

# Syllabus

PHYS-503: Electromagnetism (Online Asynchronous)

Summer Session II – 6.25.24-8.19.24

Written By: Victor Parkinson, PhD

Instructor: Bradley Mauger

Contact: [bradley.mauger@indwes.edu](mailto:bradley.mauger@indwes.edu) | 575-551-6064

## Course Description

This theoretical and problem-solving course focuses on the development and application of the integral and differential forms of Maxwell's equations from phenomenological observations, culminating in the electromagnetic wave equations. Topics include potential theory, static and dynamic electromagnetic field equations in vacuum and media, and electromagnetic waves with select applications.

Note: This course is designed for those seeking the credentials required by many regional accrediting bodies in order to be able to teach advanced placement, concurrent early college, and community college Physics courses.

**Credit Hours:** 3

**Prerequisite Courses:** None

**Prerequisite Skills and Knowledge:** Prerequisites: a bachelor's degree with a physics major or be state certified (in any state) to teach Physics at a secondary school level, and PHYE-501 or equivalent. Note: This course is designed for those seeking the credentials required by many regional accrediting bodies in order to be able to teach advanced placement, concurrent early college, and community college Physics courses.

## Course Outcomes

Upon successful completion of this course, you should be able to:

1. Define electric and magnetic fields in electrostatics, magnetostatics and electrodynamics in relation to fundamental electric and magnetic observations.
2. Solve problems involving the application of Maxwell's Equations in differential and integral form in unfamiliar circumstances.

3. Outline how Maxwell's modification to the basic electromagnetic laws unified the phenomena of electricity and magnetism and led to the conclusion that light is an electromagnetic wave.
4. Translate fluidly between phenomenological behavior and mathematical description.
5. Model solutions for electric potential problems and others using technology (e.g. Mathematica, Maple).
6. Interpret the integration of faith and science in the writings of 19th Century pioneers in electromagnetism.

## Course Textbook

Fleisch, D. (2008). *A student's guide to Maxwell's equation*. Cambridge University Press.

## Course Technology

Each student will need to purchase a temporary site license for Mathematica Online. This can be arranged through Indiana Wesleyan.

For submitting solutions to assigned problems from the text, students may use Microsoft Equation Editor, LatEx, or another text/equation editor and submit a PDF or scans of work written on paper.

## IWU Diversity Statement

IWU, in covenant with God's reconciling work and in accordance with the biblical principles of our historic Wesleyan tradition, commits to build a community that reflects Kingdom diversity.

We will foster an intentional environment for living, teaching, and learning, which exhibits honor, respect, and dignity. Acknowledging visible or invisible differences, our community authentically values each member's earthly and eternal worth. We refute ignorance and isolation and embrace deliberate and courageous engagement that exhibits Christ's commandment to love all humankind. (2016)

## Grading Scale

**NOTE:** In graduate level courses, a grade of C- or below will require the course to be repeated.

| Grade | Quality Points Per Credit | Percentage | Score |
|-------|---------------------------|------------|-------|
|-------|---------------------------|------------|-------|

|           |     |           |          |
|-----------|-----|-----------|----------|
| <b>A</b>  | 4.0 | 95%–100%  | 950–1000 |
| <b>A-</b> | 3.7 | 92%–94.9% | 920–949  |
| <b>B+</b> | 3.3 | 89%–91.9% | 890–919  |
| <b>B</b>  | 3.0 | 85%–88.9% | 850–889  |
| <b>B-</b> | 2.7 | 82%–84.9% | 820–849  |
| <b>C+</b> | 2.3 | 79%–81.9% | 790–819  |
| <b>C</b>  | 2.0 | 75%–78.9% | 750–789  |
| <b>C-</b> | 1.7 | 72%–74.9% | 720–749  |
| <b>D+</b> | 1.3 | 69%–71.9% | 690–719  |
| <b>D</b>  | 1.0 | 65%–68.9% | 650–689  |
| <b>F</b>  | 0.0 | 0%–64.9%  | 0–649    |

## Grading Policies

Your grading policy for your course is dependent on your school and program. Your grading policies can be found in the [IWU Catalog](#).

## Letter Grade Equivalencies

**NOTE:** In graduate level courses, a grade of C- or below will require the course to be repeated.

| Grade    | Description of Work  |
|----------|--|
| <b>A</b> | Clearly stands out as excellent performance. Has unusually sharp insights into material and initiates thoughtful questions. Sees many sides of an issue. Articulates well and writes logically and clearly. Integrates ideas previously learned from this and other disciplines. Anticipates next steps in progression of ideas. Example "A" work should be of such nature that it could be put on reserve for all cohort members to review and emulate. The "A" cohort member is, in fact, an example for others to follow. |

|          |  |
|----------|--|
| <b>B</b> | Demonstrates a solid comprehension of the subject matter and always accomplishes all course requirements. Serves as an active participant and listener. Communicates orally and in writing at an acceptable level for the degree program. Work shows intuition and creativity. Example "B" work indicates good quality of performance and is given in recognition for solid work; a "B" should be considered a good grade and awarded to those who submit assignments of quality less than the exemplary work described above. |
| <b>C</b> | Quality and quantity of work in and out of class is average. Has marginal comprehension, communication skills, or initiative. Requirements of the assignments are addressed at least minimally.  |
| <b>D</b> | Quality and quantity of work is below average. Has minimal comprehension, communication skills, or initiative. Requirements of the assignments are addressed at below acceptable levels.   |
| <b>F</b> | Quality and quantity of work is unacceptable and does not qualify the student to progress to a more advanced level of work.  |

## Course Module Summary

| <b>Module</b>       | <b>Optional Devotion*</b> | <b>Discussion</b> | <b>Quiz</b> | <b>Dropbox</b> | <b>Total Points per Module</b> |
|---------------------|---------------------------|-------------------|-------------|----------------|--------------------------------|
| <b>Module One</b>   | 1/0                       | 1/20              | 1/30        | 2/75           | 125                            |
| <b>Module Two</b>   | -                         | 1/30              | 1/30        | 2/90           | 150                            |
| <b>Module Three</b> | 1/0                       | 1/20              | 1/30        | 1/60           | 110                            |
| <b>Module Four</b>  | 1/0                       | 1/20              | 1/30        | 1/60           | 110                            |
| <b>Module Five</b>  | 1/0                       | -                 | 1/30        | 2/75           | 105                            |

|                             |     |       |       |        |                 |
|-----------------------------|-----|-------|-------|--------|-----------------|
| <b>Module Six</b>           | 1/0 | 1/20  | 1/30  | 2/90   | 140             |
| <b>Module Seven</b>         | -   | 1/30  | 1/30  | 2/90   | 150             |
| <b>Module Eight</b>         | 1/0 | 1/20  | 1/30  | 1/60   | 110             |
| <b>End-of-Course Survey</b> |     |       |       |        | 10 extra credit |
| <b>TOTAL</b>                | 6/0 | 7/160 | 8/240 | 13/600 | 1000            |

## Module One Outline

| Title   | Type       | Due Dates   | Time       | Points |
|---|------------|---|------------|--------|
| <b>1.1 Maxwell's Faith</b>                                  | Devotional | Suggested: Initial post due by the end of the fourth day of the module; two responses due by the end of the module. | 30 minutes | 0      |
| <b>1.2 Reading</b>  | Reading    | Complete prior to assignments.  | 2 hours    | 0      |
| <b>1.3 Gauss's Law for Electrical Fields</b>                | Discussion | Initial post due by the end of the fourth day of the module; two responses due by the end of the module.            | 2 hours    | 20     |
| <b>1.4 Introduction to Electromagnetism</b>                 | Quiz       | Due by the end of the module.   | 2 hours    | 30     |
| <b>1.5 Gauss's Law (Integral Form) Application Problems</b> | Dropbox    | Due by the end of the module.   | 5 hours    | 45     |

|                                       |         |                               |                     |            |
|---------------------------------------|---------|-------------------------------|---------------------|------------|
| <b>1.6 Gauss's Law: Student Video</b> | Dropbox | Due by the end of the module. | <b>2 hours</b>      | 30         |
| <b>Totals</b>                         |         |                               | <b>13:30 hours*</b> | <b>125</b> |

## Module Two Outline

| Title  | Type       | Due Dates  | Time           | Points |
|--|------------|--|----------------|--------|
| <b>2.1 Reading</b>   | Reading    | Complete prior to assignments.   | <b>1 hour</b>  | 0      |
| <b>2.2 Providence and Nature</b>   | Discussion | Initial post due by the end of the fourth day of the module; two responses due by the end of the module. | <b>2 hours</b> | 30     |
| <b>2.1 Reading</b>   | Reading    | Complete prior to assignments.   | <b>1 hour</b>  | 0      |
| <b>2.3 Gauss's Law (Differential Form), Electric Potential, and Electric Potential Energy</b>                  | Quiz       | Due by the end of the module.  | <b>2 hours</b> | 30     |
| <b>2.4 Gauss's Law (Differential Form), Electric Potential, Electric Potential Energy Application Problems</b> | Dropbox    | Due by the end of the module.  | <b>5 hours</b> | 60     |

|   |         |                               |                         |            |
|---|---------|-------------------------------|-------------------------|------------|
| <b>2.5<br/>Experiment<br/>One Video</b> | Dropbox | Due by the end of the module. | <b>2 hours</b>          | 30         |
| <b>Totals</b>                           |         |                               | <b>12:00<br/>hours*</b> | <b>150</b> |

## Module Three Outline

| title   | Type       | Due Dates   | Time                    | Points     |
|---|------------|---|-------------------------|------------|
| <b>3.1 Framing of the Worlds</b>                                | Devotional | Suggested: Initial post due by the end of the fourth day of the module; two responses due by the end of the module. | <b>30 minutes</b>       | 0          |
| <b>3.2 Reading</b>  | Reading    | Complete prior to assignments.  | <b>1 hour</b>           | 0          |
| <b>3.3 Gauss's Law for Magnetic Fields</b>                      | Discussion | Initial post due by the end of the fourth day of the module; two responses due by the end of the module.            | <b>2 hours</b>          | 20         |
| <b>3.4 Gauss's Law for Magnetic Fields</b>                      | Quiz       | Due by the end of the module.   | <b>2 hours</b>          | 30         |
| <b>3.5 Gauss's Law for Magnetic Fields Application Problems</b> | Dropbox    | Due by the end of the module.   | <b>5 hours</b>          | 60         |
| <b>Totals</b>   |            |   | <b>10:30<br/>hours*</b> | <b>110</b> |



# Module Four Outline

| Title   | Type       | Due Dates   | Time                | Points     |
|---|------------|---|---------------------|------------|
| <b>4.1 Physics and Scripture</b>                              | Devotional | Suggested: Initial post due by the end of the fourth day of the module; two responses due by the end of the module. | <b>30 minutes</b>   | 0          |
| <b>4.2 Reading</b>  | Reading    | Complete prior to assignments.  | <b>1 hour</b>       | 0          |
| <b>4.3 Faraday's Law</b>                                      | Discussion | Initial post due by the end of the fourth day of the module; two responses due by the end of the module.            | <b>2 hours</b>      | 20         |
| <b>4.4 Faraday's Law (Integral Form)</b>                      | Quiz       | Due by the end of the module.   | <b>2 hours</b>      | 30         |
| <b>4.5 Faraday's Law (Integral Form) Application Problems</b> | Dropbox    | Due by the end of the module.   | <b>5 hours</b>      | 60         |
| <b>Totals</b>   |            |   | <b>10:30 hours*</b> | <b>110</b> |

# Module Five Outline

| Title   | Type       | Due Dates  | Time                | Points     |
|---|------------|--|---------------------|------------|
| <b>5.1 Faraday's Faith</b>  | Devotional | Initial post due by the end of the fourth day of the module; two responses due by the end of the module. | <b>30 minutes</b>   | 0          |
| <b>5.2 Reading</b>  | Reading    | Complete prior to assignments.   | <b>30 minutes</b>   | 0          |
| <b>5.3 Faraday's Law (Differential Form)</b>                      | Quiz       | Due by the end of the module.  | <b>2 hours</b>      | 30         |
| <b>5.4 Faraday's Law (Differential Form) Application Problems</b> | Dropbox    | Due by the end of the module.  | <b>5 hours</b>      | 45         |
| <b>5.5 Faraday's and Lenz's Laws: Student Video</b>               | Dropbox    | Due by the end of the module.  | <b>2 hours</b>      | 30         |
| <b>Totals</b>   |            |  | <b>11:30 hours*</b> | <b>125</b> |

## Module Six Outline

| Title   | Type       | Due Dates   | Time                | Points     |
|---|------------|---|---------------------|------------|
| 6.1 Genuine Reality   | Devotional | Suggested: Initial post due by the end of the fourth day of the module; two responses due by the end of the module. | 30 minutes          | 0          |
| 6.2 Reading   | Reading    | Complete prior to assignments.  | 1 hour              | 0          |
| 6.3 Ampère's Law  | Discussion | Initial post due by the end of the fourth day of the module; two responses due by the end of the module.            | 2 hours             | 20         |
| 6.4 Ampère-Maxwell Law (Integral Form)                      | Quiz       | Due by the end of the module.   | 2 hours             | 30         |
| 6.5 Ampère-Maxwell Law (Integral Form) Application Problems | Dropbox    | Due by the end of the module.   | 5 hours             | 60         |
| 6.6 Experiment Two Video                                    | Dropbox    | Due by the end of the module.   | 2 hours             | 30         |
| <b>Totals</b>   |            |   | <b>12:30 hours*</b> | <b>140</b> |

## Module Seven Outline

| Title   | Type       | Due Dates  | Time                | Points     |
|---|------------|--|---------------------|------------|
| 7.1 Reading   | Reading    | Complete prior to assignments.   | 1 hour              | 0          |
| 7.2 Max Planck on Science and Faith                             | Discussion | Initial post due by the end of the fourth day of the module; two responses due by the end of the module. | 2 hours             | 30         |
| 7.3 Ampère-Maxwell Law (Differential Form)                      | Quiz       | Due by the end of the module.  | 2 hours             | 30         |
| 7.4 Ampère-Maxwell Law (Differential Form) Application Problems | Dropbox    | Due by the end of the module.  | 5 hours             | 60         |
| 7.5 Ampère-Maxwell Law: Student Video                           | Dropbox    | Due by the end of the module.  | 2 hours             | 30         |
| <b>Totals</b>   |            |  | <b>12:00 hours*</b> | <b>150</b> |

## Module Eight Outline

| Title   | Type       | Due Dates   | Time                | Points     |
|---|------------|---|---------------------|------------|
| 8.1 Anthropic Principle                           | Devotional | Suggested: Initial post due by the end of the fourth day of the module; two responses due by the end of the module. | 30 minutes          | 0          |
| 8.2 Reading                                       | Reading    | Complete prior to assignments.  | 1 hour              | 0          |
| 8.3 Electromagnetism Pioneers of the 19th Century | Discussion | Initial post due by the end of the fourth day of the module; two responses due by the end of the module.            | 2 hours             | 20         |
| 8.4 The Wave Equation                             | Quiz       | Due by the end of the module.   | 2 hours             | 30         |
| 8.5 The Wave Equation Application Problems        | Dropbox    | Due by the end of the module.   | 5 hours             | 60         |
| <b>Totals</b>                                     |            |   | <b>10:30 hours*</b> | <b>110</b> |

## Course Assignments

|               |                  |      |
|---------------|------------------|------|
| <b>TOTALS</b> | <b>*93 hours</b> | 1000 |
|---------------|------------------|------|

\* These times are only estimates. Actual assignment completion times will vary.

# Course Development Resources

- CalTech. (2018). *Electromagnetic Induction*. [Video file]. Retrieved from <https://www.youtube.com/watch?v=ygVZjQK5z-8>
- Griffiths, D.J. (2017). *Introduction to electrodynamics* (4th ed.). Cambridge University Press.
- Liao, S., Dourmashkin, P., & Belcher, J. (2004). Electric Potential. In *Visualizing E&M*. (Chapter 3). Retrieved from <http://web.mit.edu/viz/EM/visualizations/notes/modules/guide03.pdf>
- Liao, S., Dourmashkin, P., & Belcher, J. (2004). Gauss's Law. In *Visualizing E&M*. (Chapter 4). Retrieved from <http://web.mit.edu/viz/EM/visualizations/notes/modules/guide04.pdf>
- Liao, S., Dourmashkin, P., & Belcher, J. (2004). Magnetostatics. In *Visualizing E&M*. [Video file]. Retrieved from <http://web.mit.edu/8.02t/www/802TEAL3D/visualizations/magnetostatics/index.htm>
- Liao, S., Dourmashkin, P., & Belcher, J. (2004). Sources of Magnetic Fields. In *Visualizing E&M*. (Chapter 9). Retrieved from <http://web.mit.edu/viz/EM/visualizations/notes/modules/guide09.pdf>
- University of Colorado Boulder. (2018). PHET Interactive Simulations. [Video file]. Retrieved from <https://phet.colorado.edu/en/simulation/charges-and-fields>
- Walker, J., Halliday, D., & Resnick, R. (2013). *Fundamentals of physics*, (10th ed.). Wiley.
- Yung-kuo, L. (1993). *Problems and Solutions in Electromagnetism*. World Scientific Publishing Company.

All photos © AL unless otherwise noted.

# Expectations, Policies, and Important Student Information

| School/Division   | Link  |
|---|---|
| DeVoe School of Business<br>Division of Liberal Arts<br>School of Services and Leadership | <a href="#"><u>View School/Division Expectations, Policies, and Student Information</u></a> |
| School of Educational Leadership  | <a href="#"><u>View School/Division Expectations, Policies, and Student Information</u></a> |
| Wesley Seminary @ IWU   | <a href="#"><u>View School/Division Expectations, Policies, and Student Information</u></a> |
| Nursing - Undergraduate   | <a href="#"><u>View School/Division Expectations, Policies, and Student Information</u></a> |
| Nursing - Graduate  | <a href="#"><u>View School/Division Expectations, Policies, and Student Information</u></a> |