Name: ______________________________

Instructor: ________________________

**Math 20550, Exam 1, Practice**
**September 22, 2015**

- The Honor Code is in effect for this examination. All work is to be your own.
- No calculators.
- The exam lasts for 1 hour and 15 minutes..
- Be sure that your name is on every page in case pages become detached.
- Be sure that you have all 9 pages of the test.
- Each multiple choice question is 6 points, each partial credit problem is 12 points. You will receive 4 extra points.

PLEASE MARK YOUR ANSWERS WITH AN X, not a circle!

| | | | | | |
|---|---|---|---|---|---|
| 1. | (a) | (b) | (c) | (d) | (e) |
| 2. | (a) | (b) | (c) | (d) | (e) |
| 3. | (a) | (b) | (c) | (d) | (e) |
| 4. | (a) | (b) | (c) | (d) | (e) |
| 5. | (a) | (b) | (c) | (d) | (e) |
| 6. | (a) | (b) | (c) | (d) | (e) |
| 7. | (a) | (b) | (c) | (d) | (e) |
| 8. | (a) | (b) | (c) | (d) | (e) |
| 9. | (a) | (b) | (c) | (d) | (e) |
| 10. | (a) | (b) | (c) | (d) | (e) |

**Please do NOT write in this box.**

| | |
|---|---|
| Multiple Choice | ________ |
| 11. | ________ |
| 12. | ________ |
| 13. | ________ |
| Extra Points. | 4 |
| Total | ________ |

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Multiple Choice

**1.**(6 pts) Let $\mathbf{a} = \langle 1, 2, 0 \rangle$, $\mathbf{b} = \langle 3, 1, -1 \rangle$, and let $\mathbf{c} = \text{proj}_{\mathbf{a}}\mathbf{b}$ be the vector projection of $\mathbf{b}$ onto $\mathbf{a}$. Which one of the following vectors is orthogonal to $\mathbf{b} - \mathbf{c}$?

(a) $\langle 0, 1, 1 \rangle$ (b) $\langle 2, 1, -1 \rangle$ (c) $\langle 1, 2, 0 \rangle$

(d) $\langle 2, 1, 0 \rangle$ (e) $\langle 1, 0, 1 \rangle$

**2.**(6 pts) Find the radius of the sphere given by the equation

$$x^2 + y^2 + z^2 - 6x + 4z + 7 = 10.$$

(a) 3 (b) 9 (c) $-4$ (d) 2 (e) 4

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**3.**(6 pts) A particle moves with the position function $\mathbf{r}(t) = \langle t^2, -t, 2 \rangle$. Find the normal component of acceleration.

(a) $a_N = \dfrac{2}{\sqrt{1+4t^2}}$ (b) $a_N = 4t$ (c) $a_N = 2$

(d) $a_N = \dfrac{4t}{\sqrt{1+4t^2}}$ (e) $a_N = \sqrt{1+4t^2}$

**4.**(6 pts) Find the volume of the parallelepiped determined by the vectors $\mathbf{a} = \langle 1, 2, 2 \rangle$, $\mathbf{b} = \langle 3, 2, 2 \rangle$, and $\mathbf{c} = \langle 7, 3, 1 \rangle$.

(a) $-4$ (b) $8$ (c) $3$ (d) $-8$ (e) $4$

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**5.**(6 pts) Where does the line with parametric equations

$$x = -1 + 3t \qquad y = 2 - 2t \qquad z = 3 + t$$

intersect the plane $3x + y - 4z = -4$?

(a) they do not intersect (b) $(-3, -3, -2)$ (c) $(8, -4, 6)$

(d) $(-10, 8, 0)$ (e) $(0, 0, 1)$

**6.**(6 pts) Find symmetric equations for the line through the point $(1, -2, -4)$ which is orthogonal to the plane $2x - y + 3z = 18$.

(a) $\dfrac{x+1}{2} = \dfrac{y-2}{1} = \dfrac{z-4}{3}$ (b) $\dfrac{x-1}{2} = \dfrac{-y-2}{-1} = \dfrac{z+4}{3}$

(c) $\dfrac{x-1}{2} = \dfrac{y+2}{-1} = \dfrac{z+4}{3}$ (d) $\dfrac{x-1}{\sqrt{14}} = \dfrac{-y-2}{\sqrt{14}} = \dfrac{z+4}{\sqrt{14}}$

(e) $\dfrac{1+2x}{\sqrt{14}} = \dfrac{-y-2}{\sqrt{14}} = \dfrac{-4+3z}{\sqrt{14}}$

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**7.**(6 pts) Find the position $\mathbf{r}(1)$ of a particle at time $y = 1$ if it has acceleration $\mathbf{a}(t) = e^t\mathbf{i} - 6t\mathbf{k}$, the initial position of the particle is $\mathbf{r}(0) = \langle 1, 0, -1\rangle$ and the initial velocity is $\mathbf{v}(0) = \langle 1, 1, 0\rangle$.

(a) $\mathbf{r}(1) = \langle 1, 0, 1\rangle$ (b) $\mathbf{r}(1) = \langle e, 0, 0\rangle$ (c) $\mathbf{r}(1) = \langle e, 1, -1\rangle$

(d) $\mathbf{r}(1) = \langle e, 1, -2\rangle$ (e) $\mathbf{r}(1) = \langle 0, 1, 2\rangle$

**8.**(6 pts) Which of these is an equation of the tangent line to the curve

$$\mathbf{r}(t) = \langle t^2 + 2t + 3,\ 4t\cos(t),\ 2e^{3t}\rangle$$

at the point where $t = 0$?

(a) $\langle x, y, z\rangle = \langle 3, 4, 2e\rangle + t\langle 2, 0, 6e\rangle$ (b) $\langle x, y, z\rangle = \langle 3, 0, 2\rangle + t\langle 1, 2, 3\rangle$

(c) $\langle x, y, z\rangle = \langle 3, 0, 2\rangle + t\langle 1, -2, 3\rangle$ (d) $\langle x, y, z\rangle = \langle 3, 4, 2\rangle + t\langle 1, 2, 3\rangle$

(e) $\langle x, y, z\rangle = \langle 3, 0, 2e\rangle + t\langle 2, 4, 6\rangle$

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**9.**(6 pts) Which of the following expressions gives the length of the curve defined by $\mathbf{r}(t) = t^2\mathbf{i} - \mathbf{j} + \ln t\,\mathbf{k}$ between the points $(1, -1, 0)$ and $(e^2, -1, 1)$?

(a) $\int_1^{e^2} \sqrt{4t^2 + 1/t^2}\, \mathrm{d}t$

(b) $\int_1^{e} \sqrt{t^2 + 1 + \ln^2 t}\, \mathrm{d}t$

(c) $\int_0^{1} \sqrt{2t + \ln t}\, \mathrm{d}t$

(d) $\int_1^{e} \sqrt{2t + \ln t}\, \mathrm{d}t$

(e) $\int_1^{e} \sqrt{4t^2 + 1/t^2}\, \mathrm{d}t$

**10.**(6 pts) Which one of the following functions has level curves drawn below?

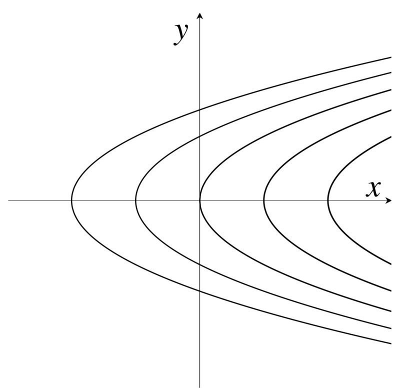
(a) $f(x, y) = y^2 + x$

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

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

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

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



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Partial Credit

You must show your work on the partial credit problems to receive credit!

**11.**(12 pts.) Find an equation for the line of intersection of the planes $3x - y + z = 0$ and $2x - 3y + z = 0$.

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**12.**(12 pts.) The position function of a moving object is $\mathbf{r}(t) = t^2\mathbf{i} - \mathbf{j} + \ln t\,\mathbf{k}$.

(a) Find the unit tangent vector $\mathbf{T}$, the principal normal vector $\mathbf{N}$, and the bi-normal vector $\mathbf{B}$ at $t = 1$.

(b) Find an equation of the normal plane at $t = 1$.

(c) Find an equation of the osculating plane at $t = 1$.

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**13.**(12 pts.) Find the distance from the point $(-4, 1, 4)$ to the plane containing the points $P(0, 0, 3)$, $Q(1, 1, 3)$, and $R(1, 0, -1)$.