This print-out should have 12 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering.

001 10.0 points

Locate and classify all the local extrema of

$$f(x, y) = x^3 - y^3 - 3xy - 3.$$

1. local min at $(-1, 1)$, local max at $(0, 0)$

2. local min at $(0, 0)$, saddle point at $(-1, 1)$

3. local min at $(-1, 1)$, saddle point at $(0, 0)$

4. local max at $(-1, 1)$, saddle point at $(0, 0)$

5. local max at $(0, 0)$, saddle point at $(-1, 1)$

002 10.0 points

Which one of the following properties does the function

$$f(x, y) = x^3 + 2xy^2 - 5x - 4y + 20$$

have?

1. local min value 14 at $(1, 1)$

2. saddle point at $(1, 1)$

3. local max value 14 at $(-1, 1)$

4. local max value 14 at $(1, 1)$

5. local min value 14 at $(-1, 1)$

6. saddle point at $(-1, 1)$

003 10.0 points

Locate and classify the local extremum of f when

$$f(x, y) = 3x + \frac{y}{3} + \frac{1}{xy} + 1, \quad (x, y > 0).$$

1. local min at $\left(\frac{1}{3}, 3\right)$

2. local min at $(3, 3)$

3. local max at $\left(\frac{1}{3}, 3\right)$

4. saddle at $(3, 3)$

5. saddle at $\left(\frac{1}{3}, 3\right)$

6. local max at $(3, 3)$

004 10.0 points

Which of the following most correctly describes the behaviour of the graph of the function

$$f(x, y) = 2(x + y)(xy + 9) + 4.$$

1. saddle-points at $(3, -3)$, $(-3, 3)$

2. local max at $(3, -3)$, $(-3, 3)$

3. saddle-points at $(3, 3)$, $(-3, -3)$

4. local max at $(3, 3)$, $(-3, -3)$

5. saddle $(3, -3)$, local max $(-3, 3)$

005 10.0 points

Locate and classify the critical point of

$$f(x, y) = \ln(xy) + 4y^2 - 2y - 2xy + 4,$$

for $x, y > 0$.

1. saddle-point at $\left(\frac{1}{4}, 2\right)$

2. saddle-point at $\left(2, \frac{1}{4}\right)$

3. local minimum at $\left(2, \frac{1}{4}\right)$

4. local maximum at $\left(2, \frac{1}{4}\right)$

5. local maximum at $\left(\frac{1}{4}, 2\right)$

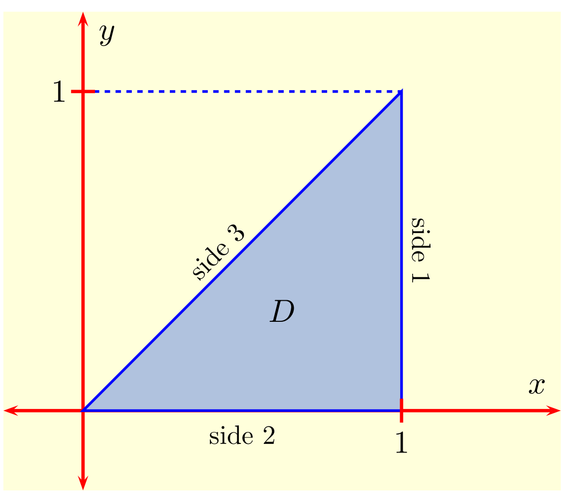
6. local minimum at $\left(\frac{1}{4}, 2\right)$

006 10.0 points

Locate the point at which the function

$$f(x, y) = x^2 - 2y^2 - x + y$$

has its absolute maximum on the shaded triangular region D shown in



1. on side 1 but not at an end-point

2. at a critical point inside D

3. on side 2 but not at an end-point

4. on side 3 but not at an end-point

5. at a vertex of D

007 10.0 points

Determine the absolute maximum of

$$f(x, y) = x^2 + y^2 - x - y + 2$$

on the unit disk

$$D = \{(x, y) : x^2 + y^2 \leq 1\}.$$

1. absolute max $= 4$

2. absolute max $= 3$

3. absolute max $= 3 + \sqrt{2}$

4. absolute max $= \frac{3}{2}$

5. absolute max $= 3 - \sqrt{2}$

008 10.0 points

Determine the absolute maximum value of

$$f(x, y) = -2 \cos x \cos y$$

on the square $0 \leq x, y \leq \pi$.

1. absolute max $= 2\pi$

2. absolute max $= 2$

3. absolute max $= -2\pi$

4. absolute max $= 0$

5. absolute max $= -2$

009 10.0 points

Use the method of Lagrange multipliers to minimize

$$f(x, y) = \sqrt{3x^2 + y^2}$$

subject to the constraint

$$x + y = 1.$$

1. min value $= \dfrac{1}{2}\sqrt{3}$

2. min value $= \sqrt{3}$

3. min value $= 1$

4. no min value exists

5. min value $= \dfrac{1}{2}$

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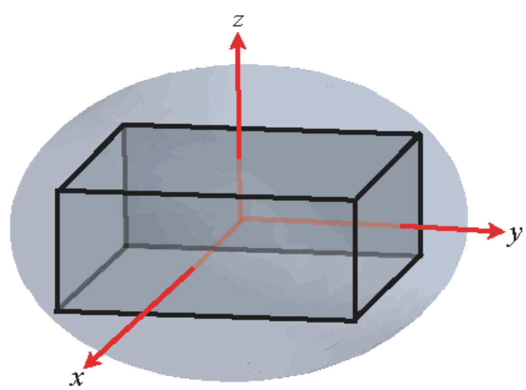
010 10.0 points

A rectangular box with edges parallel to the axes is inscribed in the ellipsoid

$$3x^2 + y^2 + z^2 = 9$$

similar to the one shown in



Use Lagrange multipliers to determine the maximum volume of this box.

Note: *all 8 vertices of the box will lie on the ellipsoid when the volume is maximized.*

1. volume $=$ 24 cu. units

2. volume $=$ 72 cu. units

3. volume $=$ 36 cu. units

4. volume $=$ 12 cu. units

5. volume $=$ 18 cu. units

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011 10.0 points

Use Lagrange multipliers to find the maximum and minimum values of the function $f(x, y) = 2x^2y$, subject to the constraint

$$2x^2 + y^2 = 300\,.$$

1. $f_{max} = 2000$, $f_{min} = 0$

2. $f_{max} = 1000$, $f_{min} = -1000$

3. $f_{max} = 500$, $f_{min} = -500$

4. $f_{max} = 2000$, $f_{min} = -2000$

5. $f_{max} = 0$, $f_{min} = -1000$

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012 10.0 points

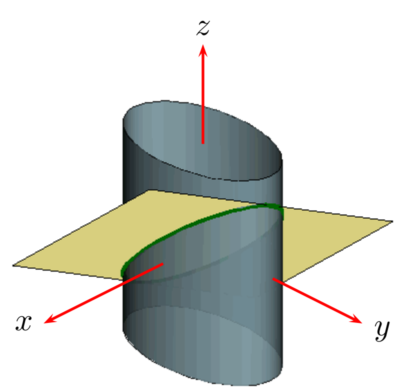
Finding the minimum value of

$$f(x, y) = x + 2y - 1$$

subject to the constraint

$$g(x, y) = 3x^2 + 4y^2 - 3 = 0$$

is equivalent to finding the height of the lowest point on the curve of intersection of the graphs of f and g shown in



Use Lagrange multipliers to determine this minimum value.

1. min value $= -4$

2. min value $= -2$

3. min value $= -1$

4. min value $= -3$

5. min value $= -5$