NS 545 Concepts in Physics VI: Electromagnetic Induction and Physical Optics
Course Schedule

N.B.: The schedule below has not yet been adapted to the blended schedule of online and in-class meetings. Course readings may vary between course offerings.

Session 1: Faraday's Law

Sections from Cutnell & Johnson: 22.1 – 22.4, 22.10
Philosophy/History/Education Research: Faraday and his experiments.
Laboratory experiment: Investigating the interactions between a magnet and a coil connected to a galvanometer.
Reading assignment for Session 3:

- Toulmin, S. & Goodfield, J. (1962).The classical synthesis (chapter 3). In *The architecture of matter*. Chicago: University of Chicago Press.
- In Shamos, M. (Ed.) *Great experiments in physics*. New York: Holt, Rinehart and Winston.

Optional reading:

- Tricker, R.A.R. (1962) Early electrodynamics. In *The first law of circulation.* London: Pergamon Press.

Session 2: Lenz's Law.

Sections from Cutnell & Johnson: 22.2
Laboratory experiment: "Faraday's Law"
Mathematics and Problem-Solving: Typical Faraday's Law problems.
Web assignment 1

Session 3: Motional emf and eddy currents.

Sections from Cutnell & Johnson: 22.5
Philosophy/History/Education Research: The mechanical view of electromagnetic phenomena.
Laboratory experiment: Eddy currents
Applications: Train brakes.
Reading assignment for Session 6:

- Huygens, C. (1955). *Treatise on light.* (pp. 10 – 22). Chicago: University of Chicago Press.

Recommended reading:

- Whitaker, E. (1952) The luminous medium from Bradley to Fresnel. In *A history of the theories of aether and electricity. The classical theories.* (pp. 101 -108; 114 – 117). New York: Thomas Nelson and Son Co.

Session 4: Transformers and Generators

Sections from Cutnell & Johnson: 22.7 – 22.8, 22.10
Demonstrations: A generator and a motor; a transformer.
Laboratory experiment: "Generating electricity"
Mathematics and Problem-Solving: Ideal transformers.

Applications: Power generation and transmission.
Web assignment 2

Session 5: Test 1; Electromagnetic Waves and Polarized light.

Sections from Cutnell & Johnson: Chapter 24.
Test 1: 1-hour test on sessions 1-4.
Applications: Radio and television; microwave ovens.
Laboratory experiment: "Polarized light"
Mathematics and Problem-Solving: Solving problems using Malus' law.

Session 6: The interference of light.

Sections from Cutnell & Johnson: 27.1, 27.2, 27.10
Philosophy/History/Education Research: Huygens and he wave theory of light.
Laboratory experiment: "Interference and Diffraction"
Applications: Radar detectors; The Doppler shift as a tool in Astronomy.
Web assignment 3
Reading assignment for Session 7:

- Young,T. (1959) The interference of light. In Shamos (Ed.) *Great experiments in physics*. New York: Holt, Rinehart and Winston.

Session 7: Interference and Diffraction.

Sections from Cutnell & Johnson: 27.5 – 27.9
Philosophy/History/Education Research: Wave theories of light: Young's experiment and Fresnel transverse waves.
Laboratory Experiment: "Interference and Diffraction"
Mathematics and Problem-Solving: Solving problems involving single and double slits.
Reading assignment for Session 8:

- Newton, I. (1952) The second book of Opticks. In *Opticks or a treatise of the reflections, refractions, inflections and colours of light*. (pp. 193 – 208 through obs. 12; 279-282). New York: Dover.

Session 8: Thin-film interference.

Sections from Cutnell & Johnson: 27.3, 27.10
Philosophy/History/Education Research: Discussing Newton's Opticks.
Demonstrations: Various thin films.
Applications: Soap bubbles; non-reflective coatings.
Web assignment 4
Reading assignment for Session 10:

- Articles from Selections from Physics Education Research Literature as listed above in the bibliography.

Session 9: Test 2; Inductors and Inductance.

Sections from Cutnell & Johnson: 22.9
Test2: 1-hour test on sessions 6 – 8.
Laboratory experiment: "RL Circuits"
Mathematics and Problem-Solving: Using exponentials.

Session 10: Introduction to AC Circuits.

Sections from Cutnell & Johnson: 23.1 – 23.4
Philosophy/History/Education Research: Wave theories of light: Young's experiment and Fresnel transverse waves.
Laboratory experiment: "Introduction to AC Circuits"
Mathematics and Problem-Solving: Understanding the impedance triangle.
Web assignment 5

Session 11: RLC Circuits and Resonance

Sections from Cutnell & Johnson: 23.5 – 23.7
Laboratory experiment: "RLC Circuits"
Mathematics and Problem-Solving: Applying the impedance triangle.

Session 12: Presentations

Philosophy/History/Education Research: Students' presentations
Web assignment 6

Session 13: Test3; Course wrap-up.

Review of AC Circuit concepts and applications.
Take home exam.
Hand in journals.
Course evaluation.

Bibliography

Selections from primary sources

Huygens, C. (1955). *Treatise on light.* (pp. 10 – 22). Chicago: University of Chicago Press.

Faraday, M. (1959). Electromagnetic induction and laws of electrolysis. In Shamos, M. (Ed.) *Great experiments in physics*. New York: Holt, Rinehart and Winston.

Young,T. (1959) The interference of light. In Shamos, M. (Ed.) *Great experiments in physics*. New York: Holt, Rinehart and Winston.

Newton, I. (1952) The second book of Opticks. In *Opticks or a treatise of the reflections, refractions, inflections and colours of light*. (pp. 193 – 208 through obs. 12; 279-282). New York: Dover.

Selections from secondary sources

Toulmin, S. & Goodfield, J. (1962).The classical synthesis (chapter 3). In *The architecture of matter*. Chicago: University of Chicago Press.

Tricker, R.A.R. (1962) Early electrodynamics. In *The first law of circulation.* London: Pergamon Press.

Whitaker, E. (1952) The luminous medium from Bradley to Fresnel. In *A history of the theories of aether and electricity. The classical theories*. (pp. 101 -108; 114 – 117). New York: Thomas Nelson and Son Co.

Selections from Physics Education Research Literature

Serouglou, F; Koumaras, P. and Tselfes, V. (1998). History of science and instructional design: the case of electromagnetism. *Science and Education* 7, 261-280.

Hickey, R and Schibeci, R.A. (1999). The attraction of magnetism. *Phys. Educ*. 34 (6), 383-388.

Tornkvist, S., Pettersson, K.A., and Transtomer, G. (1993) Confusion by representation: on student's comprehension of the electric field concept. *Am. J. Phys*. 61 (4), 335-338.

Ambrose, B.S., Heron, S. V., and McDermott, L.C. (1999) Student understanding of light as an electromagnetic wave: relating the formalism to physical phenomena. *Am. J. Phys.* 67(10), 891 - 898.

Cavichi, E. (1997). Experimenting with magnetism: ways of learning of Joann and Faraday. *Am. J. Phys.* 65 (9), 867-882.