Math & Physics Video Modules

These 5 modules were created by Maribeth Oscamou and Norman Paris and administered through Camino in Fall 2014 in three sections of Math 14. They were offered as extra credit in both sections, as they covered material not covered in class and required extra time outside of class to watch the videos and complete the assigned questions in the module. They are mainly geared toward students who are taking Math 14 and Physics 33 concurrently, or who are taking Physics 33 before taking Math 14.

Each module consists of 1-2 videos (less than 10 minutes each) and 5 questions. Three of the questions ask for feedback about the videos and two of the questions are designed to measure student comprehension. The first comprehension question is a multiple choice question that is geared to be straightforward after watching the videos. The second is a more challenging comprehension question (not multiple choice) in which we require students to upload work supporting their answer.

We are currently in the process of compiling and analyzing the student data from this and will be presenting the results at a SCU Faculty Collaborative for Teaching Innovation CAFÉ in the future.

Below are links to the videos for each module and snapshots of the questions administered through Camino. For any faculty interested in using the modules through Camino, please contact Norm or Maribeth and we will send you the files to import into Camino.

VIDEO MODULE 1

Students are instructed to watch BOTH of the following videos, then answer the following 5 questions.

Video 1: Overview of Integration

Video 2: Introduction to Line Integrals
Question 1 pts

The videos provided me useful connection(s) between Math 14 and Physics 33

- 5 - Strongly Agree
- 4 - Agree
- 3 - Undecided
- 2 - Disagree
- 1 - Strongly Disagree

Question 2 pts

Which of the following are equal to the total charge of a uniformly charged ring of radius R, with charge density \( \lambda \)? Please choose ALL that apply.

- \( \int_C \lambda \, ds \)
- \( \iint \lambda \, dA \)
- \( \int_C \lambda \, dl \)
- \( \lambda 2\pi R \)
- \( \iiint \lambda \, dV \)

Question 1 pts

A thin wire sits in the first quadrant of the xy plane, along the quarter of the circle with radius 3 cm centered at the origin. The density along the wire on this quarter circle is \( \delta(x, y) = 2\mu \) (g/cm). Find the total mass of the wire. Please enter your answer numerically here. In the next question you will need to upload work supporting this answer.

18 (with margin: 0)

Question 4 pts

Upload a .pdf file with work supporting your answer to the previous question. Please write your name on the top of the page. Please make sure all your work can be CLEARLY read.
VIDEO MODULE 2

Students are instructed to watch BOTH of the following videos, then answer the following 5 questions (note the first 3 questions have been omitted here as they are the same as in Video Module 1)

Video 3: Introduction To Vector Fields
Video 4: Finding Electric Fields

Question

Suppose a positive point charge, q, is placed at the origin in xyz-space. In the video, we gave the electric field due to this point charge in terms of \( \hat{r} \) where \( \hat{r} \) is a unit radial vector. Which of the following is an equivalent way of writing the electric field from this point charge in terms of Cartesian coordinates? (i.e. what is the electric field at the point \((x, y, z)\) in terms of \(\hat{i}, \hat{j}, \text{and} \hat{k}\)?

- \( \vec{E} = k \frac{q}{x^2 + y^2 + z^2} (x\hat{i} + y\hat{j} + z\hat{k}) \)
- \( \vec{E} = k \frac{q}{x^2 + y^2 + z^2} (\frac{\hat{i} + \hat{j} + \hat{k}}{\sqrt{x^2 + y^2 + z^2}}) \)
- \( \vec{E} = k \frac{q}{x^2 + y^2 + z^2} (\frac{x\hat{i} + y\hat{j} + z\hat{k}}{\sqrt{x^2 + y^2 + z^2}}) \)
- \( \vec{E} = kq (\frac{x\hat{i} + y\hat{j} + z\hat{k}}{\sqrt{x^2 + y^2 + z^2}}) \)
- \( \vec{E} = k \frac{q}{(x^2\hat{i} + y^2\hat{j} + z^2\hat{k})} \)

Question

A thin rod bent into the shape of an arc of a half circle of radius R (see figure below), has varying charge density and carries a charge per unit length \( \lambda = \lambda_0 \cos \theta \) (where \( \lambda_0 \) is a constant). Determine the electric field \( \vec{E} \) at the origin. Remember to write your final answer as a vector. Please upload a .pdf file with work showing all of your steps and your final answer. (Hint: you may also want to review the last example in Video 2 from Module 1).
VIDEO MODULE 3

Students are instructed to watch BOTH of the following videos, then answer the following 5 questions (note the first 3 questions have been omitted here as they are the same as in Video Module 1)

**Video 5: Electric Field Due To Uniformly Charged Disk**

**Video 6: Double Integrals and Electric Fields**

---

### Question

Which of the following is the total charge of a charged circular disk of radius 3, centered at the origin, with charge density $\sigma = \sigma_0 e^{-\sqrt{x^2 + y^2}}$? (Note: $\sigma_0$ is a constant).

- $\sigma_0 \pi \left(1 - e^{-3}\right)$
- $\sigma_0 9\pi$
- $\sigma_0 \pi \left(1 - e^{-9}\right)$
- $2\pi \sigma_0 \left(1 - e^{-9}\right)$

---

### Question

A charged circular plate, G, of radius 2, is sitting centered at the origin in the xy-plane. The charge density on G is $\sigma = \frac{\sigma_0}{\sqrt{x^2 + y^2}}$.

Find the electric field at the point (0,0,4) due to the charged plate, G. Give your final answer as a vector, with each component fully simplified (i.e. given as a number). Please upload a .pdf file with your work and your final answer for this question.
VIDEO MODULE 4

Students are instructed to watch BOTH of the following videos, then answer the following 5 questions (note the first 3 questions have been omitted here as they are the same as in Video Module 1)

**Video 7: Line Integrals and Path Independence**

**Video 8: Conservative Fields in Physics**

<table>
<thead>
<tr>
<th>Question</th>
<th>2 pts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suppose the electric potential due to a certain charge distribution can be written in Cartesian coordinates as $V(x, y, z) = Ax^2y^2 + Byyz$. Where A and B are constants. What is the associated electric field?</td>
<td></td>
</tr>
<tr>
<td>$\vec{E} = -Ax^2y^2\hat{i} + Bxyz\hat{j}$</td>
<td></td>
</tr>
<tr>
<td>$\vec{E} = (2Ax^2y + Byz)\hat{i} + (2Ax^2y + Bxz)\hat{j} + Bxy\hat{k}$</td>
<td></td>
</tr>
<tr>
<td>$\vec{E} = -2Ax^{2}\hat{i} - Bxz\hat{j} - Bxy\hat{k}$</td>
<td></td>
</tr>
<tr>
<td>$\vec{E} = (-2Ax^{2} - Byz)\hat{i} - (2Ax^{2}y + Bxz)\hat{j} - Bxy\hat{k}$</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question</th>
<th>5 pts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suppose the electric field due to a certain charge distribution is given by $\vec{E} = (2x\ln y - yz)\hat{i} + (x^2 / y - xz)\hat{j} - xy\hat{k}$. Show that $\vec{E}$ is conservative and then find the difference in electric potential starting from the point $(1, 2, 1)$ and ending at the point $(2, 1, 1)$. Please upload a file with your work and your answer.</td>
<td></td>
</tr>
</tbody>
</table>
VIDEO MODULE 5

Students are instructed to watch the following video, then answer the following 9 questions (note the first 3 questions have been omitted here as they are the same as in Video Module 1)

Video 9: Maxwell's Equations

<table>
<thead>
<tr>
<th>Question</th>
<th>1.5 pts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faraday's Law, $\oint \mathbf{E} \cdot d\mathbf{r} = -\frac{d}{dt} \int_S \mathbf{B} \cdot \hat{n} , dA$</td>
<td></td>
</tr>
<tr>
<td>can be rewritten in differential form, $\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$</td>
<td></td>
</tr>
<tr>
<td>using:</td>
<td></td>
</tr>
<tr>
<td>- The Divergence Theorem</td>
<td></td>
</tr>
<tr>
<td>- The Fundamental Theorem of Line Integrals</td>
<td></td>
</tr>
<tr>
<td>- Stokes's Theorem</td>
<td></td>
</tr>
<tr>
<td>- Duct tape</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question</th>
<th>1.5 pts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gauss's Law, $\int_S \mathbf{E} \cdot \hat{n} , dA = \frac{q_{enc}}{\varepsilon_0}$</td>
<td></td>
</tr>
<tr>
<td>can be rewritten in differential form, $\nabla \cdot \mathbf{E} = \frac{\rho}{\varepsilon_0}$</td>
<td></td>
</tr>
<tr>
<td>using:</td>
<td></td>
</tr>
<tr>
<td>- The Divergence Theorem</td>
<td></td>
</tr>
<tr>
<td>- Stokes's Theorem</td>
<td></td>
</tr>
<tr>
<td>- The Fundamental Theorem of Line Integrals</td>
<td></td>
</tr>
<tr>
<td>- Luck</td>
<td></td>
</tr>
<tr>
<td>- Norm's Ego</td>
<td></td>
</tr>
</tbody>
</table>
These next questions are regarding all of the 5 Math/Physics modules as a whole:

Overall, these 5 Math/Physics modules increased my motivation to learn and understand the math topics in Math 14.

- 5-Strongly Agree
- 4-Agree
- 3-Undecided
- 2-Disagree
- 1-Strongly Disagree

Overall, these 5 Math/Physics modules increased my motivation to learn and understand the physics topics covered in Physics 33.

- 5-Strongly Agree
- 4-Agree
- 3-Undecided
- 2-Disagree
- 1-Strongly Disagree

Is there anything we should to do change or improve these 5 Math/Physics modules?

Do you recommend we continue to use these 5 Math/Physics modules when we teach Math 14 in the future? If so, please explain what was most useful. If not, please explain why and whether you have any suggestions for something else that would be more useful.