12.09.18 (2nd Half)

B. Tech/Odd Sem (Mid Term Exam.)

2018

410

PHYSICS

PHC 01

Time – Two hours

Full Marks – 30

Answer three questions with question no. 1 as compulsory.
The figures in the margin indicate full marks.

1. Answer any five question $5\times2 = 10$
   a) What is Lissajous figure?
   b) What do you mean by mean decay time of a damped harmonic oscillator and how does it change with damping coefficient?
   c) What are the conditions of stationary interference of light?
   d) Prove that the conservation of energy is maintained in interference experiment.
   e) Give two experimental examples of division of wave front and division of amplitude for interference of light.
   f) If the width of the double slits increases or decreases then what will be the effect on the fringe pattern?

2. (a) What is superposition principle? Show that it holds only for linear differential equations.

   (b) Two perpendicular harmonic motions acting simultaneously on a particle are given by $x = A_1 \cos\omega t$, $y = A_2 \cos(\omega t + \delta)$. Find the resultant motion of the particle when the phase difference $(i)\ \delta = 0$ and $(ii)\ \delta = 3\pi/2$.

   (c) Two SHMs of the same frequency act on a particle simultaneously in the same direction. These SHMs are represented by $x_1 = \cos\omega t$, $x_2 = 1.5\cos\left(\omega t + 60^0\right)$. Find the amplitude of resultant motion. Here amplitude is in cm unit. 3+5+2

3. (a) Distinguish between free damped vibration and forced vibration.

   (b) Establish the equation of motion for a damped harmonic oscillator and solve it. Discuss the case of 'overdamping'.

   (c) A massless spring suspended from a rigid support carries a mass of 200g at its lower end. It is observed that the system oscillates with time period of 0.2s and amplitude of oscillations

reduces to half of its initial undamped value in 30 seconds. Calculate the relaxation time of the system. 2+5+3

4. (a) Explain about the formation of fringes having equal inclination and equal thickness in case of interference of light, with examples.

(b) Calculate the fringe width formed by Fresnel bi-prism and find out the relation between the separation of two virtual sources, refractive index and angle of bi-prism.

(c) The incline faces of a bi-prism of refractive index of 1.5 makes an angle of 2 degree with the base. A slit of monochromatic light is placed at a distance of 10 cm from the bi-prism. If the distance between two dark fringes at a distance of 1 m from the bi-prism is 0.18 mm. Find the wavelength of the light used. 2+(3+2)+3

5. (a) If an oil film of thickness t has been grown on the surface of water then, find out the condition with which the minimum and maximum interference pattern will be formed on the front side of the oil film. Also, show that the conditions will be reversed for the transmitted rays at the opposite face of the oil film. Given that the refractive index of the oil and water are μ_1 and μ_2 ($<\mu 1$), respectively.

(b) Describe the construction and working principle of a Michelson's Interferometer. Explain the formation of Circular and Straight fringes.

(c) If in a Newton Ring experiment air is replaced by a liquid of refractive index of 1.33, in what proportion would be the diameter of a ring change. 5+3+2

14.09.18
1st Half (CS, EC, IT)

B.Tech/Odd Sem (Mid–Term Exam.)

231

2018

Physics of Semiconductor Devices

PHC 331

Time – 2 Hours Full Marks – 30

Answer three questions including question no. 1 as compulsory.
The figures in the margin indicate full marks.

1. Answer any five questions 5×2 = 10
   a) What is direct and indirect band gap semiconductors? Give examples.
   b) Deduce the expression of Fermi energy at T = o K from $n = \int_0^\infty f(E)g(E)dE$. The symbol have their usual meaning.
   c) The intrinsic carrier concentration of silicon is 5×10^{19} m^{-3} at 150°C. The electron and hole mobilities are 0.07 m^2/V-s and 0.023 m^2/V-s respectively. Calculate the electrical conductivity of Si.
   d) The conductivity of Ge is 0.7 $\Omega^{-1}cm^{-1}$ at 0°C and 2 $\Omega^{-1}cm^{-1}$ at 20°C. What is the energy gap for Ge?
   e) what is a pinch-off voltage? Show it in the transconductance curve of a JFET.
   f) How will you determine the drain characteristics of a JFET? What do they indicate?
   g) What are the advantages of MOSFETover JFET?
   h) A JFET has a drain current of 5 mA. If I_{DSS}=10 mA and $V_{GS(OFF)}$= -6 V, find the values of V_{GS} and V_P.

2. Deduce the expression of electron and hole concentration in conduction band and valance band of intrinsic semiconductor. Also determine the position of fermi level. 4+4+2

3. (a)What is Hall effect? Deduce the expression of Hall constant of semiconductor material.
   (b)What do you mean by effective mass? What is its significance? (2+5)+3

4. (a)Draw the dc and ac equivalent circuits of a J-FET. Calculate the voltage gain of a JFET from this.
   (b) what is the rms output voltage of the unloaded amplifier where I_{DSS}=8 mA, $V_{GS(OFF)}$= -10 V and I_D=1.9 mA, V_{DD}= +12 V,R_D=3.3 Kohm, v_{in}= 100 mV, R_G= 10 Mohm, R_S= 2.7 Kohm, C_2= 10 microohm. 5+5=10

5. Write the construction and working of a D-MOSFET. 10

14.09.18
1st Half (EE)

082

B. Tech/Odd Sem (Mid Term Exam.)

2018-19

Electromagnetic Field Theory

PHC332

Time – Two hours

Full Marks – 30

Question No. 1 is compulsory. Answer any *other TWO* questions.
The figures in the margin indicate full marks.

1. Answer any five 2×5

(a) Define the gradient of a scalar point function. If $\vec{r}$ is the position vector and $\phi = \frac{1}{|\vec{r}|}$, find $\vec{\nabla}\phi$.

(b) Show that curl of an electrostatic field is zero.

(c) Using Gauss's divergence theorem prove that $\iiint_V \vec{\nabla}\phi \, dV = \iint_S \phi \, dS$.

(d) Starting from Biot- Savart law find the expression for $\nabla \times B$.

(e) Write Ampere's law in differential form.

(f) Calculate the induced emf when the magnetic flux is given by 3sin t + 5cos t?

2. (a) What do you mean by divergence of a vector field? Show by vector method that $\nabla^2(1/r) = 0$. 3

(b) State and prove Green's theorem. 5

(c) Find the value of $\vec{\nabla} \times (\vec{\nabla}\phi)$, where ϕ is a scalar point function. 2

3. (a) State and prove the Gauss's law in electrostatics. 5

(b) Derive Coulomb's law from Gauss's law. 3

(c) Show that the vector function $\vec{u} = \left(6xy + z^3\right)\hat{i} + \left(3x^2 - z\right)\hat{j} + \left(3xz^2 - y\right)\hat{k}$ is irrotational. 2

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27/08/2018

4. (a) The electric field in certain region of space is given in spherical polar coordinates as $\vec{E} = \frac{A}{r}\hat{r} - B\sin^3\varphi\hat{\varphi}$. Determine the charge density.

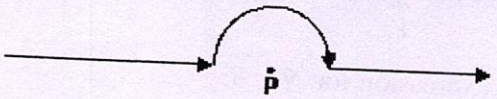
(b) Find the expressions for bound charge density induced in dielectric medium when placed in an external electric field. Explain the physical origin of the above induced charge density.

(c) What do you mean by electric potential? 4+4+2

5. (a) The electric potential of some configuration is given by the expression $V(r) = A\frac{e^{-\lambda r}}{r}$, where A and λ is constants. Find the electric field E (r), the charge density $\rho(r)$ and total charge Q.

(b) Find the electric field a distance z above the midpoint of a straight line segment of length 2L, which carries a uniform line charge λ.

(c) Part of a long current carrying wire is bent in the form of a semicircle of radius R. Calculate the magnetic field at the center of the semi-circle.



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27/08/2018

4+3+3

15.09.18
1st Half (3rd Sem)

153

B.Tech/Odd Sem (Reg.)(Mid Term Exam)

2018-19

Physics of Engineering Materials (PHC 333)

Time – 2 hrs

Full Marks – 30

Answer any three questions. Question no. 1 is compulsory. The figures in the margin indicate full marks.

(1) Answer any five question: 5×2

(a) Find out the expression of the effective mass of an electron.
(b) Explain the difference of direct and indirect bandgap semiconductors. Give examples.
(c) Define Fermi energy. What is its importance?
(d) Define carrier relaxation time and find the relation with conductivity of a metal.
(e) Write down the different steps for semiconductor device fabrication process.
(f) Find out the expression for electrical heat conductivity of a metal.

(2) Derive expressions for the densities of electrons and holes in the conduction and valance bands respectively in an intrinsic semiconductor. Show that the Fermi energy level in an intrinsic semiconductor lies approximately half way between the top of the valence band and the bottom of the conduction band. 7+3

(3) What is a barrier potential? Derive an expression for barrier potential of a p-n junction diode at equilibrium. How does it vary with the bias applied across the junction? A germanium p-n junction diode has 10^{22} donor atoms/m^3 of the n-region and 2×10^{21} acceptor atoms/m^3 of the p-region. Find the value of the barrier potential developed across the unbiased junction at room temperature. Given n_i $2.4 \times 10^{19}/m^3$. 1+4+2+3

(4) Point out the drawbacks of free electron model of solids and explain the Sommerfeld corrections. What is the importance of Fermi surface for explaining the electrical conductivity of metal? The density of silver is 10.5×10^3 Kg/m^3. The atomic weight of silver is 107.9. Assuming that each silver atom provides one conduction electron, calculate the density of electrons. The conductivity of silver at 20 ^{0}C is 6.8×10^7 Ω^{-1}m. Calculate also the mobility of electrons in silver. Find the expression for number of electrons in the energy state between E and E+dE. 2+2+3+3

(5) Establish Matthiessen's rules for the resistivity of a metal and explain the residual resistivity and high temperature resistivity of a metal. Explain the formation of band gap in solids from K-P theory. What is the length of the 1st Brillouin Zones? 4+5+1

Amiruddha Mondal
15/09/18

154

B.Tech/Odd Sem (Reg.)(Mid Term Exam)

2018-19

Physics of Engineering Materials (PHC 333)

Time – 2 hrs

Full Marks – 30

Answer any three questions. Question no. 1 is compulsory. The figures in the margin indicate full marks.

(1) Answer any five question: 5×2

(a) Find out the expression of the effective mass of an electron.
(b) Explain the difference of direct and indirect bandgap semiconductors. Give examples.
(c) Define Fermi energy. What is its importance?
(d) Define carrier relaxation time and find the relation with conductivity of a metal.
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(5) Establish Matthiessen's rules for the resistivity of a metal and explain the residual resistivity and high temperature resistivity of a metal. Explain the formation of band gap in solids from K-P theory. What is the length of the 1st Brillouin Zones? 4+5+1

Aniruddha Mondal

14.09.18
1st Half (1. MSc)

19

B. Tech/Odd Sem (Mid Term Exam.)

2018-19

Physics II

PHC334

Time – Two hours

Full Marks – 30

Question No. 1 is compulsory. Answer any *other TWO* questions.
The figures in the margin indicate full marks.

1. Answer any five 2×5

   (a) If $\vec{r}$ is the position vector, find the value of div $\vec{r}$.

   (b) Using Stoke's theorem prove that $\iint_S d\mathbf{S} \times \vec{\nabla}\phi = \oint \phi \, dl$.

   (c) Show that $\text{div}(\phi \vec{A}) = \phi \, \text{div}\, \vec{A} + \vec{A}.\text{grad}\, \phi$.

   (d) What are dielectrics?

   (e) State amperes circuital law.

   (f) What is meant by displacement current?

2. (a) What do you mean by curl of a vector field? Show that $r^n \vec{r}$ is an irrotational vector for any value of n, but solenoidal only if $n+3 = 0$. 3

   (b) State and prove Gauss's divergence theorem. 5

   (c) If $\vec{a}$ is a constant vector, show that $\vec{\nabla} \times (\vec{r} \times \vec{a}) = -2\vec{a}$. 2

3. (a) State Gauss's law in electrostatics. 2

   (b) Use Gauss's law to calculate the electric field intensity due to a uniformly charged sphere at an external point. 5

   (c) Show that div (curl $\vec{u}$) = 0, where $\vec{u}$ is a vector point function. 3

4. (a) Find the electric field a distance z above the midpoint of a straight line segment of length 2L. 4

   (b) One of these is an impossible electrostatic field. Which one?

   (i) $\vec{E} = K[xy\hat{i} + 2yz\hat{j} + 3xy\hat{k}]$;
   (ii) $\vec{E} = K[y^2\hat{i} + (2xy + z^2)\hat{j} + 2yz\hat{k}]$

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Here K is a constant with the appropriate unit. For Possible one find the potential using the origin as your reference point. 6

5. (a) Find the expression of the electric potential of a dipole. And then find the expression for electric field for a dipole.

   (b) Show that Maxwell's Equations are consistent with conservation of charge.

   (c) What do you mean by magnetic vector potential?

5+3+2

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13/09/18 (2nd Half)

790

2018-2019

ENGINEERING MECHANICS

XEC-01

Time- 2 Hours | Full Marks- 30

Answer any THREE questions

1. (a) State the conditions for equilibrium of a rigid body under three forces. **2**

   (b) With the help of an example explain briefly the principle of transmissibility of a force. **2**

   (c) A mass less rod AB of length L supports a hanging mass m as shown in Fig. 1. What minimum torque T should be applied at the pulley of radius r so that the inextensible rope DC can hold the rod at an angle θ in static equilibrium. Assume the pin joint at A to be friction less and the distance of point C as a from the pin joint. **6**

2 (a) State and proof the Varignon's theorem of moment. **3**

   (b) A mast AB supported by spherical socket at A and horizontal guy wires BD and BE carries a vertical load P at B as shown in Fig. 2. Find the axial force induced in each of the three members of the system. **7**

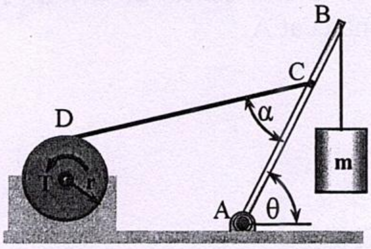

Fig. 1

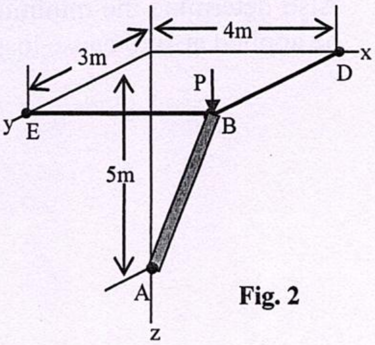

Fig. 2

3. (a) For Belt Friction establish the relation $(T1/T2) = e^{\mu\beta}$, where the notations carry their usual meaning (Ref Fig. 3a). **5**

   (b) What minimum mass m must be hanged at the end of the inextensible and mass less rope, which passes over a fixed circular drum as shown in Fig. 3b, to keep the block of mass M at rest on the inclined plane of angle θ. The friction coefficient between the block and the inclined plane is μ_1 and that between the rope and the drum is μ_2. **5**

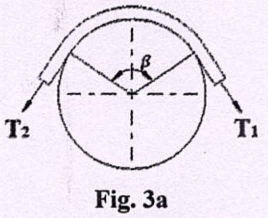

Fig. 3a

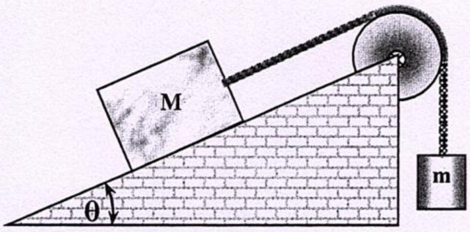

Fig. 3b

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(N. BANERJEE)

4. Determine the magnitude of the forces and their nature in the members of the truss shown in Fig. 4. **10**

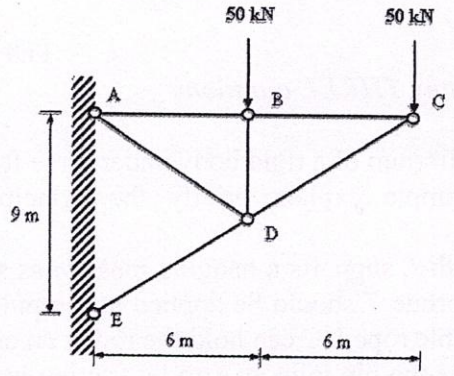

Fig. 4

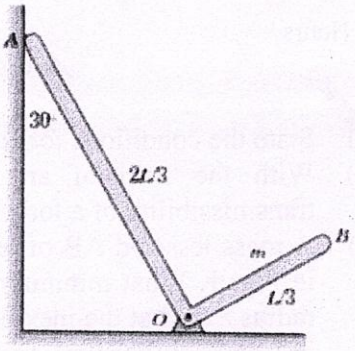

Fig. 5

5. The right-angle uniform slender bar *AOB,* as shown in Fig. 5, has mass *m.* If friction at the pivot *O* is neglected, determine the magnitude of the normal force at *A* and the magnitude of the pin reaction at *O*. Also determine the minimum value of the vertical downward force to be applied at B to cause loss of contact at A. **10**

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