Name:
ID:
Section:

This exam has 17 questions:

- 15 multiple choice questions worth 5 points each.
- 2 hand graded questions worth 25 points total.

Important:

- No graphing calculators! Any non scientific calculator is fine.
- For the multiple choice questions, mark your answer on the answer card.
- Show all your work for the written problems. You will be graded on the ease of reading your solution.
- You are allowed both sides of 3×5 note "cheat card" for the exam.

1. If v_1 and v_2 are vectors in $\mathbb{R}^3$ with $\|v_1\| = 2$, $\|v_2\| = 5$ and $v_1 \cdot v_2 = -6$ find $\|v_1 \times v_2\|$.

   (a) 0
   (b) $2\sqrt{3}$
   (c) $3\sqrt{2}$
   (d) $\sqrt{51}$
   (e) 8
   (f) $4\sqrt{6}$
   (g) $5\sqrt{3}$
   (h) $2\sqrt{21}$
   (i) 10
   (j) None of the above

2. Which of the following is an equation of the plane containing the origin and parallel to the two vectors

$$v_1 = (1, 3, 4), \quad v_2 = (2, -1, 1)$$

(a) $x + 3y + 4z = 0$
(b) $2x - y + z = 0$
(c) $x + y - z = 0$
(d) $x - y - z = 0$
(e) $x + 3y + 4z = 3$
(f) $2x - y + z = 3$
(g) $x - y - z = 3$
(h) None of the above

3. Which of the following are equations for a plane that is parallel to the line

$$r(t) = (1 + t, 2 - t, 3 + 2t)$$

(a) $x + y = 6$
(b) $x + y = 5$
(c) $2y + z = 6$
(d) $2y + z = 5$
(e) $2x + 4y + z = 0$
(f) All of these
(g) More than one of these, but not zero or all of them
(h) None of these

4. Find the distance from the point $(3, 1, 1)$ to the line $r(t) = (2 - t, 2 + t, 1 + 2t)$.

   (a) 0
   (b) $\frac{1}{\sqrt{6}}$
   (c) $\frac{1}{\sqrt{3}}$
   (d) $\frac{2}{\sqrt{3}}$
   (e) 2
   (f) 3
   (g) $\sqrt{6}$
   (h) $2\sqrt{5}$
   (i) $\sqrt{11}$
   (j) None of the above

5. Find the distance between the planes

$$x - 2y - z = 1$$
$$x - 2y - z = 4$$

   (a) 0
   (b) $1/\sqrt{6}$
   (c) $1/\sqrt{3}$
   (d) $1/\sqrt{2}$
   (e) $\sqrt{2/3}$
   (f) $\sqrt{3/2}$
   (g) $\sqrt{2}$
   (h) $\sqrt{3}$
   (i) $\sqrt{6}$
   (j) None of the above

6. Find an equation of the line through the point $(1, 0, 2)$ that is orthogonal to the plane

$$x + 2y + 7z = 12$$

(a) $r(t) = (1 + t, 2, 7 + 2t)$
(b) $r(t) = (1 + t, 2t, 2 + 7t)$
(c) $r(t) = (1 - t, 2t, 2 - 7t)$
(d) $r(t) = (12 + t, 12, 12 + 2t)$
(e) $r(t) = t + 2t + 7t - 12$
(f) $r(t) = (x + 1, 2y, 7z + 2)$
(g) None of the above

7. Compute the **larger** angle between the two planes $x + z = 213$ and $x + y = -17$.

(a) 0
(b) $\pi/8$
(c) $\pi/6$
(d) $\pi/5$
(e) $\pi/4$
(f) $\pi/2$
(g) $2\pi/3$
(h) $3\pi/4$
(i) $5\pi/6$
(j) π

8. If

$$r(t) = \left(1 - t, \frac{1}{t}, 2t, -3\right) \qquad \text{and} \qquad s(t) = \left(t, -t, t^2, t^3\right)$$

compute

$$\frac{d}{dt}(r \cdot s)(t)\Big|_{t=1} =$$

(a) -6
(b) -5
(c) -4
(d) -3
(e) -2
(f) -1
(g) 0
(h) 1
(i) 2
(j) 3
(k) None of the above

9. Find the equation of the line that is tangent to the curve

$$r(t) = \left(t, t^2, \frac{2}{t}\right)$$

when $t = 2$.

(a) $L(t) = (1, 1, 2) + t(1, 2, -2)$
(b) $L(t) = (1, 2 - 2) + t(1, 1, 2)$
(c) $L(t) = (1, 1, 2) + t(0, 2, 4)$
(d) $L(t) = (0, 2, 4) + t(1, 1, 2)$
(e) $L(t) = (-2, 4, -1) + t\left(1, -4, -\frac{1}{2}\right)$
(f) $L(t) = \left(1, -4, -\frac{1}{2}\right) + t(-2, 4, -1)$
(g) $L(t) = \left(1, 4, -\frac{1}{2}\right) + t(2, 4, 1)$
(h) $L(t) = (2, 4, 1) + t\left(1, 4, -\frac{1}{2}\right)$
(i) None of the above

10. Find a rectangular representation for the parametrized curve

$$r(t) = (19 - 4\sin 3t, 23 + 3\cos 3t)$$

(a) $\left(\frac{x-19}{4}\right)^2 + \left(\frac{y-23}{3}\right)^2 = 1$

(b) $\left(\frac{x+19}{4}\right)^2 + \left(\frac{y+23}{3}\right)^2 = 1$

(c) $\left(\frac{x-23}{4}\right)^2 + \left(\frac{y-19}{3}\right)^2 = 1$

(d) $\left(\frac{x+23}{4}\right)^2 + \left(\frac{y+19}{3}\right)^2 = 1$

(e) $(x-19)^2 + (y-23)^2 = 1$

(f) $(x+19)^2 + (y+23)^2 = 1$

(g) $(x-23)^2 + (y-19)^2 = 1$

(h) $(x+23)^2 + (y+19)^2 = 1$

(i) $(x-19)^2 + (y-23)^2 = 12$

(j) $(x+19)^2 + (y+23)^2 = 12$

(k) None of the above

11. Let $f(x, y, z) = x^2 y e^{-3z}$. Find

$$\frac{\partial^3 f}{\partial x \partial y \partial z}(3, 2, 0)$$

(a) -54

(b) -36

(c) -27

(d) -18

(e) 0

(f) 4

(g) 9

(h) 12

(i) 18

(j) 162

(k) None of the above

12. If $f(x,y,z) = x^2 - 2xy\ln z$, compute

$$\nabla f(1,-1,1) = \text{grad} f(1,-1,1) =$$

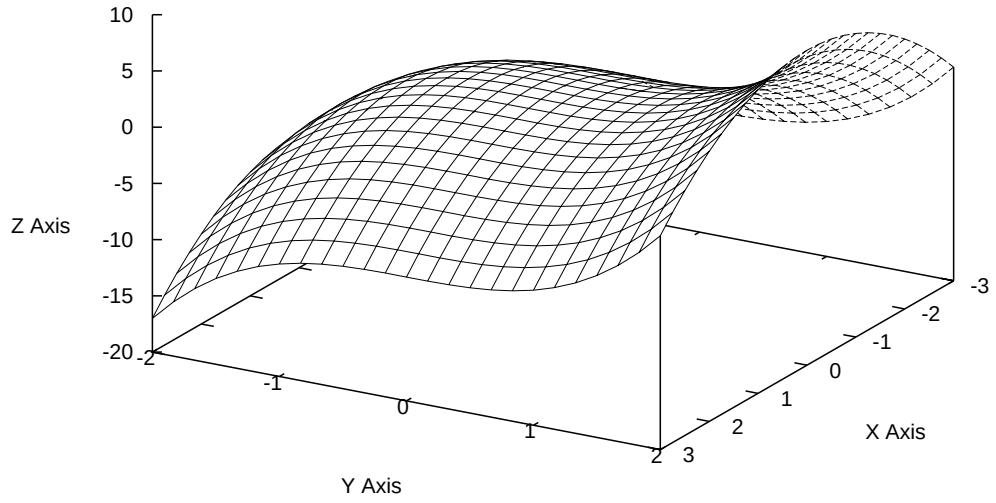
(a) 0
(b) 1
(c) 2
(d) 4
(e) $(1,-1,1)$
(f) $(2,0,2)$
(g) $(2,0,-2)$
(h) $(2,1,2)$
(i) $(2,1,-2)$
(j) None of the above

13. Let $f(x,y,z) = x + y^2 + z^2$ and $r(t) = (2-t, \cos t, \sin t)$. Compute

$$\frac{d}{dt}(f \circ r)(t)\Big|_{t=1} =$$

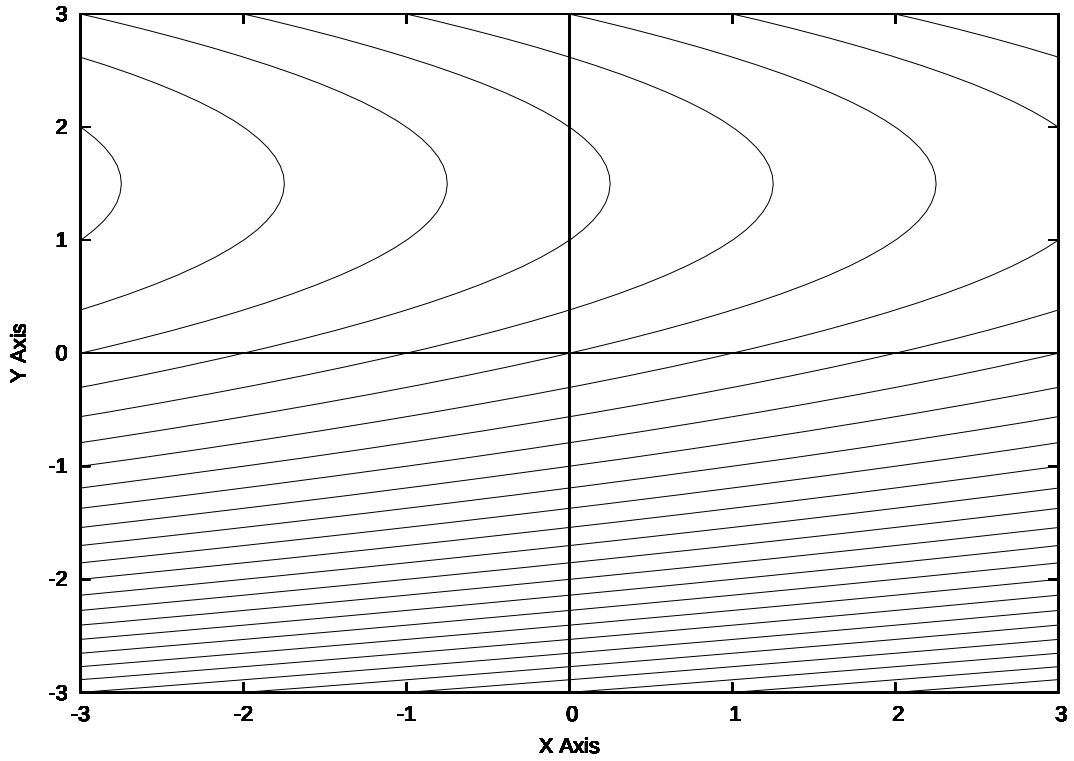
(a) -2
(b) -1
(c) 0
(d) 1
(e) 2
(f) 3
(g) 4
(h) 5
(i) 6
(j) 7
(k) None of the above

14. Match the graph to the correct function.



(a) $f(x, y) = y^2$
(b) $f(x, y) = x^2$
(c) $f(x, y) = x - y^2$
(d) $f(x, y) = y - x^2$
(e) $f(x, y) = y^3 - x^2$
(f) $f(x, y) = x^2 - y^3$
(g) $f(x, y) = y^4 - x^2$
(h) $f(x, y) = x^4 - y^2$
(i) $f(x, y) = y^4 - x$
(j) $f(x, y) = x^4 - y$

15. Match the level curves to the correct function.



(a) $f(x, y) = x^2$

(b) $f(x, y) = y^2$

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

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

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

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

(g) $f(x, y) = y + x^2 + 3x$

(h) $f(x, y) = y + x^2 - 3x$

(i) $f(x, y) = x + y^2 + 3y$

(j) $f(x, y) = x + y^2 - 3y$

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Note: You will be graded on the readability of your work. Use the back of the page, if necessary.

16. Consider the curve $r(t) = (2t^3, 3t^2)$.

    (a) Compute the velocity at time t

    (b) Compute the acceleration at time t

    (c) Compute the speed at time t

    (d) Compute the arc length from $t = 1$ to $t = 4$

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17. Consider the surface $z^2 = x^2 - y^2$

    (a) Draw the slices for $x = -2, -1, 0, 1, 2$ in the same plane

    (b) Draw the slices for $y = -2, -1, 0, 1, 2$ in the same plane

    (c) Draw the slices for $z = -2, -1, 0, 1, 2$ in the same plane

    (d) Draw the surface in 3-space.