
Problem 2. \( r'(t) = \langle -\sin t, \cos t, 1 \rangle \), \( |r'(t)| = \sqrt{2} \), therefore
\[ T = \frac{1}{\sqrt{2}} \langle -\sin t, \cos t, 1 \rangle. \]

Then,
\[ T'(t) = \frac{1}{\sqrt{2}} \langle -\cos t, -\sin t, 0 \rangle, \]
\[ |T'(t)| = \frac{1}{\sqrt{2}}, \]
\[ N(t) = \langle -\cos t, -\sin t, 0 \rangle. \]

Finally,
\[ B(t) = T(t) \times N(t) = \frac{1}{\sqrt{2}} \langle \sin t, -\cos t, 1 \rangle. \]

Problem 3. \( f_x = 4x + 2y - 2 = 0, f_y = 2y + 2x + 1 = 0. \) Solve this system: from the first equation, we obtain: \( 2y = 2 - 4x, y = 1 - 2x; \) plug into the second equation: \( 2(1 - 2x) + 2x + 1 = 0, 3 - 2x = 0, x = 3/2, y = 1 - 2x = -2. \) The only critical point is \((3/2, -2)\). \( f_{xx} = 4, f_{xy} = 2, f_{yy} = 2; D = f_{xx}f_{yy} - f_{xy}^2 = 4 > 0. \) Use the Second Derivative Test and conclude that this is a local minimum point. Since it is unique, it is a global minimum point. Answer: \(-5/2.\)

Problem 4.
\[
V = \iiint_D z\,dA = \iiint_{x^2+y^2\leq 4} (x^2 + 2y^2 + 1)\,dA = \int_0^{2\pi} \int_0^2 (r^2 + r^2 \sin^2 \theta + 1)r\,dr\,d\theta = \int_0^{2\pi} \int_0^2 \left(\frac{1}{4}r^4 + \frac{1}{4}r^4 \sin^2 \theta + \frac{1}{2}r^2\right)\,dr\,d\theta = \int_0^{2\pi} (4 + 4 \sin^2 \theta + 2)\,d\theta = \int_0^{2\pi} (6 + 2(1 - \csc(2\theta))\,d\theta = (8\theta - \sin(2\theta))\bigg|_0^{2\pi} = 16\pi.
\]

Problem 5.
\[
M = \iint_D \rho(x, y)\,dA = \int_0^2 \int_0^{4-2x} x(y + 1)\,dy\,dx = \int_0^2 x(y^2/2 + y)\bigg|_{y=0}^{y=4-2x} \,dx = \int_0^2 x(2(2-x)^2 + 4 - 2x)\,dx = \int_0^2 x(8 - 8x + 2x^2 + 4 - 2x)\,dx = \int_0^2 (12x - 10x^2 + 2x^3)\,dx = \left(6x^2 - \frac{10}{3}x^3 + \frac{1}{2}x^4\right)\bigg|_0^2 = 24 - \frac{80}{3} + 8 = 5\frac{1}{3} = \frac{16}{3}.
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