SAULT COLLEGE OF APPLIED ARTS AND TECHNOLOGY

SAULT STE. MARIE, ONTARIO

Sault College

COURSE OUTLINE

COURSE TITLE:	***APPLIED MECHANICS – STATICS***
CODE NO. :	MCH 110 **SEMESTER:** 1
PROGRAM:	***MECHANICAL ENGINEERING TECHNOLOGY***
AUTHOR:	GEOFFREY DISANO/DEAN MATTHEW/ROBERT ACKERT
DATE:	SEP 2007 **PREVIOUS OUTLINE DATED:** JAN 2007
APPROVED:	
	_____ _____
	DEAN **DATE**
TOTAL CREDITS:	4
PREREQUISITE(S):	***those required for admission into the mechanical engineering technology program.***
HOURS/WEEK:	4 hours per week

I. COURSE DESCRIPTION:

The intention of this course is to introduce the student to a number of fundamental concepts of 'statics' which should prove useful to the mechanical technology student. The fundamental concepts are very important as they form the basis for other courses in technology such as dynamics, strength of materials and mechanics of fluids. ***Every effort will be made not to dwell on the theory of these concepts but to instead stress practical applications through the extensive use of problem solving and the presentation of the solutions in a style consistent with standard engineering practice.***

II. LEARNING OUTCOMES AND ELEMENTS OF THE PERFORMANCE:

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

1. **INTRODUCTION**
    a. Illustrate with a sketch of a right-angled triangle the accepted method of labeling both the sides and the angles of this triangle.
    b. Recall the six trigonometric functions and apply these to simple *right-angled triangle* problems to solve for the lengths of unknown sides or the magnitude of unknown angles.
    c. Apply the basic principle know as the *Pythagorean theorem.*
    d. Recall both the *sine law* and the *cosine law* and apply these to the solution of triangles which are non-right-angled. Show haw the cosine law is related to the *Pythagorean theorem.*
    e. Recall the relationships that exist by way of conversion factors between the *S.I. metric* and the *Imperial system of units* for quantities such as length, mass, weight and force. Convert between systems of units using the *method of multiplying by ratios equal to one*.

2. **VECTOR ANALYSIS**
    a. Define what is meant by a *scalar quantity* and list at least a dozen examples of *scalar quantities*.
    b. Define what is meant by a *vector quantity* and list seven examples of *vector quantities.*
    c. List the various types of *forces* along with their

characteristics and the commonly used units for forces both in the S.I. metric and the Imperial system of units.

d. Describe what is meant by the *resultant* of a system of forces.
e. Describe what is meant by the *equilibrant* of a system of forces.
f. Using the method known as the *parallelogram method*, determine the *resultant* of two vector quantities using both a *graphical* and a *mathematical approach*.
g. Using the method known as the *string polygon method*, determine the *resultant* of two or more vector quantities using a graphical approach.
h. Given a vector quantity superimposed onto an x-, y-coordinate plane, resolve the vector into its two *orthogonal components*, namely its *x-component* and its *y-component*.
i. Determine the *resultant* of two or more vector quantities by the analytical method known as the *method of components*.

3. **MOMENTS AND COUPLES**
   a. Define what is meant by the *moment* or *torque* of a force about
   b. a given point of rotation.
   c. Write the equation for determining the *moment* or *torque* of a
   d. force about a given point of rotation.
   e. Calculate the *moment* of a force by:
      i. multiplying the *total force* by its *perpendicular distance to the*
      ii. *point of rotation*; &.
      iii. multiplying *each of the force's components* by their respective
      iv. *perpendicular distances to the point of rotation*.
   f. Determine the *resultant moment* for a system *of moments*.
   g. Name the three factors that together constitute what is known as
   h. a '*couple*'.
   i. Calculate the *moment* of a given *couple*.
   j. Replace a given *couple* with an equivalent *couple* at a different
   k. location.
   l. Analyze the effects of *couples* on a body.

4. **EQUILIBRIUM OF FORCES IN TWO DIMENSIONS**
   a. Write the 3 equations that represent the three requirements

that must be met for a body to be in a state of '*static equilibrium*'.

b. Explain what is meant by a '*free body diagram*'.
c. List the assumptions or conventions that one must employ when drawing *free body diagrams* and replacing supports with equivalent supporting forces.
d. Construct a *free body diagram* for parts or the whole of given mechanisms or structures.
e. Differentiate between '*externally applied loads*' and '*internal reactions*'.
f. Apply the *three conditions of equilibrium* to *free body diagrams* and determine the reactions.
g. Describe what is meant by a '*two force member*' and explain the implications for a *free body diagram* involving such members.
h. Apply the principles of equilibrium to the solution of problems involving static systems of pulleys.
i. Describe what is meant by and solve problems involving
j. '*coplanar concurrent force systems*'.
k. Explain the difference between what is known as a '*concentrated*
l. *load*' and what is known as a *'distributed load*'.
m. Describe what is meant by and solve problems involving
n. '*coplanar parallel force systems*' including both *uniform* and *non-*
o. *uniform beam loading*.
p. Describe what is meant by and solve problems involving
q. 'coplanar, non-concurrent force systems'.

5. **STRUCTURES AND MEMBERS**

a. Recognize the difference between the forces of '*tension*' and
b. '*compression*' in structural members such as *struts* and *ties*.
c. Differentiate between the structures known as '*trusses*' and those known as '*frames*'.
d. Identify '*members that carry no load*' in *trusses* and *frames.* Appreciate the importance of identifying such members in the solution of internal forces in structural members such as *trusses* and *frames*.
e. Describe what is meant by a '*two-force member*' and list the implications that this type of member has on the solution of forces in members of *trusses* and *frames*.
f. Describe what is meant by and list the assumptions that apply to, what is known as a '*pin connection*' in a *truss* or a *frame*.
g. Using the method known as the '*Method of Joints*',

determine the loads in individual members of *coplanar pin-connected trusses* and *frames* being certain to identify whether the members are in *tension* or *compression*.

h. Using the method known as the '*Method of Sections*' determine the forces in <u>selected</u> members of a *truss* being certain to identify whether the members are in *tension* or *compression*. This will require the drawing of a *free body diagram* of a '*partial truss*' that is part of the entire truss.
i. Describe what is meant by a '*three-force member*' and identify clearly the difference between this type of member and the previously used '*two-force member*'.
j. Using the method known as the '*Method of Members*' determine
k. the forces in members of various mechanisms being certain to
l. identify whether the members are in *tension* or *compression*

6. **STRUCTURES AND MECHANISMS IN THREE DIMENSIONS**

a. Explain what is meant by '*isometric sketching*' and use *isometric sketching* to aid in visualizing forces acting on mechanisms in three dimensions.
b. Construct *'isometric free body diagrams'* of the whole, or parts of, three dimensional mechanisms.
c. Apply the six basic equations of *three dimensional equilibrium*,

$$\Sigma F_x = 0,\ \Sigma F_y = 0,\ \Sigma F_z = 0,\ \Sigma M_x = 0,\ \Sigma M_y = 0,\ \Sigma M_z = 0$$

to the three-dimensional systems of:

i. Parallel forces,
ii. Concurrent forces, &
iii. Nonconcurrent forces

7. **THE LAWS OF FRICTION**

a. Write the characteristics that pertain to the force known as the '*friction force*'.
b. Sketch the graph of the *friction force* versus the *applied force* when a force is applied to a block, initially at rest, on a horizontal, flat surface. The *applied force* starts at zero and increases gradually up to and beyond the point where the block begins to slide.
c. Indicate clearly the two distinct regions of the graph drawn above, namely, the '*static region*' and the '*kinetic region*'.
d. Explain what is meant by the '*coefficient of friction*'.
e. Write the equation for the '*coefficient of static friction*'.

f. Write the equation for the '*coefficient of kinetic friction*'.
g. Explain what is meant by the '*angle of friction*'.
h. Write the equation for the '*angle of friction*' in terms of the '*maximum force of static friction*' and the '*normal reaction force*' between the object and the surface upon which it rests.
i. Solve a variety of problems involving friction. These problems will include those that require the student to determine whether *motion is impending or not*. Also, solve those problems that require the student to determine whether *tipping* or *sliding* will occur.

8. **CENTROIDS AND CENTRES OF GRAVITY IN TWO AND THREE DIMENSIONS**
   a. Explain what is meant by the term '*centroid*'' of a plane figure or solid object.
   b. Explain what is meant by the term '*centre of gravity*' of an object.
   c. Describe, using an example, a situation where the *centroid* and the *centre of gravity* of an object coincide. Be certain to list the two conditions that must be met for this to be true.
   d. Describe, using an example, a situation where the *centroid* and the *centre of gravity* of an object do not coincide.
   e. Locate the *centroids* of simple areas such as squares, rectangles, triangles, circles, semicircles and quarter circles.
   f. Calculate the *centroids* of composite areas by breaking the composite area into a number of simple areas and using the *moments* about both the x- and y-axes.

III. TOPICS:

1. ***INTRODUCTION***
   Mathematics of Mechanics
   Conversions of Units

2. ***VECTOR ANALYSIS***
   Vector* and *Scalar Quantities
   ***Forces*, *Resultants* and *Equilibrants* of force systems**

3. ***MOMENTS AND COUPLES***

4. ***EQUILIBRIUM OF FORCES IN TWO DIMENSIONS***
   The Three Conditions of Equilibrium

5. ***STRUCTURES AND MEMBERS***
   Force Analysis of Structures using the '*Method of Joints'*, the '*Method of Sections'* and the '*Method of Members'*.

6. ***STRUCTURES AND MECHANISMS IN THREE DIMENSIONS***

   THE LAWS OF FRICTION
   Coefficients of Static* and *Kinetic Friction
   Impending Motion
   Sliding versus Tipping Motion

7. ***CENTROIDS AND CENTRES OF GRAVITY IN TWO AND THREE DIMENSIONS***

IV. REQUIRED RESOURCES/TEXTS/MATERIALS:

***Keith M. Walker, APPLIED MECHANICS FOR ENGINEERING TECHNOLOGY, Eight edition.* Prentice-Hall Publishers. Toronto. 2004. ISBN: 978-0-13-172151-7**

V. EVALUATION PROCESS/GRADING SYSTEM:

<give breakdown of tests/assignments and their weights relative to calculating the final grade for the course>

The following semester grades will be assigned to students:

Grade	Definition	*Grade Point Equivalent*
A+	90 – 100%	4.00
A	80 – 89%	
B	70 - 79%	3.00
C	60 - 69%	2.00
D	50 – 59%	1.00
F (Fail)	49% and below	0.00

CR (Credit)	Credit for diploma requirements has been awarded.
S	Satisfactory achievement in field /clinical placement or non-graded subject area.
U	Unsatisfactory achievement in field/clinical placement or non-graded subject area.
X	A temporary grade limited to situations

	with extenuating circumstances giving a student additional time to complete the requirements for a course.
NR	Grade not reported to Registrar's office.
W	Student has withdrawn from the course without academic penalty.

VI. SPECIAL NOTES:

Special Needs:
If you are a student with special needs (e.g. physical limitations, visual impairments, hearing impairments, or learning disabilities), you are encouraged to discuss required accommodations with your professor and/or the Special Needs office. Visit Room E1101 or call Extension 703 so that support services can be arranged for you.

Retention of Course Outlines:
It is the responsibility of the student to retain all course outlines for possible future use in acquiring advanced standing at other postsecondary institutions.

Communication:
The College considers ***WebCT/LMS*** as the primary channel of communication for each course. Regularly checking this software platform is critical as it will keep you directly connected with faculty and current course information. Success in this course may be directly related to your willingness to take advantage of the ***Learning Management System*** communication tool.

Plagiarism:
Students should refer to the definition of “academic dishonesty” in *Student Code of Conduct*. Students who engage in academic dishonesty will receive an automatic failure for that submission and/or such other penalty, up to and including expulsion from the course/program, as may be decided by the professor/dean. In order to protect students from inadvertent plagiarism, to protect the copyright of the material referenced, and to credit the author of the material, it is the policy of the department to employ a documentation format for referencing source material.

Course Outline Amendments:
The professor reserves the right to change the information contained in this course outline depending on the needs of the learner and the availability of resources.

Substitute course information is available in the Registrar's office.

<*include any other special notes appropriate to your course*>

VII. PRIOR LEARNING ASSESSMENT:

Students who wish to apply for advanced credit in the course should consult the professor. Credit for prior learning will be given upon successful completion of a challenge exam or portfolio.

VIII. 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.