SAULT COLLEGE OF APPLIED ARTS AND TECHNOLOGY

SAULT STE. MARIE, ONTARIO

Sault College

COURSE OUTLINE

COURSE TITLE: ***APPLIED MECHANICS – STATICS***

CODE NO. : ***MCH 100*** **SEMESTER:** ***TWO***

PROGRAM: ***CIVIL, ARCHITECTURAL & CONSTRUCTI0N TECHNICIAN***

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DATE: ***AUGUST 2006*** **PREVIOUS OUTLINE DATED:** ***JUNE 2005***

APPROVED:

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DEAN **DATE**

TOTAL CREDITS: ***4***

PREREQUISITE(S): ***PHY 100***

LENGTH OF COURSE: ***4 hours per week***

I COURSE DESCRIPTION:

The objective of this course is to introduce the student to a number of fundamental concepts of statics which should prove useful to the civil, architectural and construction technician student.
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.
The topics to be covered will include, but may not be limited to the following: a review of the mathematics of mechanics; force systems; moments and torques; nonconcurrent – coplanar forces (trusses); concurrent-noncoplanar forces; static and kinetic friction; centre of gravity and centroids.

II LEARNING OUTCOMES AND ELEMENTS OF THE PERFORMANCE:

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

I ***MATHEMATICS OF MECHANICS***

Using the theorems, laws and functions of both right-angle and non right-angle trigonometry, and an understanding of basic algebra and geometry, solve trigonometric problems.

Potential Elements of the Performance:

1) Write both a verbal and a mathematical statement of the basic principle known as the '*Pythagorean theorem'*.
2) Illustrate with a sketch of a right-angled triangle the accepted method of labeling both the sides and the angles of this triangle.
3) 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.
4) Recall both the '*sine law'* and the '*cosine law'* and apply these to the solution of triangles which are non-right-angled. Show that for a right-angled triangle the *cosine law* reduces to the *Pythagorean theorem*.
5) 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'*.

6) Recall the two main concepts of '*dimensional analysis'* that an algebraic relationship involving quantities must satisfy.
7) Recall the basic rules of geometry involving: *intersecting straight lines*, '*supplementary angles'*, '*complementary angles'*, the relationships between angles when a *straight line intersects two parallel lines*, *interior angles of a triangle*, '*similar triangles'* and the equations for the '*circumference'* and the '*area' of a circle*.
8) Review the concepts of '*accuracy'* and '*precision'* and their respective use in calculations involving primarily multiplication & division versus calculations involving addition & subtraction.
9) Review the process of *rounding off* quantities in light of the concepts of *accuracy* and *precision* above.
10) Define what is meant by a '*scalar quantity'* and list at least a dozen examples of *scalar quantities.*
11) Define what is meant by a '*vector quantity*' and list seven examples of *vector quantities.*
12) Briefly discuss the meaning of the term 'statics' as it applies to someone in a civil engineering, construction or architectural program might interpret it.

II ***FORCES AND FORCE SYSTEMS***

Determine the 'resultants' and the 'equilibrants' of systems of forces both by adding the vector quantities and by adding the vector components.

Potential Elements of the Performance:

1) 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.
2) Describe what is meant by the '*resultant*' of a system of forces.
3) Describe what is meant by the '*equilibrant'* of a system of forces.
4) Explain what is meant by the term '*concurrent'* as it pertains to a system of forces.
5) Explain what is meant by the term '*collinear'* as it pertains to a system of forces.
6) Determine the *resultant* and the *equilibrant* of a system of *collinear* forces.
7) Explain, with reference to Newton's third law of motion, what is meant by the terms '*action'* and '*reaction'* forces.
8) Describe what is meant by and give several examples of each of the categories of forces known respectively as '*tension forces*' and '*compression forces'*.

9) Using the method known as the '*parallelogram method'*, determine the *resultant* of two vector quantities using both a *graphical* and a *mathematical approach*.
10) Using the method known as the '*string polygon method'*, determine the *resultant* of two or more *vector quantities* using a graphical approach.
11) Given the classic situation of '*three concurrent forces in equilibrium'*, solve the problem for an unknown force using the '*triangle of forces method*''.
12) Given a vector quantity superimposed onto an x-, y-co-ordinate plane, resolve the vector into its two '*orthogonal components'*, namely its '*x-component'* and its' *y-component'*.
13) Determine the *resultant* and the *equilibrant* of two or more vector quantities by the analytical method known as the '*method of components'*.
14) Describe what is meant by a '*free-body diagram'* and draw the *free-body diagram* for an object being acted upon by a system of '*concurrent forces in equilibrium'*.
15) Construct a *free body diagram* for parts or the whole of given mechanisms or structures.

III ***MOMENTS AND COUPLES***

Determine the 'moment' of a force about a given point of rotation and solve problems involving moments and 'couples'.

Potential Elements of the Performance:

1) Define what is meant by the '*moment'* or '*torque'* of a force about a given point of rotation.
2) Write the equation for determining the *moment* or *torque* of a force about a given point of rotation.
3) Calculate the *moment* of a force by:
   (a) multiplying the *total force* by its *perpendicular distance to the point of rotation* - it's '*moment arm'*; &.
   (b) multiplying *each of the force's components* by their respective *perpendicular distances to the point of rotation*.
4) Determine the '*resultant moment'* for a system *of moments*.
5) Discuss the algebraic signs given to *moments* and *couples* given that they are *vector quantities* having only two possible directions.
6) Solve problems involving *equilibrium* of '*systems of parallel forces*'.
7) Solve problems involving beams and planes in *equilibrium* (both

'*translational'* and *'rotational'*) under systems of '*uniformly distributed loads'*.

8) Name the three factors that together constitute what is known as a '*couple'*.
9) Calculate the *moment* of a given *couple*.
10) Replace a given *couple* with an equivalent *couple* at a different location.
11) Analyze the effects of *couples* on a body.

IV ***EQUILIBRIUM OF FORCES IN TWO DIMENSIONS***

Apply the "Three Conditions of Equilibrium" to determine unknown forces in various force systems.

Potential Elements of the Performance:

1) Write the 3 equations that represent the three requirements that must be met for a body in two dimensions to be in a state of '*static equilibrium*'.
2) Differentiate between '*externally applied loads*' and '*internal reactions*'.
3) Apply the *three conditions of equilibrium* to *free body diagrams* and determine the reactions.
4) Describe what is meant by a '*two force member*' and explain the implications for a *free body diagram* involving such members.
5) Describe what is meant by and solve problems involving '*coplanar-concurrent force systems*'.
6) Describe what is meant by and solve problems involving '*coplanar-nonconcurrent force systems'.*
7) Explain the difference between what is known as a '*concentrated load*' and what is known as a *'distributed load*'.
8) Describe what is meant by and solve problems involving '*coplanar parallel force systems*' including both '*uniform'* and '*non-uniform beam loading'*.

V ***STRUCTURES AND MEMBERS – TRUSSES AND FRAMES***

Use the 'method of joints', the 'method of sections' and the 'method of members' to solve for the internal forces in structures such as 'trusses' and 'frames'.

Potential Elements of the Performance:

1) Recognize the difference between the forces of '*tension*' and '*compression*' in structural members such as '*struts'* and '*ties'*.
2) Differentiate between the structures known as '*trusses*' and those known as '*frames*'.
3) 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*.
4) 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*.
5) 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*.
6) 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*.
7) Using the method known as the '*Method of Sections*' determine the forces in selected 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.
8) 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*.
9) Using the method known as the '*Method of Members*' determine the forces in members of various mechanisms being certain to identify whether the members are in *tension* or *compression*.

VI ***THE LAWS OF FRICTION***

Apply the laws of friction for dry surfaces to flat surfaces to determine if motion is impending and whether tipping or sliding will occur.

Potential Elements of the Performance:

1) Write the characteristics that pertain to the force known as the '*friction force*'.
2) 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.
3) Indicate clearly the two distinct regions of the graph drawn above, namely, the '*static region*' and the '*kinetic region*'.
4) Explain what is meant by the '*coefficient of friction*'.
5) Write the equation for the '*coefficient of static friction*'.
6) Write the equation for the '*coefficient of kinetic friction*'.
7) 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.

VII ***CENTROIDS AND CENTRES OF GRAVITY IN TWO AND THREE DIMENSIONS***

Apply the concepts of 'centroids' and 'centre of gravity' to the solution of problems in two and three dimensions.

Potential Elements of the Performance:

1) Explain what is meant by the term '*centroid*'' of a plane figure or solid object.
2) Explain what is meant by the term '*centre of gravity*' of an object.
3) 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.
4) Describe, using an example, a situation where the *centroid*

and the *centre of gravity* of an object do not coincide.

5) Locate the *centroids* of simple areas such as squares, rectangles, triangles, circles, semicircles and quarter circles.
6) 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.
7) Calculate the *centre of gravity* of composite solids by breaking the composite solid into a number of simple solids and using the *moments* about the x-, y- and z-axes.

III TOPICS:

I *MATHEMATICS OF MECHANICS* **Chapter 1**

Introduction
Mathematics of Mechanics
Conversions of Units
Numerical Accuracy and Dimensional Analysis

II *FORCES AND FORCE SYSTEMS* **Chapter 1 & Chapter 2**

Vector* and *Scalar Quantities
Forces
***Resultants* and *Equilibrants* of force systems**

III *MOMENTS AND COUPLES* **Chapter 2**

The concept of *Moments*
The *Principle of Moments*
Finding the *Resultant* of *Parallel Force Systems*
Resultants* of *Nonconcurrent Force Systems

IV *EQUILIBRIUM OF FORCES IN TWO DIMENSIONS* **Chapter 3**

Construction of "*Free-Body Diagrams"*
The meaning of the term *Equilibrium*
The Three Conditions of Equilibrium
Equilibrium of *Colinear Force Systems*
Equilibrium of *Concurrent Force Systems*
Equilibrium of *Parallel Force Systems*
Equilibrium of *Nonconcurrent Force Systems*

V *STRUCTURES AND MEMBERS – TRUSSES AND FRAMES*
Chapter 4

'*Truss*' behavior
Force Analysis of Trusses using
the '*Method of Joints'*,
the '*Method of Sections'*
Introduction to '*Frames*'
Force Analysis of Frames using
the '*Method of Members'*

VI ***THE LAWS OF FRICTION*** **Chapter 5**

the *force of friction*
Coefficients of Static Friction* and *Kinetic Friction
Impending Motion
Sliding versus Tipping Motion

VII ***CENTROIDS AND CENTRES OF GRAVITY*** **Chapter 6**

the '*centroid*' of a two-dimensional figure
the '*centre of gravity*' of a two-dimensional figure
the *centroid* of a three-dimensional body
the *centre of gravity* of a three-dimensional body

IV REQUIRED RESOURCES/TEXTS/MATERIALS:

Burns, Thomas; *APPLIED STATICS AND STRENGTH OF MATERIALS*,
First edition. Delmar Publishers. Toronto. 1997.
ISBN 0-8273-6959-X

V EVALUATION PROCESS/GRADING SYSTEM:

Your final grade in MCH100 will be determined on the basis of ***four tests*** to be administered during the semester. 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 four ***tests*** are as follows:

Test #1 ----- Topic Number I
Topic Number II

Test #2 ----- Topic Number III
Topic Number IV

Test #3 ---- Topic Number V

Test #4 ---- Topic Number VI
Topic Number VII

The four ***tests*** are of equal weight. (i.e. **Each of the four tests is worth 25% of your final grade.**) As a result, ***provided you have received a passing grade on each of the unit tests*****, your final grade will simply be the average of your four test results**. In order to obtain your letter grade the percentage-letter grade equivalents shown on page 12 will be used.

If your final average is below 50%, ***or*** if you have received a failing grade in one or more of the unit tests, whether you receive an 'X' (*Incomplete*) or an 'F' (*Fail*) grade is entirely at the professor's discretion. The decision will be based upon *your final average* (e.g. 32% **would** result in an 'F' grade while 48% **might** result in an 'X' grade); *your attendance* during the semester; *your attitude* while in the classroom; *your perceived level of effort* during the semester; etc..

In any case, should you find yourself with an 'X' grade at the end of the semester, in order to upgrade your mark to a passing grade you will be required to write a "make-up" **examination *covering the entire course content***. *Should you receive a passing grade on the make-up exam (50% or higher) your X grade will be upgraded.* The best you can do after having received an X grade as a result of a failing average is a 'C'! If you were required to write the make-up examination as a result of having failed or missed one test you may substitute the exam result for this test result.

Prior to administering any test you will be notified a full week in advance. Should you, for any reason (*within reason of course*), not be able to be in attendance on a day for which the test has been scheduled it is ***your responsibility*** to notify the professor ***prior*** to the test! *If your reasons are acceptable*, a date will be set during which you may write a ***substitute*** test for the one you have missed.

The following *<u>end</u> of semester grades* will be assigned to students in postsecondary courses:

Grade	**<u>Definition</u>**	*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 493 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.

Plagiarism:

Students should refer to the definition of "academic dishonesty" in *Student Rights and Responsibilities*. 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 course outline as detailed on pages 2 to 8 and *summarized* on pages 9 and 10 lists the subtopics to be covered under each of the seven main topic headings. Some topics may be deleted from the outline or given only cursory coverage at the discretion of the course professor and/or others may be introduced. In other words, *the professor reserves the right to modify the course as he/she deems necessary depending on the needs of the student and the availability of resources. This creates the possibility for some latitude in the grading scheme as detailed on page* 11.

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

VII PRIOR LEARNING ASSESSMENT:

Students who wish to apply for advanced credit in the course should consult with the professor. Credit for prior learning will be given upon successful completion of the following:

1) A discussion with the professor will determine if the course that the student has previously taken at another *post secondary institution* is sufficiently close in content to warrant consideration.

2) Given that step (1) above is granted, the student will need to bring to the professor an ***official*** *course outline* for the course in question to verify step (1). See **VIII Direct Credit Transfers** below.

3) The student will be required to have available in the Registrar's office an ***official*** *transcript* from the *post secondary institution* in question. This transcript will contain the final grade of the course which is being presented to obtain a credit for this course in statics. See **VIII Direct Credit Transfers** below.

4) Given that the student has obtained *at least a* ***'B'*** *standing* in the course in question, a credit for MCH 100 will be granted.

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 an official transcript (**not** a photocopy) and an official course outline (**not** a photocopy) related to the course in question.