Academic conduct statement [3 points] Please write out the statement "I am aware that this exam, like any exam, is governed by the Boston University academic conduct code."

Please print your name:

Please sign your name:

Please write your BU ID number:

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Midterm 1b – MA 225 – Fall 2016

Thursday, October 6, 2016

Name: ______________________________ BU ID: ______________________________

Discussion section (circle one):

B2: W 9-10, B3: W 2-3, B4: W 1-2, B5: Th 830-930, B6: Th 930-1030

Instructions: Please write clearly and **show all work. If an answer is not justified, no points will be awarded.** Points may be deducted for messy, unclear, or poorly explained work. Books, notes, and calculators are NOT permitted during this exam.

Do not write in the following box.

Problem	Possible	Score
Academic Conduct Statement	3	
Name, BU ID, discussion	2	
1	20	
2	10	
3	15	
4	10	
5	10	
6	10	
7	10	
8	10	
Total	100	

Question 1 [20 points] Let

$$\mathbf{u} = \langle 3, -1, 4 \rangle, \qquad \mathbf{v} = \langle 5, -1, 2 \rangle, \qquad \mathbf{w} = \langle 3, -1, c \rangle$$

be vectors in $\mathbb{R}^3$, where c is a scalar.

(i) Find a nonzero vector that is orthogonal to $\mathbf{u}$.

(ii) Find a value of c such that $\text{proj}_{\mathbf{u}}\mathbf{w} = \mathbf{0}$.

(iii) Find a value of c so that $\mathbf{w}$ is orthogonal to $\mathbf{u} \times \mathbf{v}$.

(iv) Find a unit vector with the same direction as $\mathbf{u}$.

Question 2 [10 points] Let

$$\mathbf{u} = \langle 2, -1, 5 \rangle, \qquad \mathbf{v} = \langle 0, 2, 1 \rangle, \qquad \mathbf{w} = \langle 1, 2, 3 \rangle$$

be vectors in $\mathbb{R}^3$. For each of the following, if the quantity makes sense, compute it. If it does not make sense, explain why.

(i) $|-\mathbf{w}|$

(ii) $(\mathbf{u} \cdot \mathbf{v}) \cdot \mathbf{w}$

(iii) $(\mathbf{u} - \mathbf{v}) \cdot \mathbf{w}$

(iv) $2\mathbf{u} \times \mathbf{v}$

Question 3 [15 points]

(i) [**5 points**] Give a geometric description of the set of points (x, y, z) that satisfy

$$x^2 + y^2 + 6x \leq 10.$$

(ii) [**5 points**] Write down an equation describing a plane that is orthogonal to the yz-plane and that contains the origin.

(iii) [**5 points**] Describe the set of all vectors that are parallel to $\mathbf{j} \times \mathbf{k}$ and draw a picture of the collection of all such vectors.

Question 4 [10 points]

(i) [**7 points**] Suppose a projectile begins at the point $(1, 2, -1)$ with an initial velocity vector of $\langle 2, -1, 4\rangle$. If its acceleration is given by

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

find the velocity and position vectors for $t \geq 0$.

(ii) [**3 points**] Consider the motion of a projectile given by $\mathbf{r}(t) = \langle 2t + 4, 3\sin t\rangle$, which is launched from the point $(4, 0)$ at $t = 0$. Where will it hit the ground?

Question 5 [10 points]

(i) **[5 points]** Find an equation of the plane containing the points $(1, 0, -2)$, $(2, 1, -3)$, and $(0, 1, -3)$.

(ii) **[5 points]** Sketch the curve described by the following function and describe in words all key aspects of your picture.

$$\mathbf{r}(t) = \langle t^2, \cos t, \sin t \rangle, \qquad -\infty < t < \infty$$

Question 6 [10 points]

(i) **[5 points]** Compute the arc length parameter for the curve $\mathbf{r}(t) = \langle \cos(6t), -\sin(6t), t \rangle$ with base point at $t = 0$.

(ii) **[5 points]** Consider a point $S(c, 1, 0)$ for some scalar c and consider the plane $x + y + z = 6$. Find a value of c such that the distance from the point to the plane is equal to 8.

Question 7 [10 points]

(a) **[5 points]** Find the equation of the line that is orthogonal to the plane $3x - 2y + z = 8$ and contains the point $(1, -1, 2)$.

(b) **[5 points]** Consider the curve $\mathbf{r}(t) = \langle \cos t, e^{-t}, t^3 \rangle$. For which value(s) of t is its tangent line parallel to the y-axis?

Question 8 [10 points] Consider the surface described by the equation

$$6x^2 - \frac{y^2}{4} + z^2 = 0.$$

Sketch the traces in the three coordinate planes. Then sketch the complete surface in $\mathbb{R}^3$. Please be sure to justify your answer.