the rod. In terms of  $Q$  and  $r$ , what is the electric field due to the rod at point P? [5]



11. What will be the change in the capacitance of a capacitor if a dielectric slab of thickness 'b' is inserted between the plates of a parallel plate capacitor. Take d-distance between the plates, b-thickness of the plate and K-relative permittivity. [5]
12. The resistance of a wire at 30°C is 3Ω. At what temperature will the resistance be 5Ω? The temperature coefficient of wire is  $5.66 \times 10^{-3} \text{C}^{-1}$ . [5]
13. Describe the working principle 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. [2+3]
14. Explain Ampere's theorem for the case of non-steady currents. Point out one similarity and one difference between the conduction and displacement currents. [3+2]

OR

Derive the magnetic field at point P due to curve wire segment flowing current I as shown in below figure. [R' is the radius of circle of Arc.] [5]



15. Prove that, the relation  $\frac{\partial \rho}{\partial t} = -\nabla \cdot \vec{J}$ , where symbols have their usual meanings. Also write the physical meaning of this equation. [3+2]
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 20Å, calculate the Reflection coefficient of the beam from the barrier. [5]

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1. Give a theory of forced vibration and write the condition for amplitude resonance. Also include a note on sharpness of resonance. [3+1+1]
2. A 0.5 kg body oscillates in SHM on a spring that, when extended 2mm from its equilibrium position, has an 8N restoring force. What are the angular frequency of oscillation and the capacitance of an LC circuit with the same period if Inductor is 5 H? [3+2]
3. Distinguish between the particle velocity and wave velocity. Show that the function  $y = A \sin kx \cos \omega t$  satisfies the wave equation. [2+3]
4. Light containing two wavelengths  $\lambda_1$  and  $\lambda_2$  falls normally on a plano-convex lens of radius of curvature R resting on a glass plate. If the  $n^{\text{th}}$  dark ring due to  $\lambda_1$  coincides with  $(n-1)^{\text{th}}$  dark ring due to  $\lambda_2$ , prove that the radius of the  $n^{\text{th}}$  ring of  $\lambda_1$  is  $\sqrt{\frac{\lambda_1 \lambda_2 R}{\lambda_1 - \lambda_2}}$ . [5]

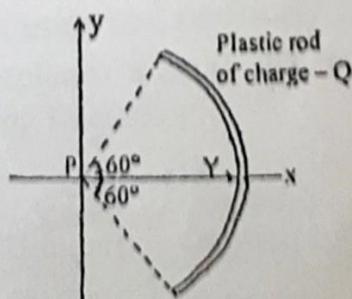
OR

Discuss the Fraunhofer diffraction pattern at a double slit and explain the condition for diffraction maxima and minima.

5. Light of wavelength 624nm is incident perpendicularly on a soap film ( $\mu = 1.33$ ) suspended in air. What are the non-zero a) least and b) second least thickness of the film for which the reflections from the film undergo fully constructive interference? [2.5+2.5]
6. What is Nicol Prism? How is it constructed? Write some of its applications. [1+3+1]
7. Explain Chromatic Aberration with suitable sketches? Show that longitudinal chromatic aberration is equal to  $\omega \times f$ , when object is at infinite, where symbols have their usual meanings. [5]
8. What is the principle behind the functioning of an optical fibre? Point out the advantages of optical fiber communication over conventional communication system? [2+3]
9. How much work is required to turn an electric dipole  $180^\circ$  in a uniform electric field of magnitude 46.0N/C if dipole moment is  $3.02 \times 10^{-25}$  C-m and the initial angle is  $64^\circ$ . [5]
10. Prove that the electric intensity at any point within the charged dielectric sphere is directly proportional to the distance of point from the Centre if the charge is uniformly distributed within the sphere. [5]

OR

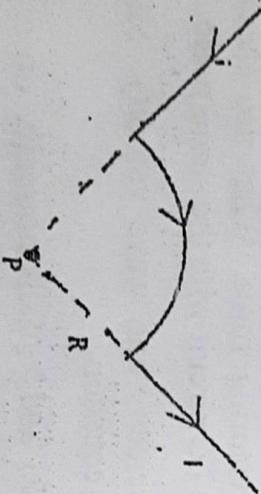
Figure below shows a plastic rod having a uniformly distributed charge  $-Q$ . The rod has been bent in a  $120^\circ$  circular arc of radius  $r$ . We place coordinate axes such that the axis of symmetry of the rod lies along the x axis and the origin is at the center of curvature P of the rod. In terms of  $Q$  and  $r$ , what is the electric field due to the rod at point P? [5]



11. What will be the change in the capacitance of a capacitor if a dielectric slab of thickness 'b' is inserted between the plates of a parallel plate capacitor. Take d-distance between the plates, b-thickness of the plate and K-relative permittivity. [5]
12. The resistance of a wire at 30°C is 3Ω. The temperature coefficient of wire is 5.66 × 10<sup>-3</sup>°C<sup>-1</sup>. Take d-distance between the plates, b-thickness of the plate and K-relative permittivity. [5]
13. Describe the working principle 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. [2+3]
14. Explain Ampere's theorem for the case of non-steady currents. Point out one similarity and one difference between the conduction and displacement currents. [3+2]

OR

Derive the magnetic field at point P due to curve wire segment flowing current I as shown in below figure. [R' is the radius of circle of Arc.] [5]



15. Prove that; the relation  $\frac{\partial \rho}{\partial t} = -\nabla \cdot \vec{J}$ , where symbols have their usual meanings. Also write the physical meaning of this equation. [3+2]

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 20Å, calculate the Reflection coefficient of the beam from the barrier. [5]

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Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE, BME, BGE	Pass Marks	32
Year / Part	I / II	Time	3 hrs,

**Subject: - Engineering Physics (SH452)**

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

1. How forced E-M oscillation is set up? Write the differential equation with its solution of such oscillation. And hence discuss about resonance curve and significance of Quality factor. [1+2+2]
2. A mass of 1 kg is suspended from a spring of spring constant 25N/m. If the undamped frequency is  $\frac{2}{\sqrt{3}}$  times the damped frequency, what will be the damping factor? [5]
3. At  $t = 0$ ; the displacement  $x(0)$  of the block in linear oscillator is -8.50 c.m. The Block's velocity  $v(0)$  then is -0.920 m/s and its acceleration  $a(0)$  is  $47 \text{ m/s}^2$ . Find  
 a) Angular frequency b) Phase constant [2.5+2.5]
4. How Newton's Rings are differ from Haidinger fringes? Derive an expression for the diameter of bright rings in transmitted light. How can you obtain central fringe dark in this system? [1+3+1]

**OR**

- Define diffraction of light. Show that the intensity of first maxima is  $1/22$  of the central maxima. [1+4]
5. Show that fringe width of wedge shaped film is constant for a given wedge angle. [5]
  6. A Quarter wave plate is meant for  $\lambda_0 = 5.893 \times 10^{-5} \text{ cm}$ . what phase retardation  $\phi$  will show for  $\lambda = 4.358 \times 10^{-5} \text{ cm}$ ? (Neglect changes of  $\mu_0$  and  $\mu_e$  with  $\lambda$ ) [5]
  7. Define cardinal points of a coaxial lens system. Find the equivalent focal length for the combination of two coaxial thin lens of focal length ' $f_1$ ' and ' $f_2$ ' separated by a distance ' $d$ '. [2+3]
  8. Discuss the significance of numerical aperture (NA). How does it depend on refractive index of cladding and core? [2+3]
  9. How Gauss law is superior than Columb's law? Show that the electric field on the axis of a uniformly charged disk is equal to the electric field near an infinite plane of charge in limiting case. [1+4]
  10. Show that the motion of an electron constrained to move along the axis of a thin non conducting ring of radius 'a' uniformly and positively charged with linear charge density  $\lambda$  is simple harmonic if it is displaced a small distance 'x' along the axis ( $x \ll a$ ) and released. Hence find the oscillating frequency. [5]

**OR**

- 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? [5]

11. Prove that the capacitance of a concentric spherical capacitor of radii  $a$  and  $b$  is  $C = 4\pi\epsilon_0[b^2/(b-a)]$ . If outer plate is charged positively and inner sphere is earthed. [5]
12. A copper wire has cross-sectional area  $3.31 \times 10^{-6} \text{ m}^2$  and carries a current of 10 A. What is the drift speed of the electrons? (Density of copper =  $8.95 \text{ gm cm}^{-3}$ , Avogadro's number  $N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$ , molar mass of copper = 64 gm) [5]
13. A circular parallel plate capacitor of area  $154 \text{ cm}^2$  is being charged has a uniform current density of a displacement current, having a magnitude  $20 \text{ A/m}^2$ . Calculate (a) the magnitude of magnetic field at the distance  $r = 50 \text{ mm}$  about the central axis between the plates. (b)  $dE/dt$  in this region [2.5+2.5]
14. With necessary circuit and graph, derive an expression for rise and fall of current in LR circuit. Hence explain the inductive time constant for this circuit. [2+3]

**OR**

What is cyclotron? Show that the maximum energy of the ion in cyclotron is directly proportional to the square of the frequency. [1+4]

15. Sunlight strikes the earth outside its atmosphere with an intensity of  $2 \text{ Cal/cm}^2\text{-min}$ . Calculate the magnitude of electric and magnetic fields. [5]
16. Using Schrodinger wave equation, calculate the values of the energy of a particle in an one-dimensional infinitely deep potential well. Indicate graphically the first three wave function for such a particle. [3+2]

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Exam.	Back		
Level	BE	Full Marks	80
Programme	BCE, BGE, BME	Pass Marks	32
Year / Part	I / II	Time	3 hrs.

**Subject: - Engineering Physics (SH452)**

- ✓ 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 the resonance condition in an LCR circuit. Briefly explain the quality factor and hence show the quality factor will be higher if the band width of the circuit is lower.
2. What is Ultrasound? How these waves are produced? Write the fields of major application of Ultrasound.
3. Show that the wave equation of a transverse wave in a string is

$$\frac{d^2y}{dx^2} = \frac{1}{v^2} \frac{d^2y}{dt^2}, \text{ where } v = \sqrt{\frac{F}{\mu}}, \text{ where } \mu = \text{mass per unit length}$$

4. Explain how Newton's rings are formed and describe the method for the determinations of refractive index of liquid using Newton's ring formula.

**OR**

Discuss Fraunhofer diffraction due to a single slit. Draw a curve indicating distribution of intensity of diffraction patterns. Is there any fundamental difference between interference and diffraction? Give the reasons.

5. What is double Refraction? Explain how Nicol prism can be used as polariser and analyser?
6. A diffraction grating has 4000 lines per cm and is used at normal incidence. Calculate the dispersive power of the grating in the third order spectrum for the wavelength 500nm.
7. Write down the characteristics of LASER and its use in holography. How semi conductor laser is produced?
8. It is desired to make a converging achromatic lens of mean focal length 30 cm by using two lenses of materials A and B. If the dispersive powers of A and B are in the ratio 1:2. Find the local length of each lens.
9. Define electric flux. Determine electric field due to an infinite line of charge.

**OR**

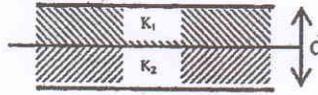
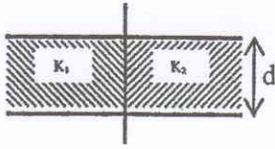
What is dielectric constant? Prove the relation  $\vec{D} = \epsilon_0 \vec{E} + \vec{P}$ , Where symbols carry their usual meanings.

10. Two tiny conducting balls of identical mass  $m$  and charge  $q$  hang from non conducting thread each of length  $L$ . Derive an expression for the equilibrium separation ' $x$ ' between the balls assuming that the separation angle to be small.

**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?

11. A parallel plate capacitor contains two dielectric slabs (of equal dimensions) of dielectrics  $K_1$  and  $K_2$  as shown in figure below (i) Find the capacitance in each case if  $A$  is the area of each plate. (ii) If  $K_1 = 2$  and  $K_2 = 3$ , what will be the ratio of the capacitance in two cases.



12. A p.d. of 1V is applied to a 30.5 m length of copper wire (diameter 0.02 inch). Calculate (i) The current (ii) Current density (iii) The electric field strength (Given, Resistivity of copper is  $1.7 \times 10^{-8} \Omega m$ ).
13. Discuss the Hall Effect. Derive (i) Hall voltage (ii) Hall coefficient and (iii) Hall resistance. Explain that the Hall resistance leads to the quantum Hall effect.
14. Derive an expression for the magnetic flux density inside a long solenid, carrying current  $I$ , at a point near its center.

**OR**

Derive an expression for growth and decay of current in inductance and resistance circuit. Also explain the decay current in LR circuit.

15. Prove that charge conservation theorem with the help of maxwell's equation of electromagnetism.
16. Using the uncertainly principle, calculate the minimum uncertainty in velocity when an electron is confined to a box having a length 1nm. Given,  $m = 9.1 \times 10^{-31}$  Kg,  $h = 6.6 \times 10^{-34}$  Js.

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Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE, BGE, BME	Pass Marks	32
Year / Part	I / II	Time	3 hrs.

**Subject: - Engineering Physics (SH452)**

- ✓ 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 compound pendulum and show that they are interchangeable. What length of the pendulum has its maximum time period?

**OR**

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

2. What are basic conditions for acoustics of buildings? Derive Sabine's reverberation formula and also write its two importances.
3. A rod vibrating at 12Hz generates harmonics waves with amplitude of 1.5 mm in a string of linear mass density 2gm/m. If the tension in the string is 15N, what is the average power supplied by the source.
4. Explain the circular nature of the Newton's interference fringes. Show that square of radius of the nth bright fringe of Newton's ring due to the reflected light is proportional to  $2n-1$ .

**OR**

Show that coherent light waves represented by equation  $E_x = E_1 \sin(\omega t + \delta)$   
 $E_y = E_2 \sin \omega t$

Give rise generally to an elliptically polarised wave that can become linearly and circularly polarised wave under special condition.

5. What is the highest order spectrum which may be seen with monochromatic light of wavelength 600 nm by means of a diffraction grating with 4500 Lines/cm.
6. Write the physical significance of dispersive and resolving power of grating. Also establish the relation between them.
7. What is population inversion? Explain why laser action cannot occur without population inversion between atomic levels? Write a method for getting He-Ne Laser.
8. Two thin lens of focal length  $f_1$  and  $f_2$  separated by a distance  $d$  have equivalent focal length 50 cm. The combination satisfies the conditions for no chromatic aberration and minimum spherical aberration. Find the value of  $f_1$ ,  $f_2$  and  $d$ . Assume that both the lens are the same material.
9. What is quadruple? Derive an expression of the electric field intensity at a point due to quadruple at axial line?

**OR**

Find the expression for the electric field intensity at a point along the center perpendicular axis of the charge disk and distance  $z$  from center. Extend this result in infinite charge disk.

10. If copper coin has mass 3.11 gm, what is the total charge on the nucleus of the atoms in the coin? Also find number of protons inside the nucleus. Molar mass ( $M$ ) = 63.5 gm/mole, Avogadro number ( $N_A$ ) =  $6.02 \times 10^{23}$  atom/mole.
11. Discuss a microscopic view of ohm's law and show that resistivity of a conductor is independent of the external electric field.

**OR**

State and derive Ampere's law in magnetism. Why and how Maxwell modified it?

12. A circular coil having radius  $R$  carries a current  $I$ . Calculate the magnetic flux density at an axial distance  $x$  from the center of the coil. Explain how the coil behaves for a large distance point and at what condition field will be maximum?
13. Find the expression for maximum energy of a rotating particle in a cyclotron. How cyclotron is different from synchrotron?
14. An inductance  $L$  is connected to a battery of emf  $E$  through a resistor. Show that the potential difference across the inductance after time  $t$  is  $V_L = Ee^{-(R/L)t}$ . At what time is the potential difference across the inductance equal to that across the resistance such that  $i = i_0/2$ .
15. Write Maxwell equation in differential form. Convert them into integral form. Explain the physical significance of each of them.
16. Derive Schrodinger time independent wave equation. Explain the physical significance of the wave functions.

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Exam.	New Back (2066 & Late Batch)		
Level	BE	Full Marks	80
Programme	BCE, BGE, BME	Pass Marks	32
Year / Part	I / II	Time	3 hrs.

*Subject: - Engineering Physics (SH452)*

- ✓ 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. What is compound pendulum? Derive the expression of its time period and discuss about the collinear points in compound pendulum.

**OR**

Discuss about the damped electromagnetic oscillation. Find the expression for damped frequency. Also discuss about over damping, critical damping and under damping conditions.

2. In damped harmonic motion, calculate the time in which (i) its amplitude and (ii) its energy falls to  $1/e$  of its undamped value if the mass of the system is 0.25 gm and damping constant is 0.01 g/s?
3. Define reverberation time. Derive Sabine's formula for reverberation time.
4. Explain the formation of Newton's rings in reflected light. Prove that in reflected light the diameters of dark rings are proportional to the square roots of natural numbers.

**OR**

Describe how will you produce linearly, circularly and elliptically polarized light.

5. 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.
6. A glass wedge of angle 0.01 radian is illuminated by monochromatic light of wavelength  $6000\text{\AA}$  falling normally on it. At what distance from the edge of the wedge, will the  $10^{\text{th}}$  fringe be observed by reflected light?
7. Define acceptance angle in optical fiber. Show that, Numerical Aperture (NA) =  $\mu_1 \sqrt{2\Delta}$ ; where  $\mu_1$  is refractive index of core of optical fiber,  $\Delta$  is fractional refractive index change.
8. Light is incident normally on a grating 0.5cm wide with 2500 lines. Find the angles of diffraction for the principal maxima of the two sodium lines in the first order spectrum,  $\lambda_1 = 5890\text{\AA}$  and  $\lambda_2 = 5896\text{\AA}$ . Are the two lines resolved?
9. Derive an expression for the electric field and 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  $x \gg a$ ?

**OR**

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

10. A neutral water molecule in its vapor state has an electric dipole moment of magnitude  $7.1 \times 10^{-30}$  c-m. If the molecule is placed in an electric field of  $2.5 \times 10^4$  N/C, (i) what maximum torque can the field exert on it? (ii) How much work must an external agent do to turn this molecule end for end in this field?
11. Prove the capacitance of a concentric spherical capacitor of radii  $a$  and  $b$  is  $C = 4\pi\epsilon_0 \left[ \frac{b^2}{b-a} \right]$ . If outer plate is positively charged and inner sphere is earthed.
12. Differentiate between semiconductors and super conductors. Discuss about critical magnetic field in superconductors. Also prove that superconductors are diamagnetic in nature.
13. Derive the relation for rise and fall of current in LR circuit. Explain the graph between current and time and obtain inductive time constant in both cases.

**OR**

State Ampere's law. Find out the expression for magnetic field at a point outside, inside and on the surface of a current carrying conductor using this law.

14. What is self induction? Develop a relation for induced emf in a coil. Calculate the self-inductance of the solenoid having length  $l$ , number of turns  $N$ , area of cross-section  $A$ , and current  $I$ .
15. A certain plane electromagnetic wave emitted by a microwave antenna has a wavelength of 3cm and a maximum magnitude of electric field of  $2 \times 10^4$  v/cm.
- (i) What is the frequency of the wave?
  - (ii) What is the maximum magnetic field? and
  - (iii) What is the maximum energy density?
16. Prove that the energy levels are quantized, when the electron is confined in an infinite potential well of width "a".

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Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE, BGE, BME	Pass Marks	32
Year / Part	I / II	Time	3 hrs.

*Subject: - Engineering Physics (SH452)*

- ✓ 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 motion of a disk of a torsion pendulum is angular harmonic motion. Find an expression for its angular frequency and time period of oscillation.

**OR**

What is em oscillation? Derive the differential equation of forced em oscillation. Hence find its resonance frequency.

2. A mass of 2 kg is suspended from a spring of spring constant 18 N/m. If the undamped frequency is  $2/\sqrt{3}$  times the damped frequency, what will be the damping factor?
3. The volume of a hall is  $475 \text{ m}^3$ , the area of the wall is  $200 \text{ m}^2$ , areas of the floor and ceiling each is  $100 \text{ m}^2$ . If absorption coefficients of the wall, ceiling and floor are 0.03, 0.04 and 0.05 respectively, find the reverberation time for the hall.
4. Is it necessary that the interfering waves should have equal amplitude? Derive an expression for condition of constructive and destructive interferences for reflected light in case of thin transparent film of uniform thickness.

**OR**

What are dispersive power and resolving power of a diffraction grating? Show that the resolving power of a grating is proportional to the number of order.

5. White light falls normally on a film of soapy water of thickness  $5 \times 10^{-5} \text{ cm}$  and refractive index 1.33. Which wavelength in the visible region will be reflected most strongly?
6. What are retardation plates? Find out an expression to find the thickness of a retardation plate that produces elliptically polarized light.
7. Derive the expression for the equivalent focal length of two thin lenses having focal lengths  $f_1$  and  $f_2$  separated by a distance  $d$ . Also find the position of principal points.
8. If the numerical aperture be 0.2441 and refractive index of core be 1.50, calculate the refractive index of the cladding and acceptance angle in an optical fiber.
9. What is quadrupole moment? Is it vector quantity? Derive an expression of electric field intensity due to linear quadrupole at axial line.

**OR**

What is electric flux? Is it scalar quantity? Use Gauss's law to find the electric field strength outside and inside of uniformly charge distributed conducting sphere of radius  $R$ .

10. If a parallel plate capacitor is to be designed to operate in an environment of fluctuating temperature, prove that the rate of change of capacitance  $C$  with temperature  $T$  is given by  $\frac{dC}{dT} = C \left[ \frac{1}{A} \frac{dA}{dT} - \frac{1}{x} \frac{dx}{dT} \right]$ , where symbol carries its usual meaning.
11. The super conducting state of a lead specimen has critical temperature 6.2 K at zero magnetic field and the critical field is  $6.4 \times 10^4$  A/m at 0 K. Estimate the critical field at 5K.
12. An inductance  $L$  is connected to battery of emf  $E$  through a resistance. Show that the inductor affects the growth of current  $i = i_0 \left( 1 - e^{-\left(\frac{Rt}{L}\right)} \right)$ . At which condition it reduces to  $0.63i_0$ .

**OR**

Derive an expression for energy stored in magnetic field. Show that the magnetic energy density is directly proportional to the square of magnetic field.

13. A copper strip 2 cm wide and 1 mm thick is placed in magnetic field 1.5T. If a current of 200A is setup in the strip, calculate (a) Hall voltage (b) Hall mobility of the number of electrons per unit volume is  $8.4 \times 10^{28} \text{ m}^{-3}$  and resistivity is  $1.72 \times 10^{-8} \text{ ohm-m}$ .
14. A parallel plate capacitor with circular plates is being charged by varying electric field of  $1.5 \times 10^{12} \text{ Vm}^{-1}\text{s}^{-1}$ . Evaluate the induced magnetic field if the radius of the plate is 55 mm and displacement current.
15. Write down the Maxwell's equations in free space and in dielectric medium. With the help of Maxwell's equations, derive charge conservation theorem.
16. An electron is confined in an one dimensional infinite potential well of width  $l$ , the potential energy is  $V(x) = \begin{cases} 0 & 0 \leq x \leq l \\ \infty & x < 0 \text{ and } x > l \end{cases}$ . Find the eigenfunctions  $\Psi_n(x) = A \sin\left(\frac{n\pi x}{l}\right)$  and energy eigenvalues  $E_n = \frac{n^2 \pi^2 \hbar^2}{2ml^2}$ .

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03      TRIBHUVAN UNIVERSITY  
INSTITUTE OF ENGINEERING  
**Examination Control Division**  
2072 Magh

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE, BGE, BME	Pass Marks	32
Year / Part	I / II	Time	3 hrs.

**Subject: - Engineering Physics (SH452)**

- ✓ 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. Prove that three exits four collinear point in a bar pendulum.

**OR**

Derive a relation for current floping in the circuit containing a resistor, an inductor and a capacitor in series with a sinusoidally varying emf. Find the condition for current responce.

2. A simple pendulum of length 40 cm and mass 50 gm is suspended in a car that is traveling with a constant speed 40 m/s around a circle of radius 100 m. If the pendulum undergoes small oscillations in a radial direction about its equilibrium position, what will be its frequency of oscillation?
3. Write a plane progressive wave equation for a wave propagating along the +ve x-axis. Prove the following relations:
  - i) Particle velocity at a point = - (Wave velocity) X (Slope of the displacement curve at that point)
  - ii) Particle acceleration at a point = (Wave speed)<sup>2</sup> X (Curvature of the displacement curve at that point)
4. What is chromatic aberration? Show that longitudinal chromatic aberration is equal to (i)  $\omega \times f$ , when object is at infinite and (ii)  $\frac{\omega \times v^2}{f}$ , when object is at finite. Where symbols have their usual meaning.
5. What are Newton's rings? How can you determine the refractive index of given liquid using Newton's rings experiment?

**OR**

Differentiate between quarter wave plate and half wave plate. Use the reference of double refraction to describe with diagram, how you distinguish positive and negative crystal.

6. What is the difference between the resolving and dispersive power of the plane transmission grating? Show that both resolving and dispersive powers are directly proportional to order of the spectrum.
7. A sugar solution in a tube of length 200 mm produces an optical rotation 13°. The solution is then diluted to (1/3) of its previous solution concentration. Find the optical rotation produced by 35 cm long tube containing the diluted solution.

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8. An optical fiber has a numerical aperture (NA) of 0.22. The core has refractive index 1.60. Calculate the acceptance angle in water that has refractive index of 1.33. Also, calculate the critical angle at core cladding interface.
9. Define electric dipole. Charges of an electric dipole are replaced by identical charges; find the electric field and potential at a point on its axial line.

**OR**

Derive a relation for electric field at a point on the axis of a positively charged plastic ring. Show that if an electron is constrained within the axis of ring, motion of electron will be SHM.

10. If a disk of radius 2.5 cm has a surface charge density of  $8.6 \mu\text{C}/\text{m}^2$  on its upper surface. What is the electric field (i) at a surface of the disk and (ii) at a point on the central axis at a distance 15 cm from the disk?
11. A parallel plate capacitor whose capacitance  $C$  is 13.5 pF is charged by a battery to a potential difference  $V = 12.5$  V between its plates. The charging battery is now disconnected and a porcelain slab ( $k = 6.50$ ) is supplied between the plates. (a) What is the potential energy of the capacitor before the slab is inserted (b) What is the potential energy of the capacitor –slab device after the slab is inserted?
12. A copper wire of cross-section area  $3 \times 10^{-6} \text{m}^2$  carries a steady current of 60A. Assuming one electron per atom. Calculate (i) free electron density and (ii) average drift velocity. Given, Density of Cu =  $8.9 \times 10^3 \text{kg}/\text{m}^3$ , Molar mass of Cu = 64 and Avogadro's Number =  $6.02 \times 10^{23}/\text{mole}$ .
13. Determine the energy stored in an inductor. Also, determine the energy density in magnetic field.

**OR**

Obtain an expression for magnetic field intensity due to a circular coil carrying current at its axial point. Compare the result with that due to short bar magnet.

14. Suppose a cyclotron is operated at an oscillator frequency of 15 MHz and has a dee of radius 55 cm (i) What is the resulting kinetic energy of deuteron? (ii) What is the magnetic field needed for deuteron to be accelerated in the cyclotron? Given: mass of the deuteron =  $3.34 \times 10^{-27} \text{kg}$ .
15. Write Maxwell's equations for non conducting medium. Using these equations determine the electromagnetic wave equation in terms of magnetic field for a non conducting and an-isotropic medium having finite permittivity ( $\mu$ ) and finite permeability ( $\epsilon$ ). Hence prove that the velocity of electromagnetic wave is equal to velocity of light in free space.
16. What is the physical meaning of wave function? Derive the Schrodinger time independent wave equation.

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Exam.	Regular / Back		
Level	BE	Full Marks	80
Programme	BCE, BME, BGE	Pass Marks	32
Year / Part	I / II	Time	3 hrs.

**Subject: - Engineering Physics (SH452)**

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

1. Develop and solve the differential equation of damped harmonic oscillator subjected to a sinusoidal force. Then obtain expression for its maximum amplitude and quality factor. [5]

**OR**

Obtain an expression for current in a driven LCR circuit and discuss how the current leads or lags the applied voltage in phase:

- a) When the net reactance in circuit is inductive and
- b) When the reactance in circuit is equal to resistance. Illustrate it with the help of a figure.

2. A circuit has  $L = 2 \text{ mH}$ ,  $C = 1.6 \mu\text{F}$  and  $R = 1.5 \Omega$ . (a) After what time  $t$  will the amplitude of charge oscillations drop to one half of its initial value. (b) To how many periods of oscillations does this correspond? [5]

3. Calculate the reverberation time for a hall of volume  $1400 \text{ m}^3$ , which has seating capacity of 110 persons with full capacity of audience and when audience are occupying only cushioned seats. The relevant data for the hall are: [5]

SN	Surface	Area ( $\text{m}^2$ )	Coefficient of absorption
1	Plastered Wall	98	0.03
2	Plastered Ceiling	144	0.04
3	Wooden Door	15	0.06
4	Cushioned Chairs	88	1.00
5	Audience	150	4.70

4. Prove that the condition for achromatism for the combination of two lenses of focal length  $f_1$  and  $f_2$  having dispersive power  $w_1$  and  $w_2$  placed at a separation  $x$  is [5]

$$\frac{w_1}{f_1} + \frac{w_2}{f_2} = \frac{x}{f_1 f_2} (w_1 + w_2)$$

Also prove that the separation between the lenses is equal to the focal length if  $f_1 = f_2$ .

5. In He-Ne laser, the lasing action is due to Ne gas. Then what is the role of the gas in it? Explain how the He-Ne laser works with a suitable energy level diagram on the basis of four level scheme for its action. [5]

6. Two sources of intensities  $4I$  and  $I$  are used in an interference experiment. Obtain the intensities at points where the waves from two sources superimpose with a phase difference of (a) 0 (b)  $\frac{\pi}{2}$  (c)  $\pi$ . [5]

**OR**

Explain the dispersive and resolving power of a diffraction grating. Prove that the ratio of dispersive power to resolving power is equal to the ratio of half width of peak and wavelength of incident light.

7. Derive the necessary formula for linearly, circularly and elliptically polarized light when light is emerged out of the doubly refraction crystal. [5]
8. What are Newton's rings? Derive the relation for the diameter of bright rings. What is the difference between the rings observed by reflected light and by transmitted light? Explain how does the pattern appear when white light is used? [5]
9. Define electric displacement vector. Develop a relation between electric displacement vector, electric field and polarization. Also prove that induced charge in dielectric is always less than free charge. [5]

OR

A dielectric sphere of radius  $R$  is charged uniformly. Obtain expressions for electric field intensity (a) outside (b) at the surface and (c) inside the sphere.

10. To similar balls each of mass  $m$  are hung from silk threads of length  $l$  and carry similar charges  $q$ . Assume that the angle made by each thread with vertical,  $\theta$  is small. Show that

$$x = \left( \frac{q^2 l}{2\pi \epsilon_0 mg} \right)^{\frac{1}{3}},$$

where  $x$  is separation between the balls. Also calculate the charge  $q$  on the hung mass if  $l = 1.2$  m,  $m = 20$  g and  $x = 3$  cm. [5]

11. The parallel plates in a capacitor, with a plate area of  $8.5 \text{ cm}^2$  and air filled separation of  $3$  mm are charged by a  $6$  V battery. They are then disconnected from the battery and pulled apart to a separation of  $8$  mm. Neglecting fringing, find (a) the potential difference between the plates (b) the initial energy stored and (c) final energy stored. [5]

OR

A capacitor discharges through a resistor  $R$ . (a) After how many times constant ( $\tau_c$ ) does it charge fall to one half of its original value? (b) After how many time constants does the stored energy drop to half of its initial value?

12. What is Biot-Savart law? Derive an expression for flux density due to a current carrying circular loop at its axial point. [5]
13. If a parallel plate capacitor with circular plate be charged, prove that the induced magnetic field at a distance  $r$  in the region between the plates be [5]

$$B = \frac{1}{2} \mu_0 \epsilon_0 r \frac{dE}{dt} \text{ for } r \leq R \text{ and}$$

$$B = \frac{1}{2} \frac{\mu_0 \epsilon_0 R^2}{2r} \frac{dE}{dt} \text{ for } r \geq R$$

14. In a Hall-effect experiment, a current of  $3$  A sent lengthwise through a conductor  $1$  cm wide,  $4$  cm long and  $1 \mu\text{m}$  thick, produces a transverse Hall voltage of  $10 \mu\text{V}$ , when a magnetic field of  $1.5$  T is passed perpendicularly through the thickness of the conductor. Calculate (a) drift velocity of the charge carriers and (b) the number density of charge carriers. [5]
15. Define poynting vector and develop an expression of it interms of electric and magnetic fields. Using the poynting vector calculate the maximum electric and magnetic fields for sun-light if the solar constant is  $1.4 \text{ KW/m}^2$ . [5]
16. A beam of electrons having energy of each  $3$  eV is incident on a potential barrier of finite height  $4$  eV. If the width of the barrier is  $20 \text{ \AA}$ , calculate the percentage transmission of the beam through the barrier. [5]

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Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE, BGE, BME	Pass Marks	32
Year / Part	I / II	Time	3 hrs.

**Subject: - Engineering Physics (SH452)**

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

**OR**

Define the quality factor (Q). Derive a relation of quality factor (Q) from the damped harmonic motion and show that the quality factor (Q) is inversely proportional to damping constant (b).

2. An oscillatory motion of a body is represented by  $y = ae^{i\omega t}$  where y is displacement in time t, a is its amplitude and  $\omega$  is angular frequency. Show that the motion is simple harmonic.
3. What is Ultrasound? How these waves are produced? Differentiate such waves from ordinary sound wave.
4. Why colours are observed when soap bubble is exposed to sunlight? Show that the consecutive bright or dark fringes are observed when the thickness of the film increases by  $\frac{\lambda}{2}$  in an inclined plane.

**OR**

What is plane diffraction grating? How is it used to find the wavelength of a monochromatic light experimentally?

5. What is an optical fiber? How is it made? Write down the main differences between step index and graded index multimode optical fibers with well diagrams.
6. A 200 mm long glass tube is filled with a solution of sugar, containing 15 gm of sugar in 100 ml of water. The plane of polarized light, passing through this solution, is rotated through  $25^{\circ}17'$ . Find the specific rotation of sugar.
7. Two thin converging lenses of focal lengths 0.2 m and 0.3 m are placed coaxially 0.1 m apart in air. An object is located 0.6 m in front of the lens of smaller focal length. Find the position of principal points and that of image.
8. What is double refraction? Show that a beam of plane polarized light is converted into elliptically polarized light when it passes through a quarter-wave plate.

9. Obtain an expression for electric field at an axial distance  $x$  from the centre of the flat circular disc of radius  $R$  that carries a uniform surface charge density  $\sigma$ . Extend your result to calculate potential at a distance  $x$ .

**OR**

A thin ring made of plastic of radius  $R$  is uniformly charged with linear charge density  $\lambda$ . Calculate the electric field intensity at any point at an axial distance  $Y$  from the centre. If electron is constrained to be in axial line of the same ring, show that the motion of electron is simple harmonic.

10. A copper strip 2.5 cm wide and 1.5 mm thick is placed in magnetic field with  $B = 2.5$  T perpendicular to the plane of the strip and away from the reader. If a current of 250 A is set up in the strip, what Hall potential difference appears across the strip? Charge density is copper  $= 8.4 \times 10^{28}/\text{m}^3$ .
11. Compare Ampere's law with Biot Savart law. Obtain expressions for magnetic field intensity inside and outside the long straight wire carrying current.
12. A spherical drop of water carrying a charge of 30 pC has a potential of 500 V at its surface (with  $V = 0$  at infinity). (a) What is the radius of the drop? (b) If two such drops of the same charge and radius combine to form a single spherical drop, what is the potential at the surface of the new drop?
13. Calculate the displacement current between the capacitor plates of area  $1.5 \times 10^{-2} \text{ m}^2$  and rate of electric field change is  $1.5 \times 10^{12} \text{ V/ms}$ . Also find the value of displacement current.
14. Obtain expressions for growth and decay of charges in the RC circuits. Explain how you will measure experimentally the capacitance of the given capacitor.
15. Write down Maxwell equation in integral form with their physical meanings. Convert these equations into differential form.
16. An electron is confined to an infinite height box of size 0.1 nm. Calculate the ground state energy of the electron. How this electron can be put to the third energy level?

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Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE, BGE, BME	Pass Marks	32
Year / Part	I / II	Time	3 hrs.

*Subject: - Engineering Physics (SH452)*

- ✓ 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. A uniform circular disc of radius R oscillates in a vertical plane about a horizontal axis. Show that disc will oscillate with the minimum time period when the distance of the axis of rotation from the center is  $\frac{R}{\sqrt{2}}$

**OR**

In the progressive wave show that the potential energy and kinetic energy of every particle will change with time but the average energy per unit volume remains constant.

2. A  $2\mu\text{F}$  capacitor is charged up to 50 Volt. The battery is disconnected and 50mH is connected across the capacitor so that the LC oscillation occurs. Calculate the maximum value of the current in the circuit.
3. Show that the least possible distance between an object and its real image in a convex lens is four times the focal length of the lens.
4. What is path difference and phase difference in interference? Explain why we have to make a compensation in path difference in interference of light in parallel film in reflected system. Hence find out the condition for obtaining maxima in interference in this film by reflected light.

**OR**

What is Nicol Prism? How is it constructed? Discuss some of its applications.

5. A diffraction grating used at normal distance gives a green line  $\lambda=5400\text{\AA}$  in a certain order superimposed on the violet line  $\lambda=4500\text{\AA}$  of the next higher order. If the angle of diffraction is  $10^\circ$ , how many lines are there per centimeter in the grating?
6. What are Resolving Power and dispersive power of a diffraction grating? Show that the resolving power of a grating depends on the order and no of rulings of grating.
7. Calculate the reverberation time in a hall measuring  $40 \times 10 \times 20$  ft with the following parameters. (i) 7500 sq.ft of plaster,  $\alpha_1=0.03$  (ii) 400 sq.ft of glass,  $\alpha_2=0.025$  (iii) 6000sq.ft.of wood and floor etc,  $\alpha_3=0.06$  (iv) 600 seats  $\alpha_4=0.03$  and (v) audience of 500 persons,  $\alpha_5=4.0$  person.
8. What do you mean by Numerical Aperture and acceptance angle? Show that Numerical Aperture (NA) is proportional to square root of fractional refractive index change.

9. Derive an expression for the electric field intensity at any point in the axial line of a ring of charge  $q$ . From your result show that electric field is maximum at  $x = \frac{a}{\sqrt{2}}$ , where  $a$  is the radius of the ring.

**OR**

A capacitor of capacitance  $C$  is charged through a resistor obtains an expression for charging current. Show the variation of current with time. How will you use this information to calculate capacitance  $C$ .

10. What will be the force per unit area with which plates of parallel plate capacitor attract each other if they are separated by 1mm and maintained at 100 V potential difference and electric constant of the medium in unity.
11. Obtain Ohm's law in term of  $\vec{J} = \sigma \vec{E}$ , Explain why and how resistance of a conductor varies with temperature. Based on this information explain superconductor. Give at least two characteristics of superconductors.
12. Compare Ampere's law with Biot-Savart's law. Which is more useful for calculating  $B$  for a current carrying conductor. Calculate the magnetic field inside and outside a long straight wire carrying current  $I$ .

**OR**

State Faraday's law of Electromagnetic induction. Show that in electromagnetic induction the mechanical energy is converted into electric and finally in to heat energy.

13. A solenoid having an inductance of  $6.3\mu\text{H}$  is connected in series with  $1.2\text{K}\Omega$  resistor.  
(i) If a 14V battery is connected across the pair, how long will it take for the current to reach 80% of its equilibrium value? (ii) What is the current through the resistor at time  $t = \tau_L$
14. What is Hall effect? Obtain an expression for Hall resistance. Show in a graph how hall resistance varies with magnetic field.
15. Calculate the magnitude of the poyniting vector and the amplitude of the electric and magnetic fields at a distance of 10 cm from a radio station which is radiating power of  $10^5$  watt uniformly over a hemisphere with radio station as center.
16. Consider an electron of mass  $m$  is confined in an one dimensional infinite potential well of width  $l$  such that  
 $V = \infty$  for  $0 \leq x$  and  $x \geq l$   
 $V = 0$  for  $0 < x < l$

Show that inside the well electron can only have the discrete energy values.

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Exam.	Regular (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE, BME	Pass Marks	32
Year / Part	I / II	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. What are drawbacks of simple pendulum? Show that the period of torsion oscillations remain unaffected even if the amplitude be large, provided that the elastic limit of the suspension wire is not exceeded.

**OR**

In simple harmonic motion, when the displacement is one-half the amplitude, what fraction of the total energy is kinetic energy and what fraction is potential energy? At what displacement is half kinetic energy and half potential energy?

2. Derive a differential equation of LC oscillation. With the solution of this equation, show that the maximum value of electric and magnetic energies stored in LC circuits is equal.
3. How much acoustic power enters the window of area  $1.58\text{m}^2$ , through the sound wave (standard intensity level  $10^{-16}\text{W/cm}^2$ )? The window opens on a street where the street noise results in an intensity level at the window of 60dB.
4. Explain circle of least confusion. Show that the diameter of a circle of least confusion is independent of the focal length of a lens.
5. A glass clad fibre is made with core glass of refractive index 1.5 and cladding is doped to give a fractional index difference of 0.005. Find (i) the cladding index (ii) The critical internal reflection angle (iii) The external critical acceptance angle (iv) Numerical aperture (v) Acceptance angle.
6. A parallel beam of light ( $\lambda=5890\text{\AA}$ ) is incident on a thin glass plate ( $\mu = 1.5$ ) such that the angle of refraction is  $60^\circ$ . Calculate the smallest thickness of the plate which will appear dark by reflection.
7. How are Newton's Rings formed? How is the ring diameter and film thickness related? How can Newton's rings experiment be used to determine refractive index of a liquid?

**OR**

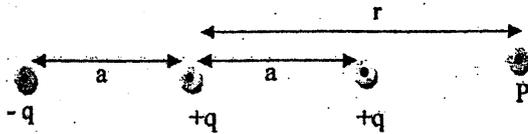
What is double refraction? How can we experimentally distinguish between plane polarized, circularly polarized and elliptically polarized light?

8. Assume that the limits of the visible spectrum are arbitrary chosen as 430nm and 680nm. Calculate the no. of rulings per millimeter of a grating that will spread the first-order spectrum through an angle of  $20^\circ$
9. Define an electric dipole. How does a dipole behave in electric field? Obtain the conditions for maximum torque and maximum potential energy in an electric field.

**OR**

For the charge configuration of the figure, show that  $V(r)$  at a point P on the line

assuming  $r \gg a$  is given by  $V = \frac{1}{4\pi\epsilon_0} \left( \frac{q}{r} + \frac{2qa}{r^2} \right)$ .



10. A long cylindrical conductor has length 1m and is surrounded by a co-axial cylindrical conducting shell with inner radius double that of long cylindrical conductor. Calculate the capacitance for this capacitor assuming that there is vacuum in space between cylinders.
11. Charges of uniform volume density  $3.2\mu\text{C}/\text{m}^3$  fill a non conducting solid sphere of radius 5cm. What is the magnitude of the electric field at (a) 3.5cm (b) 8cm from the centre of the sphere?
12. What are superconductors? How they differ from perfect conductors? Give basic properties and uses of superconductors.
13. Derive the relation for rise and fall of current in LR circuit. Plot a graph between current and time and explain the graph.

OR

In a Hall-effect experiment, a current of 3A sent length wise through a conductor 1 cm wide, 4cm long and  $10\mu\text{m}$  thick produces a transverse (across the width) Hall potential differences of  $10\mu\text{V}$ , when a magnetic field of 1.5T is passes perpendicularly through the thickness of conductor. From these data, find: (a) The drift velocity of the charge carrier and (b) The number density of charge carrier.

14. A particular cyclotron is designed with dees of radius  $R = 75\text{cm}$  and with magnets that can provide a field of 1.5T. (i) To what frequency should be oscillator be set if deuterons are to be accelerated? (ii) What is the maximum energy of deuterons that can be obtained? Given mass of the deuteron is  $3.34 \times 10^{-27}\text{kg}$ .
15. Define Poynting vector. Prove that  $\vec{S} = \frac{1}{\mu_0} (\vec{E} \times \vec{B})$ .
16. Prove that the energy levels are quantized, when the electron is confined in an infinite potential well of width a.

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Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE, BME	Pass Marks	32
Year / Part	I / II	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. What is forced oscillation? Derive differential equation for forced oscillation and show that amplitude at resonance is inversely proportional to damping constant of medium.

**OR**

Derive the differential equation for damped LCR oscillation. Obtain an expression for current and frequency of oscillation.

2. Prove that if a transverse wave is traveling along a stretched string, 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.
3. The volume of a room is  $600\text{m}^3$ , wall area of room is  $220\text{m}^2$ , the floor and ceiling area each is  $120\text{m}^2$ . If average absorption coefficient for walls is 0.03, for ceiling is 0.80 and for floor is 0.06, calculate average absorption coefficient and reverberation time.
4. Two thin lenses of power  $P_1$  and  $P_2$  are separated by a distance  $d$ . Find an expression to show that equivalent power of the combination is given as  $P = P_1 + P_2 - dP_1P_2$ .
5. Explain the formation of Newton's ring in reflected light. Prove that, in reflected light the diameter of the dark rings are proportional to the square root of natural numbers and diameter of bright rings are proportional to the square root of odd numbers.

**OR**

Write down the physical meanings of dispersive power and resolving power of plane transmission grating. Show that both resolving and dispersive power have proportional relation with the order of spectrum.

6. A 200mm long tube containing  $48\text{cm}^3$  of sugar solution produces an optical rotation of  $11^\circ$  when placed in a polarimeter. If specific rotation of sugar solution is  $66^\circ$ , calculate quantity of sugar contained in the form of solution.
7. Light is incident normally on a grating 0.5cm wide with 2500 lines. Find the angles of diffraction for the principal maxima of the two sodium lines in the first order spectrum,  $\lambda_1 = 5890\text{\AA}$  and  $\lambda_2 = 5896\text{\AA}$ . Are the two lines resolved?
8. What is principle of laser? Discuss how population inversion is carried out? With the help of energy level diagram, explain how He-Ne laser works.

9. A thin non conducting rod of finite length  $l$  carries a total charge  $q$  spread uniformly along it. Show that the electric field at any point at a distance  $y$  above from the centre of

rod is  $E = \frac{q}{4\pi\epsilon_0 y} \frac{1}{\sqrt{l^2 + 4y^2}}$ . Extend this result for infinite length.

*OR*

Find the potential at any point at an angle  $\theta$  at a distance  $r$  from the centre of the short dipole. What result do you obtain if the point is along axial line?

10. A capacitor is made of two concentric spherical plates of radii  $a$  and  $b$  of inner and outer spheres respectively. If outer plate is positively charged and inner sphere is earthed, prove

that the capacitance of such capacitor is given as,  $C = 4\pi\epsilon_0 \left[ \frac{b^2}{b-a} \right]$ .

11. Calculate the relaxation time for the electrons of sodium atom. The number of atoms per  $\text{cm}^3$  in sodium is  $2.5 \times 10^{22}$ , and the electrical conductivity is  $1.9 \times 10^7$  s/m.
12. List and explain methods to calculate magnetic field due to a current carrying conductor. Derive an expression for the magnetic field on the axial line of a long solenoid carrying current.

*OR*

What is self inductance? Calculate the inductance of a circular Toroid. From your result, show that inductance is a property of a coil and depends on permeability and shape and size of the coil.

13. Suppose a cyclotron is operated at an oscillator frequency of 12MHz and has a dee of radius 53cm.
- What is the magnitude of the magnetic field needed for deuteron to be accelerated in the cyclotron?
  - What is the resulting kinetic energy of the deuteron? Given: mass of deuteron =  $3.34 \times 10^{-27}$  kg.
14. What must be the magnitude of a uniform electric field if it is to have the same energy density that passed by a 0.50T magnetic field?
15. What is Poynting vector? Show that the intensity of an electromagnetic wave equals the average magnetic energy density times the speed of light.
16. A particle is moving in one dimensional potential well of infinite height and width  $a$ . find the expression for energy of the particle.

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Exam.	Regular / Back		
	Level	BE	Full Marks
Programme	BCE, BME	Pass Marks	32
Year / Part	I / II	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. What is a torsional pendulum? Obtain an expression for its time period and explain why, unlike a simple or a compound pendulum the time period in this case remains unaffected even if the amplitude be large?

**OR**

Derive the differential equation of the forced oscillation of LCR circuit with ac source and find the expression for the current amplitude.

2. A meter stick suspended from one end swings as a physical pendulum (a) what is the period of oscillation (b) what would be the length of the simple pendulum that would have the same period.
3. Calculate the minimum intensity of audibility in watts per square cm from a note of 1000 Hz if the amplitude of vibration is  $10^{-9}$  cm. Given density of air is 0.0013 gm/cc and velocity of sound in air is 340 m/s.
4. What is diffraction of light? Discuss the intensity distribution with special reference to diffraction of light in a single slit.

**OR**

Define circle of least confusion and show that  $d = \frac{1}{2} WD$ ,

Where

d = diameter of circle of least confusion

W = dispersive power

D = diameter of lens aperture

5. A plano-convex lens of radius 300cm is placed on an optically flat glass plate and is illuminated by monochromatic light. The diameter of the 8<sup>th</sup> dark ring in the transmitted system is 0.72cm. Calculate the wavelength of light used.
6. What is double refraction? Using the concept of double refraction show that the plane polarized and circularly polarized light are the special cases of elliptically polarized light.
7. Two similar thin convex lenses of focal length 10cm each are placed co-axially 5cm apart. Find the equivalent focal length and the position of principal points. Also find the position of the object for which the image is formed at infinity.
8. What is an optical fibre? Discuss its types. Derive the relation for Numerical Aperture (NA) in an optical fibre.

9. Find the electric field at a distance  $x$  above the centre of the flat circular disc of radius  $R$  which carries a uniform surface charge density  $\sigma$ . Extend your result in the limit  $R \rightarrow \infty$ .

**OR**

Show that the electric field due to a short dipole at a point on the axial line is twice as that of a point on the equatorial line.

10. Differentiate between polar and non-polar dielectrics. Using Gauss's law in dielectrics establish relation of electric field with displacement vector and polarization vector. Hence obtain the relation for free and induced charge in the dielectric.
11. What is the average time between collisions of free electrons in a copper wire? (At. wt. = 63 g/mol, density = 9 gm/cc and resistivity =  $1.7 \times 10^{-8} \Omega\text{m}$ ,  $N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$ )
12. A spherical drop of water carrying a charge of  $3 \mu\text{C}$  has a potential of 500V at its surface. What is the radius of drop? If two such drops of same charge and radius are combined, what is potential of the single new drop formed?
13. A variable field of  $10^{12} \text{ V/m.s}$  is applied to a parallel plate capacitor with circular plates of diameter 10cm. Calculate (a) induced magnetic field and (b) displacement current.
14. A circular coil having radius  $R$  carries a current  $I$ . Calculate the magnetic flux density at an axial distance  $x$  from the centre of the coil. Explain how the coil behaves for a large distance point and at what condition field will be maximum?

**OR**

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

15. Derive the Schrodinger time independent wave equation. What is the physical significance of wave functions?
16. Using Maxwell equations in free space, derive electromagnetic wave equations for  $\vec{E}$  and  $\vec{B}$ . Write its plane wave solution.

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Exam.	New Back (2066 Batch Only)		
Level	BE	Full Marks	80
Programme	BCE, BME	Pass Marks	32
Year / Part	I / II	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.

*Attempted*

1. Derive a relation for the time period of a compound pendulum and compare it with that of simple pendulum to locate the centre of oscillation.

OR

Obtain differential equation for forced oscillation. Write its solution. Explain the statement "quality factor (Q) is a measure of the sharpness of resonance in the case of a driven oscillator".

2. Derive a relation for speed of transverse wave in a stretched string and show that the average rate of energy transfer is  $\frac{1}{2} \rho \omega^2 A^2 v$ , Where the symbols are having usual meanings.
3. Write down the requirements for a good acoustic hall and derive a relation for reverberation time.
4. Explain chromatic aberration. Show that the longitudinal chromatic aberration is equal to the product of dispersive power and mean focal length of a lens.

OR

Define the term "optical activity". Derive a relation for the specific rotation of any optically active substance. Also write down its applications.

5. A glass clad fiber is made with the core glass of refractive index 1.5 and the cladding is doped to give a fractional index change of 0.0005. Determine
  - a) the cladding index,
  - b) the acceptance angle and
  - c) the numerical aperture.
6. Newton's rings are observed in reflected light of wavelength 5900Å. The diameter of 10<sup>th</sup> dark ring is 50mm. Find the radius of curvature of lens and thickness of air film.
7. In a grating the sodium doublet (5890Å, 5896Å) is viewed in third order at 30° to the normal and is resolved. Determine the grating element and the total width of the rulings.
8. Calculate the thickness of (i) a quarter wave plate and (ii) a half wave plate given that  $\mu_E = 1.553$ ,  $\mu_O = 1.544$  and  $\lambda = 5 \times 10^{-5}$  cm.
9. What is electric Quadrupole? Finding an expression for electric potential at any point on an axial line at a distance 'r' from centre of short Quadrupole, show that electric field at that point is inversely proportional to  $r^3$ .

OR 
$$\frac{q}{4\pi\epsilon_0 r^3} = 9 \times 10^9 \cdot (2a^2)$$

A ring of radius 'R' is carrying a uniformly distributed charge 'q'. Find an expression for electric field at any point on the axial line. Locate the point at which electric field is maximum.

10. A parallel plate capacitor each of area  $100\text{cm}^2$  has a p.d. of  $50\text{V}$  and capacitance of  $100 \times 10^{-6} \mu\text{F}$ . If a mica of dielectric constant  $5$  is inserted between plates find the magnitude of
- a) Electric field in mica
  - b) Displacement vector
  - c) Polarization vector
11. Compare the methods of Biot Savart law and Ampere's law to calculate magnetic fields due to current carrying conductor. Calculate magnetic field at an axial distance 'r' from the centre of the circular coil carrying current.
12. A current of  $1.2 \times 10^{-10}\text{A}$  exists in a copper wire (At. wt. =  $63$  and density =  $9\text{gm/cc}$ ) whose diameter is  $2.5\text{mm}$ . Assuming current to be uniform, calculate:
- a) Current density
  - b) Electrical conductivity
  - c) Mobility of electrons
13. What is cyclotron? Find an expression to show that maximum kinetic energy of charge particles coming out of dees of cyclotron is directly proportional to square of frequency of oscillator

OR

What is Hall-effect? Derive an expression for Hall coefficient and establish the relation with mobility of charge carrier and conductivity of material of wire.

14. A proton with speed of  $3 \times 10^5 \text{m/s}$  orbits just outside a charged sphere of radius  $1\text{cm}$ . What is the charge on the sphere?
15. Write Maxwell equations in integral form. Convert them in differential form. Explain each equations.
16. A free particle is confined in a box of width  $L$ . Find an expression for energy eigen value to show that the particle can have only discrete energy and momentum.

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Exam.	Old Back (2065 & Earlier Batch)		
Level	BE	Full Marks	80
Programme	BCE, B.Agri.	Pass Marks	32 -
Year / Part	I / II	Time	3 hrs.

**Subject: - Physics**

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt any Six questions selecting One each from Group A & D and Two each from Group B & C.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

**Group A**

1. a) Define physical pendulum. Show that the radius of gyration is equal to distance from centre of suspension to centre of gravity of a compound pendulum, when time period is minimum. [1+5]
- b) A solid sphere of mass  $5/2$  kg and diameter  $2/7$  m is suspended on a thin metallic wire. Find the period of angular oscillation if the torque constant of the wire is  $6 \times 10^{-3}$  Nm/rad. [4]
- c) What are particle velocity and wave velocity? Find the relation between them. [3]
2. a) Differentiate between reverberation and echo. Derive a relation for the reverberation time with reference to acoustically fit hall. [6]
- b) A mass of 6 kg stretches a spring 0.3m from its equilibrium position. The mass is removed and another body of mass 1.0 kg is hanged from the spring. What would be the period of oscillation if the spring is now stretched and released? [3]
- c) The relaxation time for a damped harmonic oscillator is 50 seconds. Determine the time in which the amplitude and energy of oscillator falls to  $1/e$  times of its initial value. [4]

**Group B**

3. a) What are coherent sources of light? Why it is essential to generate coherent sources to observe the interference? Show that there is zero energy at dark fringes of interference phenomena. [1+1+3]
- b) Differentiate between curvature of field and distortion. Also draw neat and clean diagram of such aberrations. [2.5+2.5]
- c) In a plane transmission grating the angle of diffraction for second order maxima for wavelength  $5 \times 10^{-5}$  cm is  $30^\circ$ . Calculate the number of lines in one cm of the grating surface. [4]
4. a) Explain the phenomenon of double refraction in uniaxial crystal. What are quarter wave and half wave plates? [6]
- ✓ b) Discuss the propagation mechanisms of light waves in optical fiber. [4]
- c) Distance between two slits is 0.1mm and the width of the fringes formed on the screen is 5mm. If the distance between the screen and the slit is one meter, what would be the wavelength of light used? [4]

5. a) Discuss the essential requirements for producing laser action. Describe a Ne-Ne laser. [5]  
 b) Two thin convex lenses having focal lengths 6cm and 2cm are co-axial and separated by a distance of 4cm. Calculate the combined focal length and the positions of the principal planes. [5]  
 c) A 20cm long tube containing sugar solution rotates the plane of polarization by  $11^\circ$ . If the specific rotation of sugar is  $66^\circ$ , calculate the strength of the solution. [4]

**Group C**

6. a) Define dielectric strength. Derive a relation for the capacitance of a spherical capacitor consisting of two concentric spherical shell of radii  $y$  and  $z$ , (with  $z > y$ ). [1+5]  
 b) If a copper wire is stretched to make it 2.5% longer than its original length, what is the percentage change in resistance? [4]  
 c) List industrial uses and hazard of high intensity electrostatic field. Explain in detail, one of the uses. [3]
7. a) Explain resistivity. Obtain the expression for resistivity in terms of mean free path. [5]  
 b) State Biot-Savarts law. Use it to determine the magnetic field of a narrow circular coil along its axis. [5]  
 c) The current in a LR circuit builds up to one third of its steady state value in 5 sec. What is the inductive time constant? [3]
8. a) State the Ampere's circuital law. Derive the relation for the self induction of a toroid. [5]  
 b) Two particles of equal charges of  $2.0 \times 10^{-7}C$  but opposite signs are held 15cm apart. what are the magnitudes and directions of  $\vec{E}$  at a point midway between them? [4]  
 c) A copper strip 2cm wide and 1mm thick is placed in a magnetic field with  $B = 1.5T$ . If a current of 200A is setup in the strip, what Hall p.d. appears across the strip? (Given:  $n = 8.4 \times 10^{28}$  per  $m^3$ ) [4]

**Group D**

9. a) What is displacement current? Also write its significance. [3]  
 b) Derive a differential equation for LC oscillation with initial charge  $Q_0$ . Derive an expression for the frequency of the oscillation, then relate it with spring-mass system. [6]  
 c) A 10 Henry coil has a resistance of  $180\Omega$ . What size of capacitor must be put in series with it if the combination is to resonant when connected to 60 Hz outlet? [4]
10. a) With the help of Maxwell's equations prove the relation  $C = \frac{1}{\sqrt{\epsilon_0 \mu_0}}$ , where symbols carry their usual meanings. [4]  
 b) Prove the continuity relation  $\vec{\nabla} \cdot \vec{J} + \frac{\partial \rho}{\partial t} = 0$ . [4]  
 c) The maximum electric field at a distance of 20m from an isotropic point light source is 4.0 v/m. Calculate (i) the maximum value of the magnetic field and (ii) the average intensity of light there. [5]

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Exam.	Regular/Back		
Level	BE	Full Marks	80
Programme	BCE, B.Agr.	Pass Marks	32
Year / Part	I / II	Time	3 hrs.

*Subject: - Physics*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt any Six questions selecting One each from Group A & D and Two each from Group B & C.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

**Group A**

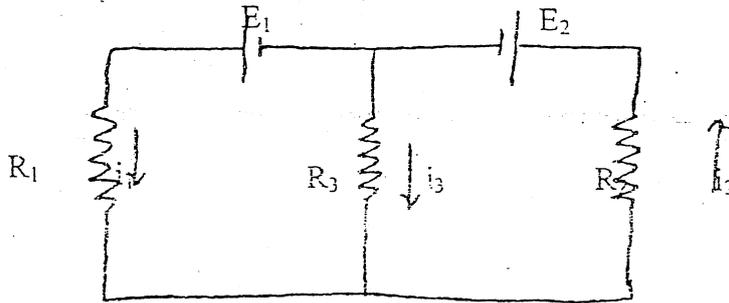
1. a) What is torsional pendulum? Show that motion of a disc of a torsional pendulum is harmonic. Find its time period. Describe how will you determine modulus of rigidity of a thin metallic wire which supports the disc. [7]
- b) The amplitude of a lightly damped oscillator decreases by 3% during each cycle. What fraction of the energy of the oscillator is lost in each full oscillation? [3]
- c) A source of sound has a frequency 2.56 Hz and amplitude of 0.25cm. Calculate the flow of energy across a square centimeter in one second if the velocity of sound in air is 340 m/s and the density of air is 0.00129 gm/cc. [3]
2. a) What is reverberation? Derive the reverberation time and explain how it depends on absorption coefficient of the medium. Discuss the significance of this formula with reference to the acoustics of a building. [7]
- b) Derive an expression for velocity of a wave in a stretched string. [3]
- c) Two sounds differ in sound level by 1.00 dB. What is the ratio of the greater intensity to the smaller intensity? [3]

**Group B**

3. a) What is an optical fiber? Explain the physics behind its functioning. Trace the ray diagram that shows the propagation of light through the step index and graded index optical fibres. [7]
- b) Define cardinal points and locate these points within the lens. [3]
- c) A dielectric slab of thickness 'b' is inserted between the plates of a parallel-plate capacitor of plate separation 'd'. Show that the capacitance is then given by 
$$C = \frac{K \epsilon_0 A}{Kd - b(K - 1)}$$
, where the symbols have their usual meanings. [4]
4. a) Explain the phenomenon of interference of light. Give the theory of the Newton's ring. How fringes can be used to find the wavelength of light. [6]
- b) Light is incident normally on a grating of total ruled width  $5 \times 10^{-3}$  m with 2500 lines in a cell. Find the angular separation of the sodium lines in the first order spectrum. Wavelengths of lines are 589nm and 589.6nm. Can they be seen distinctly? [4]
- c) What is astigmatism? What is the cause of it and how can it be reduced to a minimum? [4]
5. a) Write down the physical meanings of dispersive power and resolving power of plane transmission grating. Show that both resolving and dispersive power have proportional relation with the order of the spectrum. [7]
- b) A quarter wave plate is 12.5  $\mu$ m thick. Calculate the wavelength for which it acts as a quarter wave plate. The difference in the principal refractive indices is 0.01. [3]
- c) Find the specific rotation of a given sample of sugar solution if the plane of polarization is turned through 26.4°. The length of the tube containing 20% sugar solution is 20cm. [4]

Group C

6. a) A thin ring made of plastic of radius  $R$  is uniformly charged with linear charge density  $\lambda$ . Calculate the electric field 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 motion of electron is simple harmonic. Find frequency of oscillation. Mention any assumptions you made. [7]
- b) In the given figure, find the currents  $i_1, i_2, i_3$  if  $E_1 = 1.5V, E_2 = 3V, R_1 = R_3 = 2\Omega$  and  $R_2 = 4\Omega$ . [3]



- c) A copper strip 2cm wide and 1mm thick is placed in a magnetic field with  $B = 1.5 T$  perpendicular to the plane of the strip and away from the reader. If a current of 200A is set up in the strip, what Hall potential difference appears across the strip? Charge density of copper =  $8.4 \times 10^{28}/m^3$  [3]
7. a) Define electric dipole. Find an expression for electric potential at any point in space due to dipole of length  $2a$ . Could you extend this relation to calculate electric field intensity? If so, how? [5]
- b) What is the drift velocity of a copper wire having diameter 0.25cm carrying current of 10A? Given density of copper =  $9 gm/cm^3$ ; and molar mass of the copper is 64 gm/mole. [4]
- c) What is the magnetic energy density at the centre of the circulating electron in the hydrogen atom? Assume that the electron circulates around the nucleus in a path of radius  $5.1 \times 10^{-11} m$  at a frequency of  $6.8 \times 10^{15} rev/sec$ . [4]
8. a) Differentiate between Biot-Savart law and Ampere's law in calculating magnetic field of a current carrying conductor. Calculate the magnetic field on the axial line of a long straight solenoid carrying current. [7]
- b) A capacitor of capacitance  $C$  is charged through the resistor  $R$ . Calculate the time at which the potential across the resistor is equal to the potential across the capacitor. [4]
- c) Calculate the capacitance of the earth, viewed as a spherical conductor of radius 6400km. [3]

Group D

9. a) What is electromagnetic oscillation? Derive a differential equation for free em oscillation. Find the time period of oscillation. How frequency will be changed if there is resistance in the circuit? [7]
- b) Why and how Maxwell modified Ampere's law in magnetism? [3]
- c) Calculate the magnitudes of electric and magnetic field vectors associated with e-m waves emitted from a source 35 km away if its power of emission is 30 kW. [3]
10. a) Write Maxwell's equation in integral form and the laws in which these equations are based. Convert them into differential form. [6]
- b) Derive electromagnetic wave equations in free space. Give their plane wave solution. Based on these solutions prove that  $\frac{E}{B} = C$ . [4]
- c) In an LC circuit, what value of charge, expressed in terms of the maximum charge, is present on the capacitor when the energy is shared equally between the electric and magnetic field? [3]

Exam.	Regular/Back		
	Level	B/E	Full Marks
Programme	BCE, B.Agr.	Pass Marks	32
Year / Part	I / II	Time	3 hrs.

**Subject: - Physics**

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt any Six questions selecting at least One from Group A & D and Two from Group B & C.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

**Group A**

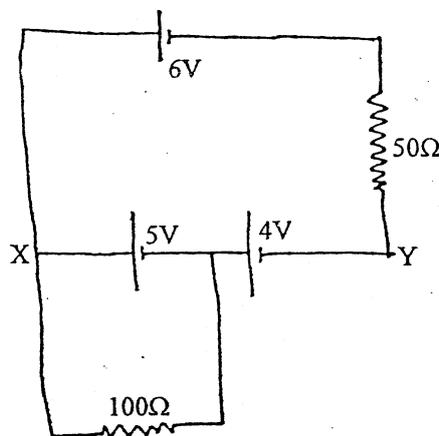
1. a) What is a compound pendulum? Deduce the expression for the time period of a compound pendulum and formulate the equivalent length of the simple pendulum. [1+6]
- b) Calculate the change in intensity level when the intensity of sound increases 100 times the original intensity. [3]
- c) A line source emits a cylindrical expanding wave. Assuming the medium absorbs no energy, find how the amplitude and intensity of the wave depend on the distance from the source. [3]
2. a) Explain the term "wave motion". Show that for a plane progressive wave, on the average, half the energy is kinetic and half potential. [1+5]
- b) A lecture hall with a volume of  $4500\text{m}^3$  is found to have a reverberation time of 1.5 sec. What is the total absorbing power of all the surfaces in the hall? If the area of the sound absorbing surface is  $1600\text{m}^2$ , calculate the average absorption coefficient. [3]
- c) A string 2.72m long has a mass of 263 gm. The tension in the string is 36.1N. What must be the frequency of travelling waves of amplitude 7.7mm in order that the average transmitted power be 85.5W? [4]

**Group B**

3. a) 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. Hence find the position of two principal points. [1+5+2]
- b) What is an optical fiber? How is it made? Write down the main differences between step index and graded index multimode optical fibers. [3]
- c) Calculate the thickness of (i) a quarter wave plate and (ii) a half wave plate, given that  $\mu_E = 1.553$ ,  $\mu_o = 1.544$  and  $\lambda = 5890\text{\AA}$  [3]
4. a) What are monochromatic aberrations? Explain the term spherical aberration and astigmatism and their minimization with suitable ray diagrams. [1+7]
- b) Newton's rings are formed by reflected light of wavelength  $5895\text{\AA}$  with a liquid between the plane and curved surfaces. If the diameter of the 6<sup>th</sup> bright ring is 3mm and the radius of curved surface is 100cm, calculate the refractive index of the liquid. [4]
- c) Distinguish between Fraunhofer and Fresnel diffraction. [2]
5. a) What is population inversion? Explain why laser action cannot occur without population inversion between atomic levels? [1+4]
- b) Explain circle of least confusion. Show that diameter of circle of least confusion is dependent of the focal length of a lens. [5]
- c) Two thin lenses of focal lengths  $f_1$  and  $f_2$  separated by a distance  $d$  have an equivalent focal length 50cm. The combination satisfies the conditions for no chromatic aberration and minimum spherical aberration. Assuming both the lenses are made of same material, find the values of  $f_1$ ,  $f_2$  and  $d$ . [4]

Group C

6. a) State general form of Gauss law. Calculate potential difference between two plates of a charged cylindrical capacitor. [5]
- b) In the given circuit diagram, find the current in each resistor and potential difference between X and Y. [4]



- c) A strip of copper  $150\mu\text{m}$  wide is placed in a uniform magnetic field  $\vec{B}$  of magnitude  $0.65\text{T}$ , with  $\vec{B}$  perpendicular to strip. A current  $23\text{A}$  is then sent through the strip such that a Hall potential difference  $V$  appears across the width of the strip. Calculate  $V$ . Given number of charge carriers per volume for copper is  $8.47 \times 10^{28}$  electron/ $\text{m}^3$ . [4]
7. a) What is dipole? Derive an expression for electric field due to dipole at the points on the (i) axis of the dipole and (ii) perpendicular bisector of dipole. [1+3+3]
- b) Show that the time constant in RC circuit is the time at which the charge in the circuit will reach a value  $\frac{1}{e}$  of its final equilibrium value. [3]
- c) Two long parallel wires are  $8.1\text{cm}$  apart. What amount of equal and antiparallel current flow in the wires if the magnetic field halfway between them is  $296\mu\text{T}$ ? [3]
8. a) State and explain Faraday laws of induction. Deduce the expression for the inductance of a toroid. [1+4]
- b) State Biot-Savart law. Use it to find magnetic field at any point due to long straight current carrying conductor. [1+3]
- c) What will be the force per unit area with which plates of parallel plate capacitor attract each other if they are separated by  $1\text{mm}$  and maintained at  $100\text{V}$  potential difference and electric constant of the medium is unity. [4]

Group D

9. a) Explain what are Maxwell's equations. Write Maxwell's equations in free space and find the electromagnetic equations for electric and magnetic field. Also provide their plane wave solutions. [7]
- b) What is displacement current? Why Maxwell's modification is necessary is Ampere's law in magnetism? [3]
- c) You are given an inductor of  $1\text{mH}$ . If you are asked to make it oscillate with a frequency of  $1\text{MHz}$ , how can you make such an oscillating device? [3]
10. a) What are free and damped electromagnetic oscillations? Deduce the frequency of a damped electromagnetic oscillation and hence show the charge distribution with time graphically. [7]
- b) The maximum electric field at a distance  $10\text{m}$  from an isotropic point light source is  $2\text{V/m}$ . (i) What is the average intensity of light there (ii) What is the power of the source? [4]
- c) Show that the displacement current in a parallel plate capacitor is given by  $C \frac{dv}{dt}$ . [2]

Exam.	Back		
Level	BE	Full Marks	80
Programme	BCE, B.Agric.	Pass Marks	32
Year / Part	I / II	Time	3 hrs.

**Subject: - Physics**

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt any Six questions selecting at least One from Group A and D and Two from Group B and C.
- ✓ All questions carry equal marks.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

**Group A**

1. a) Differentiate between free oscillation and forced oscillation. [3]
- b) What is torsional pendulum? Find the time period for torsion pendulum. Also write its significance. [5]
- c) A spring is hung vertically and loaded with a mass of 75 grams and allowed to oscillate, calculate (i) the time period and (ii) the frequency of oscillation, when the spring is loaded with 100 grams it extends by 5cm. [5]
2. a) What are the differences between interference and beats? [3]
- b) Define absorption coefficient? Derive Sabine's reverberation formula and also explain its importance in our daily life? [6]
- c) A police man on duty detects a drop of 12 percent in the pitch of a motor car as it crosses him. If the velocity of sound is 332 m/s, calculate the speed of the car. [4]

**Group B**

3. a) Calculate the equivalent focal length of two thin co-axial lenses separated by a finite distance  $x$ . Also derive expressions giving the positions of the two principal points. [4+2]
- b) Write down the properties of LASER. Also explain the terms optical pumping, population inversion and stimulated emission. Write the merit and demerit of laser. [1+3+1]
- c) In Newton's rings experiment the radius of the 4<sup>th</sup> and 12<sup>th</sup> rings are 0.26cm and 0.37cm respectively. Find the diameter of the 24<sup>th</sup> dark ring. [3]
4. a) What are the conditions for coherent sources? Explain the phenomenon of interference in thin film for reflected light. [1+5]
- b) What is optical fibre? Explain the graded index multimode optical fibre and also write the application of optical fibre in communication system as well as medical science. [4]
- c) What is the highest order spectrum, which may be seen with monochromatic light of wavelength 559nm, by means of a diffraction grating with 15000 lines/inch? [4]
5. a) State and explain the theory and resolving power of a plane transmission grating. [5]
- b) What do you mean by plane polarized light? Explain the phenomenon of double refraction in crystal. [1+4]

- c) Calculate the polarizing angle for light travelling from water of refractive index 1.34 to glass of refractive index 1.52. [4]

**Group C**

6. a) Define the term electric dipole. Calculate the potential at a point along the axis of the quadrupole. [1+4]  
b) Explain the principle of parallel plate capacitor and determine its capacitance. [4]  
c) If a copper wire is compressed to make 0.5 percent shorter. What is the percentage change in resistance? [4]
7. a) Define the terms conductance and resistivity. Explain the atomic view of Ohm's law. Also write down the limitations of Ohm's law. [6]  
b) What is difference between intrinsic and extrinsic semiconductor. Derive the relation conductivity of semiconductor. [3]  
c) Two small spheres of charge 14 micro coulomb and 35 micro coulomb placed 20cm apart. Find the location of a point between them where the field strength is zero. [4]
8. a) What is magnetic flux density? Derive an expression for magnetic flux density inside a long solenoid, carrying current I, at a point near its center. [1+4]  
b) Prove that magnetic energy density is directly proportional to the square of the magnetic flux density. [4]  
c) A copper strip 2cm wide and 1.5mm thick is placed in a magnetic field with magnetic strength 2.6 Tesla. If a current of 145A is set up in the strip, what Hall potential difference appears across the strip? The number of charges is  $8.4 \times 10^{28}$  per meter cube. [4]

**Group D**

9. a) What is meant by LC oscillation? Derive the differential equation of an LC circuit also calculate the frequency of LC oscillation.  
b) Derive the Maxwell's equations in differential form also explain their physical significance.  
c) Using Maxwell's equation prove that  $(E/B) = C$ . [3]
10. a) Define poynting vector and show that  $S = (1/\mu_0)E \times B$  where symbols carry their usual meanings. [5]  
b) What is displacement current? Prove that the displacement current density in a parallel capacitor can be written as  $\vec{J}_d = \epsilon_0 \frac{d\vec{E}}{dt}$ . [3]  
c) What should be the capacitance of a capacitor in a tuned circuit of frequency 10 MHz having an inductance of 0.01 mH? The resistance of the circuit is negligible. [4]

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