

KATHMANDU UNIVERSITY
End Semester Examination [C]
June/July 2024

Level : B.E./B.Sc.
Year : II
Time : 2 hrs. 30mins.

07 JUL 2024

Course : MATH 211
Semester : II
F. M. : 55

SECTION "C"

[3 Q. × 7 = 21 marks]

1. If the radial and transverse velocities of a point are always proportional to each other and this holds for acceleration also, prove that its velocity will vary as some power of the radius vector.
A motorist is traveling on a curved section of highway with a radius of 2500 ft at a speed of 88 ft/s. The motorist suddenly applies the brakes, causing the automobile to slow down at a constant rate. If the speed has been reduced to 66 ft/s after 8 s, determine the tangential and normal components of acceleration of the automobile immediately after the brakes have been applied. [3+2+2=7]

OR

A particle is moving in a plane curve. Find the components of velocity and acceleration at time t along and perpendicular to the radius vector drawn from a fixed point in the plane. Hence, find the same components of the particle describing a circle of radius a . [5+2=7]

2. Find the centre of gravity of a sectorial area bounded by a curve $r = f(\theta)$ and the two radii vectors $\theta = \alpha$ and $\theta = \beta$. Also, find the centre of gravity of the area bounded by the parabola $y^2 = 4ax$, the axis of x and the latus rectum. [3+4=7]
3. Define common Catenary. Using intrinsic equation of a catenary, derive Cartesian equation of a common catenary. Show that for a common catenary, $y + s = c e^{x/c}$, where the symbols have their usual meanings. [1+3+3=7]

SECTION "D"

[6 Q. × 4 = 24 Marks]

4. A particle is moving with SHM and while an excursion from one position of the rest to the other, its distance from the middle point of its path at three consecutive seconds are observed to be x_1, x_2 , and x_3 . Find that the time of complete revolution.
5. If the orbit is a cardioid, $r = 2(1 + \cos \theta)$ find the law of force.
6. A particle moves with a central acceleration which varies inversely as the cube of the distance; if it be projected from an apse at a distance a from the origin with a velocity which is $\sqrt{2}$ times the velocity for a circle of radius a , show that the equation of the path is $r \cos\left(\frac{\theta}{\sqrt{2}}\right) = a$.

7. Three forces P, Q and R act along the sides of triangle formed by the lines $x + y = 1$, $x - y = -1$, and $y = 2$. Find the magnitude of the resultant and the equation of its line of action.
8. A uniform chain of length l , which can just bear a tension of n times its weight, is stretched between two points in the same horizontal line. Show that the least possible sag in the middle is $l \left(n - \sqrt{n^2 - \frac{1}{4}} \right)$.

OR

A hyperbola is placed in a vertical plane with its transverse axis horizontal; show that the time of descent down a diameter is least when the conjugate diameter is equal to the distance between the foci.

9. Show that a system of coplanar forces consisting of any number of forces acting in a plane at different points of a rigid body can be reduced to a single force through any given point and a couple whose moment is equal to the algebraic sum of the moments of the given forces about this point.

SECTION "E"

[5 Q. \times 2 = 10 Marks]

10. A particle moving in a straight with SHM has velocities v_1 and v_2 when its distances from the centre are x_1 and x_2 . Show that the period of the motion is $2\pi \sqrt{\frac{x_1^2 - x_2^2}{v_2^2 - v_1^2}}$.
11. Define apse. Show that the radius vector is either maximum or minimum at an apse.
12. If the angular velocity of a moving point about a fixed origin be constant, prove that its transverse acceleration varies as its radial velocity.
13. Explain the process of finding the center of gravity of a solid formed by the revolution of the curve $y = f(x)$ lying between the ordinates $x = a$ and $x = b$ about x-axis.
14. If central force, $P \propto 1/r^5$, find the equation of the orbit.

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Marks Scored:

Level : B.E./B.Sc.

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Exam Roll No. :

Time: 30 mins.

Course : MATH 211

Semester : II

F. M. : 20

Date : 01 JUL 2024

Date :

Registration No.:

SECTION "A"

[10Q. × 1 = 10 marks]

Fill in the blank space(s) by writing the most appropriate word(s) or symbol(s).

1. The component of the velocity of a particle moving in a plane curve along the radius vector is _____.
2. The expression for Areal velocity is _____.
3. In a simple harmonic motion, the velocity is minimum at the _____.
4. Let P be the acceleration of the particle directed to a fixed point, then the equation of motion is _____.
5. The relation between angular and linear velocities is _____.
6. If the displacement of a particle moving in a straight line is expressed by the equation $x = a_1 \cos pt + a_2 \sin pt$, then it describes a simple harmonic motion whose time period is _____.
7. Let y_1 and y_2 be the heights of any two points on a catenary above the x -axis and T_1 and T_2 the tensions at these points. Then $T_1 - T_2 =$ _____.
8. The center of gravity of a semi-circular arc of radius a subtending an angle $\pi/2$ at the center is _____.
9. The intrinsic equation of a catenary is _____.
10. The sag of the catenary is the _____.

SECTION "B"

[10 Q. × 1 = 10 Marks]

Fill in the blank space(s), **DO NOT TICK**, by choosing the most appropriate answers from among the given ones.

11. Three coplanar forces each of weight 10 kg are acting at a particle. If their line of actions make same angle, then their resultant force will be _____.
[$10\sqrt{2}$; 20 ; $5\sqrt{2}$; 0]

12. The velocity of a projection at a distance r from the center of force is _____.
 $\left[\frac{v^2}{2} = - \int_{\infty}^r P dr; \quad v = \sqrt{Pr}; \quad \frac{v^2}{2} = \int_0^{\infty} P dr; \quad \frac{v^2}{2} = \int_0^r P dr \right]$
13. For a particle moving in a circle of radius a , transverse velocity is _____.
 $[a \dot{\theta}; \quad 0; \quad a \dot{\theta}^2; \quad a\ddot{\theta}]$
14. Pedal equation of a parabola with pole at focus is _____.
 $[r^2 = 2ap; \quad r^2 = c^2 - a^2 + 2ap; \quad p^2 = ar; \quad p = r \sin \alpha]$
15. A body in SHM has velocity 10cm/s and 8cm/s at a displacement 4cm and 5cm from mean position. The period of oscillation will be _____.
 $[\pi; \quad \frac{3\pi}{2}; \quad 2\pi; \quad \frac{\pi}{2}]$
16. A particle moves in a straight line under an repulsion from a fixed point varying inversely as the distance x from the fixed point. Its equation of motion is _____.
 $\left[\frac{d^2x}{dt^2} = \frac{\mu}{x}; \quad \frac{d^2x}{dt^2} = -\mu x; \quad \frac{d^2x}{dt^2} = \mu x; \quad \frac{d^2x}{dt^2} = -\frac{\mu}{x} \right]$
17. Three forces acting on a rigid body are represented in magnitude, direction and line of action by three sides of a triangle taken in order. The forces are equivalent to a couple whose moment is equal to _____.
 $[\text{area of the triangle}; \quad \text{twice the area of the triangle}; \quad \text{half the area of the triangle}; \quad \text{none}]$
18. If G_1 and G be the algebraic sums of the moments of forces of the given system about the points (1,1) and (0,0) respectively, then _____.
 $[G_1 = G - R_y; \quad G_1 = G + 2R_x; \quad G_1 = G + R_x - R_y; \quad G_1 = G - R_x]$
19. The center of gravity of a uniform parallelogram is _____.
 $[1/3 \text{ distance from the right corner}; \quad \text{right corner}; \quad \text{left corner}; \quad \text{point of intersection of the diagonals}]$
20. If the area under consideration is symmetrical about the y -axis, the centre of gravity lies on _____.
 $[\text{x-axis}; \quad \text{y-axis}; \quad \text{origin}; \quad \text{y} = \text{x}]$