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**A List of Topics for the First Midterm**

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Here's a list of things you should be comfortable doing for the exam.

**1. Three-Dimensional Coordinate Systems (Chapter 12.1)**

- (a) Plot points in three dimensions.
- (b) Compute the distance between two points in  $\mathbf{R}^3$ .
- (c) Recognize equations for cylinders and spheres.

**2. Vectors (Chapter 12.2)**

- (a) Recognize vectors written in a variety of forms.
- (b) Find a vector from one point to another.
- (c) Add, subtract, and scale vectors, either geometrically or algebraically.
- (d) Compute the length of a vector.

**3. The Dot Product (Chapter 12.3)**

- (a) Compute the dot product between two vectors.
- (b) Determine when two vectors are parallel or perpendicular.
- (c) Find the angle between two vectors.
- (d) Compute  $\text{proj}_{\mathbf{a}}(\mathbf{b})$  and  $\text{comp}_{\mathbf{a}}(\mathbf{b})$ .

**4. The Cross Product (Chapter 12.4)**

- (a) Compute the cross product of two vectors in  $\mathbf{R}^3$ .
- (b) Understand the connection between the directions of  $\mathbf{a}$ ,  $\mathbf{b}$ , and  $\mathbf{a} \times \mathbf{b}$ .
- (c) Find the area of a triangle or parallelogram using the cross product.

**5. Lines & Planes (Chapter 12.5)**

- (a) Find the equation for a line given a point and a direction vector.
- (b) Find the equation for a plane given a point and a normal vector.
- (c) Solve all sorts of problems involving lines & planes, including but not limited to:
  - Check whether two lines are parallel, intersecting, or skew.
  - Find the intersection of two planes.
  - Find the intersection of a line and a plane.
  - Find a plane through three points.
  - Find a plane through a point and a line.
  - Find the distance from a point to a plane.
  - Find the angle between two planes.

**6. Quadric Surfaces (Chapter 12.6)**

- (a) Complete the square to write the equation for a quadric surface in standard form.
- (b) Recognize various quadric surfaces from their equations.
- (c) Determine the shape of a quadric surface by drawing its traces.
- (d) Find the intersection(s) of a line with a quadric surface.

**7. Vector Functions and Space Curves (Chapter 13.1)**

- (a) Compute limits of vector functions.
- (b) Check whether the space curves of two vector functions intersect, and if so where.
- (c) Locate the intersection of a space curve and a quadric surface.
- (d) Find a vector function to represent the intersection of two surfaces.

**8. Derivatives and Integrals of Vector Function (Chapter 13.2)**

- (a) Take the derivative of a vector function.
- (b) Find the tangent vector to a space curve at a given point.
- (c) Compute antiderivatives of vector functions.

**9. Polar Coordinates (Chapter 10.3)**

- (a) Convert points and equations between polar form and Cartesian form.
- (b) (Roughly) sketch polar functions.

**10. Arc Length and Curvature (Chapter 13.3)**

- (a) Compute arc length for vector functions in three or more dimensions.
- (b) Find  $\kappa$ ,  $\mathbf{T}$ , and  $\mathbf{N}$  for a given vector function.

**11. Velocity & Acceleration (Chapter 13.4)**

- (a) Compute velocity and acceleration vectors for an object using its position vector.
- (b) Integrate to find the position vector using the acceleration vector.
- (c) Apply the equation  $\mathbf{F} = m\mathbf{a}$ .
- (d) Decompose an acceleration vector into its normal and tangential components.