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

COURSE OUTLINE

COURSE TITLE: APPLIED PHYSICS I

CODE NO.: PHY100-4 **SEMESTER: ONE**

PROGRAMS: ARCHITECTURAL, CIVIL TECHNICIAN/TECHNOLOGY, CONSTRUCTION TECHNICIAN, ENVIRONMENTAL, PULP & PAPER, and WATER RESOURCES TECHNOLOGIES

AUTHOR: SUBHASH VERMA/ GEOFFREY N. DISANO

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APPROVED: _____
KITTY DEROSARIO, DEAN **DATE**
SCHOOL OF TECHNOLOGY &
TRADES

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: **Approximate Time Frames (Optional)**

I) Units of Measurement
II) Motion
III) Force and Acceleration
IV) Momentum and Impulse
V) Vectors and Trigonometry
VI) Concurrent-Coplanar Force Systems
VII) Moments
VIII) Non Concurrent-Coplanar Force Systems
IX) Work, Energy, Power

X) Simple Machines

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) significant digits and **g) 'accuracy' and 'precision'**

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 *accuracy* of the '*product*' or '*quotient*' of *measurements* which are *multiplied* or *divided*.

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

h) scientific notation

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) the distinction between 'mass' and 'weight'

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

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

3) Identify clearly the distinction 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*.

3) Read chapter 1 of the reference text.

4) Answer the questions and solve the problems as assigned from chapter 1 of the reference text.

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.

3) Read chapter 3 of the reference text.

4) Answer the questions and solve the problems as presented from chapter 3 of the reference text.

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 *S.I.metric*, *C.G.S. 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*.

7) Solve the problems as presented in class dealing with *momentum* and *impulse*.

8) Read chapter 4 of the reference text.

9) Answer the questions and solve the problems as presented from chapter 4 of the reference text.

V) VECTORS AND TRIGONOMETRY

a) Right-Triangle Trigonometry

1) For any '*right-angled triangle*', indicate clearly the meaning of the term *'hypotenuse'*, and for a given angle in the triangle, the meanings of the terms *'side adjacent'* and *'side opposite'*.

2) Write equations for the six *trigonometric functions* and explain the meanings of these functions making reference to a given angle in a given *right-angled triangle*.

3) Write a verbal statement for the *'Pythagorean theorem'*.

4) Write a mathematical statement (i.e. an equation) for the *'Pythagorean theorem'*.

b) components of a vector

1) Given a vector in any position in any of the four *'quadrants'*, resolve the vector into its *'x and y components'.*

2) Read chapter 5 of the reference text.

3) Answer the questions and solve the problems as assigned from chapter 5 of the reference text.

VI CONCURRENT-COPLANAR FORCE SYSTEMS

(a) Types of force systems

1) Write definitions for the following terms: *'external force*', '*internal force'*, *'collinear forces*', '*concurrent forces'*, '*coplanar forces'* and '*rigid body*'.

2) Describe the different types of force systems including: '*concurrent - coplanar*', *'concurrent - non coplanar'*, '*non concurrent – non coplanar*' & *'non concurrent - coplanar'*.

(b) Resultant of 'collinear' forces

1) Write a definition for the term '*resultant force*'.

2) Describe how to determine the *resultant* of a number of '*collinear*' *forces*.

(c) Resultant of 'concurrent' forces

1) Explain what is meant by a system of '*concurrent*' forces.

2) Describe how to determine the *resultant* of two or more *coplanar*, *concurrent forces* using:

(i) the *'graphical parallelogram'* method of vector addition;

(ii) the '*mathematical parallelogram*' method of vector addition;

(iii) the graphical method of vector addition known as the '*string polygon'* method;

(iv) a mathematical method of vector addition known as the '*method of components.*

3) Solve the problems as introduced in class dealing with the addition of two or more *coplanar*, *concurrent forces* using one or more of the methods listed above.

(d) Equilibrium of 'concurrent' force systems

1) Write a definition for the term '*translational equilibrium*'**.**

2) Write the two equations that must be satisfied for a body, being acted upon by a number of *coplanar*, *concurrent forces*, to be in a state of *translational equilibrium.*

3) Explain what is meant by the term '*tension forces*'.

4) Explain what is meant by the term '*compression forces*'.

5) Describe what is meant by the '*triangle of forces*' principle for three *coplanar*, *concurrent* forces that are acting on a body which is known to be in *translational equilibrium*.

6) Describe what is meant by a '*free body diagram*'.

7) Solve the problems as introduced in class dealing with '*three coplanar, concurrent forces acting on a body which is known to be in translational equilibrium*'.

8) Read chapter 6 of the reference text.

9) Answer the questions and solve the problems as assigned from chapter 6 of the reference text.

VII 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*'.

5) Read Chapter 9, section 9.2 in the reference text.

VII) NON CONCURRENT - COPLANAR FORCES

(a) 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*.

6) Solve the example problems as introduced in class dealing with systems of *parallel*, *coplanar forces in equilibrium*.

7) Explain what is meant by the term '*couple*'.

8) Calculate resisting moments in '*fixed ended cantilevered systems*'.
9) Read chapter 10 of the reference text.

10) Answer the questions and solve the problems as assigned from chapter 10 of the reference text.

(b) Coplanar Force Systems in 'Equilibrium'

1) Explain what is meant by a body, being acted upon by a *system of coplanar forces* (*not necessarily parallel*), to be in a state known as '*equilibrium*'.

2) Write the **four equations** that must be satisfied for a body, being acted upon by a number of *coplanar forces*, to be in a state of **'***equilibrium*'.

3) Solve the problems as introduced in class dealing with *coplanar force systems* acting on a body which is known to be in *equilibrium*.

(c) Centre of Gravity

1) Write a definition for the term '*centre of gravity*' of a body.

2) Describe how the *centre of gravity* may be experimentally determined for an irregularly shaped two dimensional figure.

(d) Centroids

1) Write a definition for what is meant by the '*centroid*' of a two dimensional figure or a three dimensional body.

2) Illustrate the *centroid* of a number of geometric shapes and forms such as: squares, rectangles, triangles, circles, cubes, rectangular solids, cylinders and spheres.

3) Solve the example problems as introduced in class dealing with the determination of the *centroids* of *irregularly shaped two dimensional figures* that may be broken up into a number of *regularly shaped two dimensional shapes*.

4) Explain the relationship that exists, or, does not exist, between the '*centroid*' and the '*centre of gravity*' for two dimensional figures and three dimensional solids which are '*homogeneous*' in their composition.

5) Explain the relationship that exists, or, does not exist, between the '*centroid*' and the '*centre of gravity*' for two dimensional figures and three dimensional solids which are '*heterogenous*' in their composition.

6) Solve the example problems as introduced in class dealing with the determination of the *centre of gravity* of irregularly shaped two dimensional figures. Be able to solve problems involving both figures that are *homogeneous* and figures that are *heterogeneous* in their composition.

7) Solve the example problems as introduced in class dealing with the determination of the *centre of gravity* of irregularly shaped three dimensional solids. Be able to solve problems involving both solids that are *homogeneous* and solids that are *heterogeneous* in their composition.

8) Read chapter 10 of the reference text.

9) Solve the problems as assigned from chapter 10 of the reference text and any additional problems that may be handed out as exercises.

IX WORK, ENERGY, POWER AND SIMPLE MACHINES

(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.

(f) 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) List at least 7 different types of '*simple machines*'.

10) 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*'.

11) Explain what is meant by a '*compound machine*'.

12) Describe how to determine the '*mechanical advantage*' and the '*velocity ratio*' of a given '*compound machine*' in terms of the *mechanical advantage* and the *velocity ratio* of each of the '*simple machines*' of which it is comprised.

13) Read chapter 8 of the reference text and chapter 9, sections 9.6 and 9.7.

14) Answer the questions and solve the problems as assigned from chapter 8 and sections 9.6 and 9.7 of chapter 9 of the reference text.

Method of Assessment:

Your final grade in PHY100 will be determined on the basis of three quiz tests and 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 1-3	20%
Test #2 ------ chapters 4-6	20%
Test #3 ------ chapter 7-8	20%
Final exam	40%

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*)

X or R: 0% - 59% (*Incomplete or 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 unforseen 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, 1999. ISBN 0-13-692823-4

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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 (eg. physical limitations, visual impairments, hearing impairments, learning disabilities, etc.) are encouraged to discuss required accommodations confidentially with the teacher.