SAULT COLLEGE OF APPLIED ARTS AND TECHNOLOGY
SAULT STE. MARIE, ON

COURSE OUTLINE

COURSE TITLE: APPLIED PHYSICS I

CODE NO.: PHY1000-4 **SEMESTER: ONE**

PROGRAMS: ARCHITECTURAL, CIVIL, CONSTRUCTION, WATER/ENVIRONMENTAL ENGINEERING TECHNOLOGY

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REVISION DATE: May, 2002 **PREVIOUS OUTLINE: SEPTEMBER 2001**

APPROVED: _____
DEAN **DATE**

TOTAL CREDITS: 4

PREREQUISITE(S): NONE *although, grade 12 physics is highly recommended*

LENGTH OF COURSE: 4 HOURS/ WEEK FOR 16 WEEKS. TOTAL CREDIT HOURS: 64

I. COURSE DESCRIPTION:

This course introduces the student to a number of fundamental concepts of physics, which should prove useful to students in the Architectural, Civil, Construction, Environmental, Pulp & Paper and Water Resources Engineering programs. Topics to be covered include: units of measurement, vectors, forces, accelerated motion, Newton's laws of motion, momentum, work, energy and power, simple machines, force systems, and moments and torques. The assumption is that many of the students will be seeing these concepts for the first time. Because of the number of topics and the potential for difficulties in some of the more complicated areas, the emphasis will be placed on *introducing* the student to the *concepts* **rather than** a *rigorous mathematical analysis* of the topics.

II. LEARNING OUTCOMES AND ELEMENTS OF PERFORMANCE:

(Generic Skills Learning Outcomes placement on the course outline will be determined at a later date)

A. Learning Outcomes:

1) Write definitions for the concepts introduced, preferably in the student's own words.

2) Answer questions requiring knowledge of the concepts presented in class.

3) Respond to questions requiring extrapolation of the course content.

4) Solve mathematical based problems requiring an understanding of the course theory.

5) Apply the knowledge learned in this course to other courses which are 'physics based'.

B. Topics To Be Covered:

I) Units of Measurement
II) Vectors
III) Motion
IV) Force and Acceleration
V) Momentum and Impulse
VI) Torque and Parallel forces
VII) Work and Energy
VIII) Simple Machines
IX) Properties of Matter
X) Fluids

C. Learning Outcomes and Elements of the Performance:

Upon successful completion of this course the student will demonstrate the ability to:

I) UNITS OF MEASUREMENT

a) three systems of units

1) List the three *most commonly used* systems of units in use in science and engineering.

b) 'base' quantities and 'base' units

1) Define *'base'* quantity and list the 7 *base quantities*.

2) List the 3 "most common" *base quantities*.

3) State the units and the proper abbreviations for each of the 3 most common *base quantities* in each of the three systems of units of a-1 above.

c) 'derived' quantities and 'derived' units

1) Define *'derived'* quantities and list at least a dozen examples of *derived quantities*. For each of these examples write the proper units along with the proper abbreviations in both the S.I. metric system and the Imperial system.

d) S.I. prefixes and their abbreviations

1) List the *S.I. metric prefixes* along with their proper abbreviations and mathematical meanings in descending order from '*tera*' to '*femto*'.

2) Set up tables of metric length measurement, area measurement, "dry" volume measurement, "fluid" volume measurement, and mass measurement. Each table will illustrate the unit, it's abbreviation and meaning for the prefixes from '*kilo*' to '*milli*'.

3) State 2 conversion factors used to convert from "dry" volume measurement to "fluid" volume measurement in the S.I. metric system.

e) conversion of units of measurement

1) Given access to the proper conversion factors convert units of measurement in the *S.I. metric*, *C.G.S. metric* and the *Imperial systems of measurement*. Recall the method of conversion of units that involves *"multiplying by ratios equal to 1"*.

f) <u>significant digits</u> and **g) <u>'accuracy' and 'precision'</u>**

1) Explain what is meant by an *'exact' number*.

2) Explain what is meant by an *'approximate' number*.

3) Explain what is meant by the term '*accuracy*' of a measurement.

4) Explain what is meant by the term *'precision'* of a measurement.

5) Discuss the difference between the two terms *precision* and *accuracy* and give examples of measurements having various degrees and combinations of *accuracy* and *precision*.

6) List the 6 rules for determining whether a digit in a measurement is *'significant'* or not.

7) Determine the *accuracy* and the *precision* of any given measurement.

8) State the rule used to determine the <u>*accuracy*</u> of the '*product*' or '*quotient*' of *measurements* which are *multiplied* or *divided*.

9) State the rule used to determine the <u>*precision*</u> of the '*sum*' or '*difference*' of *measurements* which are *added* or *subtracted*.

h) <u>scientific notation</u>

1) Review the rules used to express numbers and measurements given in *'standard' notation* and *'scientific' notation*.

2) Given a number or measurement in '*standard*' *notation* express it in '*scientific*' *notation*.

3) Given a number or measurement in '*scientific*' *notation* express it in '*standard*' *notation*.

i) <u>the distinction between 'mass' and 'weight'</u>

1) Write a definition for the concept of *'mass'*.

2) Write a definition for the concept of *'weight'*.

3) Identify clearly the <u>distinction</u> between the two quantities '*mass*' and '*weight*'.

j) standard gravitational acceleration

1) Explain how the *'acceleration due to gravity'* is dependant upon the size, mass and *'density'* of a body *in the presence of air resistance* and demonstrate how the *'terminal velocity'* of a given body may be altered.

2) State the value for the *acceleration due to gravity* in the *absence of air resistance* in each of the *S.I. metric* and the *Imperial systems of measurement*.

3) Write the equation that relates the *mass* of a body to its *weight*.

4) Write consistent units for the equation I-j-3 above in each of the *S.I. metric*, *C.G.S. metric* and *Imperial systems of units*.

5) Given the *mass* of a body in either the S.I. metric system or the Imperial system, calculate its *weight* near the earth's surface..

6) Given the *weight*, near the earth's surface, of a body in either the S.I. metric or the Imperial system, calculate its *mass*.

k) unit analysis

1) Write the two conditions an equation must satisfy in order to be *'dimensionally' correct*.

2) Given an equation and the meaning of each of its variables, determine whether or not the equation is *dimensionally correct*.

l) Vectors

1) Define vectors and scalars
2) Understand basic trigonometry functions
3) Components of a vector using sin and cosine functions
4) Find Resultant vector knowing x,y components

II) MOTION

a) vector and scalar quantities

1) Explain what is meant by a *'scalar' quantity*.

2) List at least 10 examples of *scalar quantities*.

3) Explain what is meant by a *'vector' quantity*.

4) List 6 examples of *vector quantities*.

5) Write a definition for the concept known as *'force'* incorporating *Newton's first law of motion* to expand upon the definition.

6) Recall that *force* is a *vector* quantity.

7) Write a definition for what is known as a *'resultant force'*.

b) 'distance' and 'displacement'

1) Write a definition for the term *'distance'*.

2) Write a definition for the term *'displacement'*.

3) Recall that '*distance*' is an example of a *'scalar' quantity* while '*displacement*' is an example of a *'vector' quantity*.

c) 'speed' and 'velocity'

1) Write a definition for the term *'speed'*.

2) Write a definition for the term *'velocity'*.

3) Recall that '*speed*' is an example of a *'scalar' quantity* while '*velocity*' is an example of a *'vector' quantity*.

4) Solve problems that illustrate the distinction between the terms '*distance*' and '*displacement*' and the terms '*speed*' and '*velocity*'.

5) Explain what is meant by the term *'uniform motion'*.

6) Explain what is meant by the term *'non-uniform motion'*.

7) Write the equations for *'average speed'* and *'average velocity'*. Illustrate how the latter may be determined given a *'displacement versus time' curve*.

d) acceleration

1) Write a definition for the term *'acceleration'*.

2) For *'uniform acceleration'* indicate how the *acceleration* may be determined from a given *'velocity versus time' curve*.

e) equations for 'uniformly accelerated motion'

1) List the 4 equations for *'uniformly accelerated motion'*.

2) Solve sample problems dealing with *uniformly accelerated motion* as introduced in class.

f) the 'acceleration due to gravity' - 'free fall'

1) Recall from learning objective I-j)-(1) how the '*acceleration due to gravity*' is dependent upon the *size*, *mass* and *density* of a body *in the presence of air resistance*.

2) Recall from learning objective I-j)-(2) the values for the *'acceleration due to gravity' in the absence of air resistance* in each of the *S.I. metric*, *C.G.S. metric* and *Imperial systems* of measure.

III) FORCE AND ACCELERATION

a) Newton's first law of motion - the law of '*inertia*'

1) Write a verbal statement of '*Newton's first law of motion'* and demonstrate an understanding of the law by applying it to examples as presented in class.

b) Newton's second law of motion

1) Write a verbal statement of *'Newton's second law of motion'*.

2) Write a mathematical statement (an equation) of *'Newton's second law of motion'.* Indicate the proper units for each of the variables involved in each of the *SI metric*, and *imperial systems of measure*.

3) Write a mathematical statement (an equation) of *Newton's second law of motion* as it pertains to the force known as *'weight'* or more specifically, *'the force of gravity'*.

c) Newton's third law of motion - the law of *'action'* and *'reaction'*

1) Write a verbal statement of *'Newton's third law of motion'* and demonstrate an understanding of the law by applying it to examples as presented in class.

IV) MOMENTUM AND IMPULSE

1) Write a definition for the concept of *'momentum'*.

2) Write a mathematical statement (an equation) for the concept of *'momentum'* indicating clearly the meaning of each of the variables in the equation.

3) Write a mathematical statement (an equation) for the concept of '*impulse*' indicating clearly the meaning of each of the variables in the equation.

4) Write the equation that relates the *impulse* imparted to a body by a force acting over a given period of time, to the change in *momentum* experienced by the body.

5) Write a mathematical statement for the '*law of conservation of momentum*.

6) Identify clearly between the two types of *collisions* that bodies may experience when they collide with themselves or with stationary objects - namely, '*elastic*' *collisions* and '*inelastic*' *collisions*.

V) MOMENTS

(a) Moments and Torques

1) Describe what is meant by a '*moment*' or '*torque*' produced by a force about a given point.

2) Describe the conditions necessary for a force to produce a '*moment*' or a '*torque*' about a given point.

3) Write the equation that is used to calculate the magnitude of the *moment* or *torque* produced about a given point of rotation by a force of given magnitude and given '*moment arm*' from the point of rotation.

4) Explain why *moments* and *torques* are classified as '*vector quantities*'.

(b) Parallel Force Systems

1) Explain what is meant for a body, being acted upon by a number of *coplanar*, *non concurrent* forces, to be in a state of *'rotational equilibrium*'.

2) Write a statement of the '*First Condition of Equilibrium*' for a *system of parallel forces*.

3) Write a mathematical statement (an equation) for the '*First Condition of Equilibrium*' for a *system of parallel force*.

4) Write a statement of the '*Second Condition of Equilibrium*' for a *system of parallel forces*.

5) Write a mathematical statement (an equation) for the '*Second Condition of Equilibrium*' for a *system of parallel forces*.

V) WORK, ENERGY, POWER

(a) work and energy

1) Write a definition for the concept of '*work*'.

2) Write the equation for '*work*' in it's most general form.

3) Write a definition for the concept of '*energy*'.

4) List the proper units of *work* and *energy* in each of the *S.I. metric*, *C.G.S. metric* and *Imperial systems of measure*.

(b) power

1) Write a definition for the term '*power*'.

2) Write two equations for calculating the '*power*' required or expended by a given system or device.

3) List the proper units of *power* in each of the *S.I. metric* and *Imperial systems* of measure.

4) State the relationship between the unit known as the '*horsepower*' and the Imperial system unit of power.

5) State the relationship between the units known as the '*watt*' and the '*kilowatt*' and the metric system unit of power.

6) State the relationship that exists between the Imperial unit of power known as the '*horsepower*' and the S.I. metric units of power known as the '*watt*' and the '*kilowatt*'.

(c) kinetic energy

1) Write a definition for the concept of '*kinetic energy*'.

2) Write an equation for '*kinetic energy*'.

(d) gravitational potential energy

1) Write a definition for the term '*gravitational potential energy*'.

2) Write two equations for determining the '*gravitational potential energy*' of a body with reference to a given *datum* or reference level.

(e) the laws of conservation of energy and conservation of mechanical energy

1) Write verbal statements for each of the '*law of conservation of energy*' and the '*law of conservation of mechanical energy*'.

2) Solve the example problems as presented in class dealing with *work*, *power*, *kinetic energy*, *gravitational potential energy* and the *law of conservation of mechanical energy*.

3) Read chapter 7 of the reference text.

4) Answer the questions and solve the problems as assigned from chapter 7 of the reference text.

(VIII) SIMPLE MACHINES

1) Explain with the aid of a diagram what is meant by the concept of a '*simple machine*'.

2) Write a definition for the term '*(actual) mechanical advantage*'.

3) Write an equation for the term '*(actual) mechanical advantage*' making reference to the diagram of learning objective IX - (f) - 1) above.

4) Write a definition for the term '*ideal mechanical advantage*' or '*velocity ratio*'.

5) Write an equation for the term '*ideal mechanical advantage*' or '*velocity ratio*' making reference to the diagram of learning objective IX - (f) - 1) above.

6) Explain with the aid of a diagram what is meant by the term '*efficiency*' of a machine or system.

7) Write three equations for the term '*efficiency*' in terms of each of: (i) *work*, (ii) *energy* and (iii) *power*.

8) Write an equation for the term '*efficiency*' of a *simple machine* in terms of the *actual mechanical advantage* of the machine and it's *velocity ratio*.

9) Apply the concepts of learning activities IX - (f) above to problems involving *simple machines* such as: the '*lever*' (*first, second and third classes*), the '*inclined plane*', the '*wedge*', the '*screw*', the '*wheel and axle*', '*pulleys*' and '*pulley systems*', '*gears*' and '*gear systems*' and the '*hydraulic jack*' and the '*hydraulic press*'.

10) Describe how to determine the '*mechanical advantage*'

IX) PROPERTIES OF SOLIDS

a) Mass density

1) Write a definition for the term 'mass density'.
2) Write the equation for the term 'mass density'.
3) List the proper units for mass density in each of the S.I. metric, C.G.S. metric and Imperial system of units.

b) Weight density

1) Write the definition for the term 'weight density'.
2) Write the equation for the term 'weight density'.
3) List the proper units for weight density in each of the S.I. metric, C.G.S. metric and Imperial system of units.
4) Write the equation that relates mathematically 'mass density' and 'weight density'.

c) specific gravity

1) Write a definition for the term 'specific gravity'.
2) Write the equation for the term 'specific gravity'.
3) List the values for the mass density, the weight density and the specific gravity of pure water at its temperature of maximum density.

d) Properties of Solids

1) List the characteristics of solids that distinguish them from the other states of matter.
2) Explain what is meant by the terms 'adhesion', cohesion', 'tensile strength', 'hardness', 'ductility', 'malleability' and 'elasticity' – terms which are used to express certain mechanical characteristics of solids.

e) Properties of Liquids

1) List the characteristics of liquids that distinguish them from the other states of matter.
2) Explain what is meant by the terms 'cohesion' and 'adhesion', 'surface tension', 'viscosity' and 'capillary action' – terms which are used to describe certain mechanical characteristics of liquids.

f) Properties of Gases

1) List the characteristics of gases that distinguish them from the other states of matter.
2) Read chapter 11 of the reference text.
3) Answer the questions and solve the problems as assigned from chapter 11 of the reference text.

X) FLUIDS

a) Pressure

1) Write the general equation for the term 'pressure'.
2) List the units used to measure pressure in the S.I. metric and the Imperial system of measurement.
3) Identify the relationships that exist among the various units of pressure measurement including: pounds per square inch, kilopascals, newtons per square metre, atmospheres, millibars, inches of mercury, centimetres of mercury, millimetres of mercury, feet of water and metres of water.

b) Pressure at a depth in a liquid

1) Write the two equations used to determine the pressure exerted by a column of liquid of known density and depth beneath the surface.
2) Discuss the relationship that exists, if it exits at all, between the pressure at a

given depth in a given liquid and the shape of the containing vessel.

c) Pascal's law

1) Write a verbal statement of Pascal's law and demonstrate an understanding of the law by applying it to examples presented in class.
2) Solve example problems as presented in class involving applications of Pascal's law to hydraulic presses, hydraulic jacks, hydraulic brakes, etc.

d) Archimedes' principle

1) Demonstrate an understanding of the cause of the force of buoyancy. Do so by developing the relationship that exists between the buoyant force acting on an object, either submerged or floating, and the weight of the displace liquid.
2) Write a verbal statement of "Archimedes principle' and demonstrate an understanding of the principle by applying it to examples as presented in class.

e) Fluid flow

1) Discuss what is meant by the terms 'laminar flow' and 'turbulent flow'.
2) Write the equations for 'volumetric flow rate', 'mass flow rate' and 'weight flow rate' and indicate clearly the meaning of each of the terms in each of the equations.
3) Write a verbal statement for 'Bernoulli's principle' and discuss several applications of Bernoulli's principle including the automobile carburettor, an aircraft wing and a baseball pitcher's "curve ball".
4) Read chapter 12 of the reference text.
5) Answer the questions and solve the problems as assigned from chapter 12

Method of Assessment:

Your final grade in PHY100 will be determined on the basis of three quiz tests, work assignments and/or a final examination. Each test will examine your knowledge of a number of topics and will be administered within one week of completing those topics. The topics covered in each of the quiz test and weightage are as follows:

Test #1 ------ chapters 1-4	25%
Test #2 ------ chapter 5	25%
Test #3 ------ chapter 6, 8-10	30%
Assignments	20%
Final exam (optional)	100%

Final mark will be awarded based on the aggregate or the final examination whichever is higher

A^+ : 90% - 100% (*Consistently outstanding achievement*)

A : 80% - 89% (*Outstanding achievement*)

B : 70% - 79% (*Above average achievement*)

C : 60% - 69% (*Satisfactory or acceptable achievement*)

R: 0% - 59% (*Repeat*)

Notes to Students:

a) **Attendance** and **participation** are **critical** to the student's success in this course.

b) The course outline as detailed on pages 4 to 15 and summarized on page 3 lists the sub-topics to be covered under each of the nine main topic headings. ***Your teacher reserves the right to modify the course as he/she deems necessary in order to meet the needs of the students. This may prove to be necessary to minimize the effects of any unforeseen or unavoidable losses of class time that may occur during the semester. Also, certain topics may cause the class more difficulty than anticipated when the course outline was initially set up and, as a result, additional time may be required for their completion. As a result, some sub-topics may be deleted from the outline at the discretion of the teacher and/or others may be introduced.***

PRIMARY RESOURCES

Ewen, Nelson and Schurter, **PHYSICS FOR CAREER EDUCATION**, **Sixth edition.**
Prentice-Hall Publishing Company, 2002. ISBN 0-13-040653-8

ADDITIONAL RESOURCE MATERIALS AVAILABLE IN THE COLLEGE LIBRARY

PRIOR LEARNING ASSESSMENT:

Students who wish to apply for advanced credit in the course should consult the teacher.

SPECIAL NOTES:

Students with special needs (e.g. physical limitations, visual impairments, hearing impairments, learning disabilities, etc.) are encouraged to discuss required accommodations confidentially with the teacher.

DIRECT CREDIT TRANSFERS:

Students who wish to apply for direct credit transfer (advanced standing) should obtain a direct credit transfer form from the Dean's secretary. Students will be required to provide a transcript and course outline related to the course in question.