Name : ……………………………………………………

Roll No. : …………………………………………………

Invigilator's Signature : …………………………………….

CS/B.TECH(O)/SEM-1/PH-101/2012-13

2012

ENGINEERING PHYSICS

Time Allotted : 3 Hours   *Full Marks :* 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A

(Multiple Choice Type Questions)

1.   Choose the correct alternatives for any *ten* of the following :
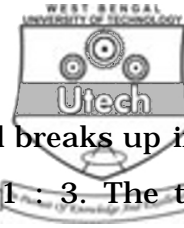
$$10 \times 1 = 10$$

   i)   Earth moves round the sun due to gravitational force which is central in nature. Sun-earth distance (R) changes periodically round the year. So which of the following is correct ?

   a)   Angular velocity of the earth round the sun is proportional to R

   b)   Angular velocity is constant

   c)   Angular velocity is proportional to $\dfrac{1}{R}$

   d)   Angular velocity is proportional to $\dfrac{1}{R^2}$.

ii) A body was at rest when it explodes and breaks up into three pieces of masses in the ratio 1 : 1 : 3. The two pieces of equal mass fly off perpendicular to each other with a speed of 30 m/s each. If the mass of the body be 1 kg then the velocity of the heavier piece is

a) 40 m/s b) 60 m/s

c) $10\sqrt{2}$ m/s d) $6\sqrt{2}$ m/s.

iii) Generalized co-ordinate can be of any dimension. However,

a) the product of generalized co-ordinate and generalized momentum is always of dimension ml^2/t

b) dimension of the work done depends on the dimension of the generalized co-ordinate

c) the generalized momentum is always of the dimension ml/t

d) the generalized force is always of the dimension ml/t^2.

(Given, mass = m, length = l, time = t)

iv) Rigid body has constraints classified in which of the following groups ?

a) Rheonomic and Holonomic

b) Rheonomic and Non-holonomic

c) Scleronomic and Holonomic

d) Scleronomic and Non-holonomic.

v) Two mutually perpendicular oscillations with same frequency, amplitude but phase difference δ will produce close curve with non-zero area enclosed

   a) for all values of δ except δ = 0

   b) only for δ = $\frac{\pi}{2}$

   c) for all values of δ except δ = 0 and δ = π

   d) for all values of δ ≥ $\frac{\pi}{2}$.

vi) Example of weakly damped harmonic oscillator is

   a) Dead-bead galvanometer

   b) Tangent galvanometer

   c) Ballistic galvanometer

   d) discharge of a charged capacitor through a resistance.

vii) Let (r, θ, φ) represent the spherical polar co-ordinates of a point in a region where the electrostatic potential V is given by $V = k\phi^2$. Then the charge density in that region

   a) is also a function of φ only

   b) is constant in that region

   c) is a function of all the co-ordinates (r, θ, φ)

   d) is a function of (r, θ) only.

viii) At a point just outside a current carrying conducting wire

   a) electric field is zero while the magnetic field is non-zero

   b) magnetic field is zero while the electric field is not

   c) both electric and magnetic fields are zero

   d) neither the electric field is zero nor the magnetic field is zero.

ix) Electromagnetic wave is propagated through a region of vacuum, which does not contain any charge or current. If the electric vector is given by

$\vec{E} = E_0 \ exp \ i \ (\ kx - wt \ ) \ \hat{j}$ then the magnetic vector is

   a) in x direction

   b) in y direction

   c) in z direction

   d) rotating uniformly in the $x - y$ plane.

x) The electric flux through each of the faces of a cube of side 1 m if a charge q coulomb is placed at its centre is

   a) $\dfrac{q}{4\in_0}$ b) $4\in_0 \ q$

   c) $\dfrac{q}{6\in_0}$ d) $\dfrac{\in_0}{6q}$.

xi) When a body collides elasticity with another of equal mass at rest

    a) the first particle comes to rest and the second particle moves with the velocity of the first particle

    b) two bodies move with equal velocities after impact

    c) two bodies move with equal accelerations

    d) the first particle comes to rest and the second particle moves with twice the velocity of the first particle.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. A sphere impinges directly on an equal sphere which is rest. Show that a fraction $\frac{1}{2}$ ($1 - e^2$) of the original *K.E.* is lost during the impact.

3. a) What is the form of Lagrange's equation of motion for a non-conservative force ?

    b) Starting from the definition of current and current density derive the equation of continuity in current electricity. $1 + (1 + 1 + 2)$

4. a) State Ampere's law in magnetostatics in integral form and from that deduce its differential form.

    b) Write down the condition of steady state current. Show that Ampere's law implies that the current is in the steady state. $(1 + 1 \frac{1}{2}) + (1 + 1 \frac{1}{2})$

5. A very long cylindrical object carries charge distribution proportional to the distance from the axis (r). If the cylinder is of radius a, then find the electric field both at $r > a$ and $r < a$ by the application of Gauss's law in electrostatics.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

6. a) If a proton is 1800 times heavier than an electron then show that the centre of mass of hydrogen atom is located practically at proton. Find the reduced mass of this system and write the Lagrangian of the reduced mass. $1 + 1 + 2$

    b) Show that if a co-ordinate is cyclic in Lagrangian it will be cyclic in Hamiltonian also.   3

    c) Two objects of mass 5 kg and 10 kg moving at an angle of 60˚ with respect to each other, symmetric to an axis on a frictionless surface with velocities 20 m/s and 10 m/s respectively collide and diverge out at angles symmetric to the above axis the velocity of the first body is 8 m/s after the collision, find the velocity of the second body after collision in the lab frame as well as centre of mass frame. Is the collision elastic ? $5 + 1$

    d) Give example of system with non-holonomic and rheonomic (one each) constraints.   2

7. a) Find out Hamilton's equations of motion for a system comprising masses m_1 and m_2 connected by a massless string of length L through a frictionless pulley such that $m_1 > m_2$.   5

    b) Find out the degree of freedom of a rigid body constrained to move along the equator and remain on the surface of the earth.   2
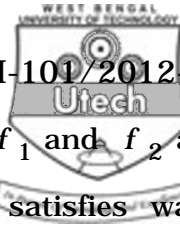
c) If $y = f_1 (x - vt) + f_2 (x + vt)$ where f_1 and f_2 are the two functions then show that y satisfies wave equation. 3

d) Define ampere from the consideration of force between two parallel currents. A test charge having charge 0·4C is moving with a velocity of $4 \hat{i} - \hat{j} + 2 \hat{k}$ m/s through an electric field of intensity $10 \hat{i} + 10 \hat{k}$ of and a magnetic field $2 \hat{i} - \hat{j} - 6 \hat{k}$. Determine the magnitude and direction of the Lorentz force acting on the test charge. 2 + 3

8. a) Calculate the time period of the liquid column of length l in a U-tube, if it is depressed in one arm by x, d is the density of liquid and A is the corss-sectional area of each arm of U-tube. 4

b) In damped harmonic motion, calculate the time in which the energy of the system falls to l/e times the initial value. 3

c) Write down the differential equation of a series L-C-R circuit driven by a sinusoidal voltage. Identify the natural frequency of this circuit. Find out the condition that this circuit will show an oscillatory decay and find out the relaxation time. 1 + 1 + 2 + 1

d) Find out the value of the driving frequency at which the voltage across the capacitor is maximum. 3

9. a) Find if the work done in moving an object in the field

$$\vec{F} = (2xy + z^3) \, \hat{i} + x^2 \, \hat{j} + 3xz^2 \, \hat{k}$$

from point (1, – 2, 1) to (3, 1, 4) is independent of the path chosen. 3

b) If the vector potential $A = (x^2 + y^2 - z^2) \, \hat{j}$ is at position (x, y, z), find the magnetic field at (1, 1, 1). 2

c) Find a unit vector perpendicular to $x^2 + y^2 - z^2 = 100$ at the point (1, 2, 3). 2

d) Find the magnetic induction $\vec{B}$, at a point on the axis of an infinitely long solenoid carrying current I, No. of turns per unit length being n. 5

e) Derive coulomb's theorem using Gauss' law of electrostatics. 3

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