



Assignment 4 - Mathematics-I
Departments: ECE, CSE, ENE
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Due: Dec 12, 2025 (Friday)

This assignment covers the following contents: Sections 6.1 - 6.4 and Sections 6.6 - 6.8 (avoiding triple integral contents) for Unit IV and Sections 7.10 - 7.14, Sections 7.22 - 7.24, Section 7.28 for Unit V (Textbook: Engineering Mathematics by Bali and Manish Goyal, 9th edition and Lecture notes)

1. Change the order of integration and evaluate $\int_0^1 \int_{\sqrt{y}}^1 \sqrt{1+x^3} \, dx \, dy$

2. Evaluate $\iint_D (x^2 + y^2)^{3/2} \, dA$, where

(a) $D = \left\{ (x, y) \mid 1 \leq x^2 + y^2 \leq 4, y \geq \sqrt{3}x, y \geq \frac{1}{\sqrt{3}}x \right\}$

(b) D is the area outside $x^2 + y^2 = 2y$, and inside $x^2 + y^2 = 4y$

Hint: Sketch the domain and see if it is a simple region in another coordinate system.

3. Evaluate $\iint_D dA$, where D is the region bounded by $xy = 1, xy = 3, y^2 = x, y^2 = 2x$

4. Find the volume of the solid under the paraboloid $z = 3 - x^2 - y^2$, above $z = 0$, and inside the cylinder $x^2 + y^2 = 1$

5. Sketch and find the parametric representation of the following curves:

(a) the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ in \mathbb{R}^2

(b) the curve given by the intersection of the cylinders $x^2 + y^2 = r^2, x^2 + z^2 = r^2$ in \mathbb{R}^3

(c) the curve given by the intersection of the cylinder $x^2 + y^2 = 4$ and the elliptic cone $z = \sqrt{3x^2 + 2y^2}$ in \mathbb{R}^3

(d) the helix that lies on the cylinder $x^2 + y^2 = 4$ and passes through the points $(2, 0, 0)$ and $(\sqrt{2}, \sqrt{2}, \sqrt{2})$ in \mathbb{R}^3

6. Suppose that a wire has the shape of a helix of radius R and height h . Its shape can be parametrized by $\vec{g}(t) = (R \cos t, R \sin t, \frac{h}{2\pi} t)$ for $0 \leq t \leq 2\pi$. Suppose that the density of the wire varies linearly with height, so that it can be described by the function $\rho(x, y, z) = \rho_0 (1 + (k - 1)\frac{z}{h})$, where k and ρ_0 are constants. Find the mass of the wire.

7. (a) Find $\phi(x, y)$ with $\phi(1, -2) = 2$ if $\nabla \phi = 2xy\hat{i} + x^2\hat{j}$.

(b) Let $\vec{F} = \nabla \phi$. Calculate the work done by \vec{F} on a particle as it travels along the path $\vec{x} = \vec{g}(t) = (\cos(t), 1 + \sin(t))$ for $\frac{3\pi}{2} \leq t \leq 2\pi$.

8. Let C be the semicircle traversed anti-clockwise from $(-2, 0)$ to $(2, 0)$. Compute $\int_C \vec{F} \cdot d\vec{x}$, where

$\vec{F} = (e^{y^2} + xy + 3y, 2xye^{y^2} + \frac{x^2}{2} + 7y)$.

(Hint: Close the curve, use Green's theorem, and move the curve. What is the force field on x -axis?)