

**Directions:** Do not simplify unless indicated. No calculators are permitted. Show all work as appropriate for the methods taught in this course. Partial credit will be given for any work, words or ideas which are relevant to the problem.

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**Please put problem 1 on answer sheet 1**

1. These problems are independent of one another.

- (a) Explain in words why the vectors  $\mathbf{a} = 5\mathbf{i} + 4\mathbf{j} - 3\mathbf{k}$  and  $\mathbf{b} = 2\mathbf{i} - 2\mathbf{j} + 1\mathbf{k}$  are not parallel to one another. [5 pts]
- (b) Calculate  $\mathbf{a} \times \mathbf{b}$  for  $\mathbf{a} = 5\mathbf{i} + 4\mathbf{j} - 3\mathbf{k}$  and  $\mathbf{b} = 2\mathbf{i} - 2\mathbf{j} + 1\mathbf{k}$  and simplify. [5 pts]
- (c) Find the tangential component of acceleration at  $t = 2$  for the object following the path parametrized by: [15 pts]

$$\mathbf{r}(t) = (t^2 - t)\mathbf{i} + e^{2-t}\mathbf{j} + t\mathbf{k}$$

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**Please put problem 2 on answer sheet 2**

2. These problems are independent of one another.

- (a) Sketch the plane  $x + 2z = 10$ . [5 pts]
- (b) Find the vector equation of the line perpendicular to the plane containing the point  $Q = (1, 2, 3)$  and containing the line  $\mathbf{r}(t) = (2t + 1)\mathbf{i} + (3 - t)\mathbf{j} + (5t)\mathbf{k}$  [20 pts]
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**Please put problem 3 on answer sheet 3**

3. These problems are independent of one another.

- (a) Explain in words why the following parametrization is not closed: [10 pts]

$$\mathbf{r}(t) = 2\sin(2t)\mathbf{i} - 3\cos(2t)\mathbf{j} \text{ for } 0 \leq t \leq 2\pi$$

- (b) Write down a parametrization  $\mathbf{r}(t) = \dots$  of the graph of  $y = \sin x$  for  $0 \leq x \leq \pi$ . [5 pts]
- (c) Draw the curve with parametrization: [10 pts]

$$\mathbf{r}(t) = (2 + t)\mathbf{i} + (1 - 2t)\mathbf{j} + (1 + t)\mathbf{k} \text{ for } 0 \leq t \leq 4$$

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**Please put problem 4 on answer sheet 4**

4. Consider the object following the parametrization:

$$\mathbf{r}(t) = t^2\mathbf{i} + 3t\mathbf{j} + t\mathbf{k} \text{ for } t \geq 0$$

- (a) At what time does the object hit the plane  $y + 2z = 10$ ? [7 pts]
- (b) At what time does the object hit the plane  $x + 2y - z = 6$ ? [8 pts]
- (c) Write down an expression (a calculation or an integral or whatever is appropriate) for the distance it travels between these two times. Do not simplify or evaluate whatever expression you write down. [10 pts]
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**The End and the TA Section List**

|          |              |              |
|----------|--------------|--------------|
| Angel    | 0311 ↔ 10:00 | 0321 ↔ 11:00 |
| Ran      | 0312 ↔ 10:00 | 0322 ↔ 11:00 |
| Geoffrey | 0331 ↔ 12:00 | 0341 ↔ 1:00  |