CHATTANOOGA STATE TECHNICAL COMMUNITY COLLEGE
CHATTANOOGA, TENNESSEE
MATH AND SCIENCES DIVISION

# COURSE SYLLABUS

## CALCULUS BASED PHYSICS II
## PHYS 2120

**Instructor:**
**Phone:**
**E-mail:**

**Class Hours/Credit Hours: 6/4**
**Semester:**
**Room: OMN 157**

Catalog Course Description

Calculus-based physics; for engineering and science majors. Electrostatics, fields and potentials, electromotive force, AC/DC circuits, electromagnetism, capacitance and inductance, and electromagnetic waves.

**Prerequisites:** PHYS 2110 with C or better; MATH-1920 (Calculus II) with C or better.

**Corequisites:** None

## Entry Level Standards

The student should have knowledge of mathematics through the integral calculus and a physics background in mechanics commensurate with a first course in calculus based university physics. A completion of the prerequisite with a grade of "C" or better will be taken as evidence of an acceptable level of competence.

## Textbook/Materials

University Physics; 12th Edition; Young and Freedman
Physics Laboratory Manual; Workshop Physics Activity Guide, Module 4, Electricity and Magnetism
Mastering Physics Student Access Code

**I.** **PSLO 5 Goal:** Issues in today's world require scientific information and a scientific approach to informed decision making. Therefore, the goals of the Natural Science requirement is to guide students toward becoming scientifically literate. This scientific understanding gained in these courses enhances students' ability to define and solve problems, reason with an open mind, think critically and creatively, suspend judgment, and make decisions that may have local or global significance.

**CSLO Student Learning Outcomes**

CSLO 1. Students will demonstrate the ability to conduct an experiment, collect and analyze data, and interpret results in a laboratory setting.

CSLO 2. Students will demonstrate the ability to analyze, evaluate and test a scientific hypothesis.

CSLO 3. Students will demonstrate the ability to use basic scientific language and processes, and be able to distinguish between scientific and non-scientific explanations.

CSLO 4. Students will demonstrate the ability to identify unifying principles and repeatable patterns in nature, the values of natural diversity, and apply them to problems or issues of a scientific nature.

CSLO 5. Students will demonstrate the ability to analyze and discuss the impact of scientific discovery on human thought and behavior.

Required assessments:

1 Tests: the students will be tested upon their ability to use basic physics language and processes, indentify unifying principles, demonstrate the ability to analyze and discuss the impact of scientific discovery, and use mathematics to solve problems and model the real world.
2 Lab Reports: Students will demonstrate the ability to conduct an experiment, collect and analyze data, and interpret results in a laboratory setting.
3 Homework: the students will be assessed upon their ability to use basic physics language and processes, identify unifying principles, demonstrate the ability to analyze and discuss the impact of scientific discovery, and use mathematics to solve problems and model the real world.

**CSLO/Assessment Alignment:**

| ***CSLO:*** | CSLO #1 | CSLO #2 | CSLO #3 | CSLO #4 | CSLO #5 |
|---|---|---|---|---|---|
| ***Assessments:*** | Labs | Group Activities | Tests<br>HW<br>Final Exam | Tests<br>Group Activities<br>Final Exam | Tests<br>Labs |

## II. Topics:

1. Electric charge and electric fields
2. Gauss's Law
3. Electric Potential
4. Capacitance and Dielectrics
5. Current, Resistance, and EMF
6. Direct Current Circuits
7. Magnetism and Magnetic Forces
8. Sources of Magnetic Fields
9. Electromagnetic Induction
10. Inductance (optional)
11. Alternating Currents (optional)
12. Electromagnetic Waves (optional)

## III. Instructional Activities

Activities may include but are limited to the following.

I1. Students present their initial ideas about a particular topic on whiteboards. (This step allows the entire class including the instructor to evaluate what initial pre-conceptions students have about a particular physics topic.)

I2. Students follow instructions in their Workshop Physics Activity Guide or instructor-produced handouts to learn the concepts associated with a particular topic. These activities are performed in groups. So, group interaction and discussion is used to learn the ideas.

I3. Students present their results and there is a brief classroom discussion or summary.

I4. Collaborative problem-solving sessions are used to help students learn how to solve numerical physics word problems.

I5. Discussion of short quizzes are administered at the beginning of some classes to assess learning.

I6. Discussion of online homework that is assigned for almost every class period.

## IV. Indicators:

Upon successful completion of the course a student should be able to:

**CHAPTER 22-Electric Charge and Electric Field**

1. Discuss briefly some of the history of our understanding of electrostatics.

2. Define all the key terms listed in the chapter summary denoting symbols and Si Units where appropriate.

3. State and give and example (i.e., draw a diagram labeling each element properly) of the law of electrostatics.

4. Explain why an object may become charged by rubbing, explaining explicitly the effect of the rubbing.

5. Sketch a 2-D diagram of the early Bohr model of the atom. Using it, describe what happens when an object becomes charged.

6. Relate the atomic number to the number of protons and electrons an atom usually possesses.

7. Discuss how the development of the planetary model of the atom affected our understanding of electrical phenomena and how this understanding impacted the development of our modern society.

8. Explain, using words and sketches, the use of an electroscope.

9. Explain why attraction to a charged object alone is not enough to tell one that the attracted object is charged.

10. Explain in detail why an uncharged object may be attracted to a charged object of either sign.

11. Explain how to charge an electroscope by conduction or induction, either positively or negatively (4 ways).

12. State Coulomb's Law from memory.

13. Use Coulomb's Law to determine the force on a point charge due to 1, 2, or 3 other charges.

14. Use Coulomb's Law to locate a position of equilibrium along to line joining two charges.

15. Using the field intensity equation, determine either of the three items included when the others are known or determinable.

16. Determine acceleration, velocity and kinetic energy for a charged object of known mass placed in a given electric field.

17. Determine the dipole moment of a pair of charges and the torque on the dipole when placed in a known electric field.

18. Explain what happens to a dipole placed in (a) a uniform electric field and (b) a field which increases with x. (optional)

19. Find the force on the dipole exerted by an electric field with a non-zero gradient.

20. Compute the electric field at any point for the given charge distributions:
    a. 1,2,3, and 4 point charges, and
    b. along the axis of a charged ring
    c. at a specific distance from a long straight wire
    d. anywhere near an infinite plane

21. Sketch several (7 or more) lines of force for the following charge configurations:
    e. point charge (+ or -)
    f.two point charges (+ +;- -;+ -)
    g. two oppositely charged plates.

**CHAPTER 23 Gauss's law**

22. Define all the key terms listed in the chapter summary denoting symbols and Si Units where appropriate.

23. State Gauss's Law in integral form defining each of the literal symbols used.

24. Use Gauss's law to determine the electric field and a point in any of the charge distributions studied.

25. State the effects of E being perpendicular to, parallel to, and zero on all points of a surface on the surface integral.

**CHAPTER 24 - Electric Potential**

26. Define all the key terms listed in the chapter summary denoting symbols and Si Units where appropriate.

27. State the requirement for a field to be conservative.

28. Derive the equation expressing the work done on a charge in moving it from one point to another in the field of a point charge (Eq. 24-8).

29. Use equation derived in #3 to express the electric potential energy at a point in the field of several point charges. (Eqns. 24-10-11).

30. Give an argument as to why the field lines at a conducting surface are normal to the surface.

31. Write and use the defining equations for electric potential and potential difference.

32. Derive the equations, giving potential/potential differences
    a. near charged spherical conductor
    b. between a line charge and conducting cylinder
    c. between parallel plates

33. Sketch a few lines depicting equipotential surfaces near the charge distribution shown in Figure 24.

34. Relate potential gradient to electric field.

35. Outline the principles involved in sharing of charge by conductors (a) for external contact, (b) internal-external contact. Tell why the charge stops flowing from one to another when it does.

**CHAPTER 25 - Capacitance and Dielectrics**

36. Define all the key terms listed in the chapter summary denoting symbols and Si Units where appropriate.

37. Write and use the equation relating the capacitance charge, and potential difference between the plates of a capacitor.

38. Recognize and reproduce the pictorial symbol for a capacitor.

39. Write the equations for equivalent capacitance in series and parallel circuits.

40. From dW = Vdq, derive the equations for energy stored by a charged capacitor.

41. Show that energy density is given by $u = 0.5\, eE^2$ (optional)

42. Explain why a dielectric affects a capacitor as it does.

43. Explain how an uncharged object can be attracted to a charged one

44. Differentiate between total charge, bound charge, and free charge.

**CHAPTER 26 - Current Resistance and EMF**

45. Define all the key terms listed in the chapter summary denoting symbols and Si Units where appropriate.

46. Estimate drift velocity for a given current in a wire of known dimensions and material.

47. Sketch graphs of resistivity as a function of temperature for metals, superconductors, and semiconductors.

48. Compute the resistivity of a listed material at any applicable temperature.

49. Derive Ohm's Law from basic considerations.

50. Distinguish between a potential difference and an electromotive force.

51. Relate terminal voltage to Emf and internal resistance.

52. Sketch, label and recognize all circuit elements presented diagramatically in this chapter.

53. Sketch I as a function of V diagram for
    (a) resistor obeying Ohm's Law
    (b) vacuum diode
    (c) semiconductor diode

54. Determine the power input and consumed for a given d.c. circuit.

**CHAPTER 27 - Direct-Current Circuits**

55. Define all the key terms listed in the chapter summary denoting symbols and Si Units where appropriate.

56. Set up and solve series,parallel, and simple series-parallel circuits, using Ohm's Law.

57. State and apply Kirchoff's rules as stated in class or as done in text for simple 2 to 4 loop circuits.

58. Describe the components of a typical ammeter or voltmeter.

59. Give the requirements for good ammeters and voltmeters with regard to resistance.

60. Draw circuits and determine either the shunt resistor or multiplying resistor necessary to use a given meter movement as (a) voltmeter or (b) an ammeter, having a given range.

61. Derive the equations for the charge on the capacitor and current in the R-C circuit as a function of time for charging and discharging modes.

**CHAPTER 28 - Magnetic Field and Magnetic Forces**

62. Define all the key terms listed in the chapter summary denoting symbols and Si Units where appropriate.

63. Briefly describe the discoveries of Oersted and Faraday with regard to currents and magnetic effects.

64. How can the direction of B be defined?

65. Write the vector equation for the force on a charged particle moving in a magnetic field and apply it.

66. Recall and relate the various units for flux and flux density.

67. Derive the equation for the radius of the orbit of a charged particle moving in a uniform magnetic field.

68. Describe Thompson's experiment to measure e/m.

69. Describe how results of Thompson's experiment on + ions gave rise to the idea of isotopes.

70. Tell how to set up simultaneous E and B fields to determine the velocity of a charged particle.

71. Discuss the operation of the Bainbridge mass. spectrometer. Write and use the equation needed to determine m. I2 – I6

72. Prove that the force on a length (L) of a wire carrying current (I) in a field of B is given by F=IL x B.

73. Describe, and justify the presence of, the Hall effect. Tell what it is used for.

74. Derive the equation for torque on a current carrying loop and coil.

75. Describe the structure and operation of a galvanometer. (Omit the ballistic model.)

76. Given appropriate values for a series wound motor, determine its mechanical power and efficiency.

**CHAPTER 29 Sources of Magnetic Field**

77. Discuss the historical development of our understanding of magnetism.

78. Trace the origin of magnetism to its atomic basis.

79. Define all the key terms listed in the chapter summary denoting symbols and Si Units where appropriate.

80. Write from memory the vector equation for the magnetic force between two charges moving relative to each other. Sketch a figure to represent the equation you've written.

81. Derive and use the equation for the magnetic force between two charges moving relative to each other.

82. State differential and integral forms of the Biot Law.

83. Using Biot's Law, derive the Biot-Savart Law (magnetic induction magnitude near a long straight wire).

84. Give a word argument as to why $\int \mathbf{B} \bullet d\mathbf{A} = I2$

85. Derive the equation for the force per unit length between two current carrying parallel wires. Determine the direction of those forces.

86. Define the ampere.

87. Derive the equations for the magnetic field of a circular turn or coil of N turns. Find the direction of that field.

88. State Ampere's Law in symbolic form.

89. Use Ampere's Law to derive the field equations for a solenoid, a toroid, and between parallel plates.

**CHAPTER 30 Electromagnetic Induction**

90. Define all the key terms listed in the chapter summary denoting symbols and Si Units where appropriate.

91. Predict the direction and magnitude of the motional emf produced when a wire of length L moves at speed V in a field of B.

92. Derive the equation for induced emf in a rotating coil.

93. Sketch figures of E as a function of time for slip ring and commutator connections.

94. Write and use Faraday's Law applied to a coil of N turns.

95. List ways in which Faraday's Law predicts E can be induced.

96. Give an example of and discuss what happens when an electric field is induced by a changing flux.

97. Write Faraday's Law in integral form.

98. State Lenz's Law. Use it to determine the direction of the induced field.

**CHAPTER 31 Inductance (optional)**

99. Define all the key terms listed in the chapter summary denoting symbols and Si Units where appropriate.

100. Write the equations relating induced voltage to impressed voltage through the mutual inductance.

101. Find the mutual inductance for a small coil wrapped around a solenoid.

102. Write the defining relation for the self inductance, L and use it to derive the self-induced emf.

103. Use Lenz's Law to determine the "sense" of the reduced emf.

104. Derive and use the equation for self-induced energy and compute the energy density.

105. Derive and use the equation for current as a function of time in a R-L circuit.

106. For the L-C circuit, find equations to give i and q as functions of time.

107. Derive and use the equations for q and i for an L-R-C series circuit.

108. Sketch diagrams for, and interpret 3 types of damping.

**CHAPTER 32 Alternating Currents (optional)**

109. Define all the key terms listed in the chapter summary denoting symbols and Si Units where appropriate.

110. Sketch circuit diagrams, i-t and v-t graphs, and phasor diagrams for resistive, capacitive, and inductive circuits. Write equations for i and v for each. Determine phase angle and tell whether voltage leads or lags the current.

111. Write equations for and compute the reactances.

112. Solve a series L-R-C circuit by finding reactance, impedance, current through and voltage across each circuit element.

113. Compute phase angle for L-R-C.

114. Compare and differentiate in words the terms average and root-mean-square for AC circuits. Compute average and rms values of current and voltage over 1/2 period and one whole period.

115. Define power factor. Write equation to compute power in AC circuit. Use it.

116. Derive and compute resonant frequency for series LRC circuit.

117. Find impedance and current in each member for a parallel L-R-Ccircuit.

118. Write and use relations to find voltage and current n transformers.

**CHAPTER 33 Electromagnetic Waves (Optional)**

119. Define all the key terms listed in the chapter summary denoting symbols and Si Units where appropriate.

120. Recall and write Maxwell's Equations.

121. Determine speed of light from Ampere's Law and Faraday's Law.

122. Write and use equation for energy density associated with an electromagnetic wave.

123. Write and use equations to compute the Poynting vector and radiation intensity.

124. Write equation for and compute the radiation pressure.

125. Determine speed of em waves in matter.

126. Find wavelength/frequency given the other for an em wave.

127. Find the instantaneous and average values of the Poynting vector for a sinusoidal wave.

128. Write equations for E and B and compute the x positions of the nodal planes for standing em waves.

129. Given an unlabeled sketch of the electromagnetic spectrum, label regions: gamma rays, ultraviolet, Infrared, long radio, x-rays, visible, short radio.

130. Give a broad visible wavelength range. List the colors in order from shortest to longest wavelength.

131. Describe the radiation from an oscillating dipole.

## V. Assessment

A. **Unit Tests** 40% of grade.
B. **Class Participation/Laboratory**: 10 % of grade
C. **Quizzes** 15 % of grade.
D. **Homework (based on problem solving and laboratory exercises)** 15 % of grade
E. **Post test** 2 % of grade
F. **Comprehensive Final Exam** 18% of grade

## VI. Grading Scale

Grades will be assigned according to the following grading scale:

90-100 A
80-89 B
70-79 C
65-69 D
00-64 F

## VII. Course Delivery Format

Faculty may require on-line activities and assignments to include on-line tests and submission of all written and on-line communications. The extent of on-line activities/assignments may vary by course but will be specified on the syllabus.

**Standard Format** – This format is the traditional format and may use an online format to provide access to "static" materials which include the syllabus, course material, contact information, and presentations. Faculty must make available when requested a copy of syllabus and any other instructor provided course materials, including their contact information. Faculty may require on-line activities and assignments to include online tests and submission of all written and on-line communications. The extent of on-line activities/assignments may vary by course but will be specified on the syllabus.

## VIII. College Policies

**This class is governed by the policies and procedures stated in the current Chattanooga State Student Handbook. Additional or more specific guidelines may apply.**

**ADA Statement**
Students who have educational, psychological, and/or physical disabilities may be eligible for accommodations that provide equal access to educational programs and activities at Chattanooga State. These students should notify the instructor immediately, and should contact Disabilities Support Services within the first two weeks of the semester in order to discuss individual needs. The student must provide documentation of the disability so that reasonable accommodations can be requested in a timely manner. All students are expected to fulfill essential course requirements in order to receive a passing grade in a class, with or without reasonable accommodations.

**Disruptive Students**
The term "classroom disruption" means – student behavior that a reasonable person would view as substantially or repeatedly interfering with the activities of a class. A student who persists in disrupting a class will be directed by the faculty member to leave the classroom for the remainder of the class period. The student will be told the reason(s) for such action and given an opportunity to discuss the matter with the faculty member as soon as practical. The faculty member will promptly consult with the division dean and the college judicial officer. If a disruption is serious, and other reasonable measures have failed, the class may be adjourned, and the campus police summoned. Unauthorized use of any electronic device constitutes a disturbance. Also, if a student is concerned about the conduct of another student, he or she should please see the teacher, department head, or division dean.

**Affirmative Action**
Students who feel that he or she has not received equal access to educational programming should contact the college affirmative action officer.

**Academic Integrity/Academic Honesty**
In their academic activities, students are expected to maintain high standards of honesty and integrity. Academic dishonesty is prohibited. Such conduct includes, but is not limited to, an attempt by one or more students to use unauthorized information in the taking of an exam, to submit as one's own work, themes, reports, drawings, laboratory notes, computer programs, or other products prepared by another person, or to knowingly assist another student in obtaining or using unauthorized materials. Plagiarism, cheating, and other forms of academic dishonesty are prohibited. Students guilty of academic misconduct, either directly or indirectly through participation or assistance, are immediately responsible to the instructor of the class. In addition to other possible disciplinary sanctions, which may be imposed through the regular institutional procedures as a result of academic misconduct, the instructor has the authority to assign an "F" or zero for an activity or to assign an "F" for the course.

**Email Communication**
Please note all communication with instructors about your course work should be through the eLearn Email system. For assistance on how to use the eLearn Email tool go to this url:
http://river.chattanoogastate.edu/orientations/Student_PDFs/eLearn_eMail_aug09.pdf.
For all other communication the official email system used by the college is through Tiger Mail. This is accessible by clicking the blue paw icon from the top right hand side of your Tiger Web home page
https://tigerweb.chattanoogastate.edu/cp/home/displaylogin.

**The instructor reserves the right to modify this syllabus in writing during the course of the semester.**

## IX. Instructor Policies

**Attendance Policy**

Students are expected to be present for all classes, laboratories and examinations. One missed test can be replaced by the final examination grade. The lowest homework and the lowest quiz grade will be dropped. Students have two excused absences. Any additional absences will result in your class participation grade being reduced.