

SAULT COLLEGE  
of Applied Arts and Technology  
Sault Ste. Marie

COURSE OUTLINE

MATHEMATICS

MTH 551-4  
MTH 554-4

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MATHEMATICS

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TEXTS:

Washington: "Technical Calculus with Analytic Geometry"  
(Addison Wesley)

Blakely: "Calculus for Engineering Technology"  
(Wiley)

Person: "Calculus with Analytic Geometry"  
(Holt, Rinehart, Winston)  
(for Aviation Technology only)

REFERENCES:

Rice & Knight: "Technical Mathematics with Calculus"  
(McGraw-Hill)

Klaf: "Calculus Refresher for Technical Men"  
(Dover Publications)

Middlemiss: "Calculus",  
(McGraw-Hill)

Peterson: "Calculus",  
(McGraw-Hill)

Goodman: "Analytic Geometry & Calculus"  
. (Harper & Row)

Washington: "Basic Technical Mathematics with Calculus"  
(Addison Wesley)

Ayres: "Calculus",  
(Schaum Publishing Co.)

Turner: "Examples in Practical Mathematics for Technical Students"  
(Prentice-Hall)

Adler: "Thinking Machines"  
(Signet)

Richmond: "Calculus for Electronics"  
(McGraw-Hill)

Malvino & Leach: "Digital Principles and Applications"  
(McGraw-Hill)

Aircraft Flight Manuals for:

- a) Cessna 150M, 172M, ISO, 182
- b) Piper - PA-39 (Twin Comanche)

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## MATHEMATICS

MTH 551-4 - Electrical & Electronic Technology, 3rd semester  
MTH 554-4 - Mechanical Technology, Aviation Technology

### 1. TITLE OBJECTIVES:

- (a) The student is expected to complete each non-optional topic in this course in the time period indicated, during the semester (normally 14-16 weeks), plus a specified make-up period of approx. 2 weeks, prior to the beginning of the next semester in which the student wishes to take the requisite mathematics course of his particular technology program.
- (b) The student will be given instruction on each topic in the classroom or its equivalent as per the number of scheduled class periods specified by column two of the last two pages of this course outline. Normally, a topic test will be administered after such time. Variations in the number of periods utilised for a topic is at the discretion of the instructor and should not exceed 2 periods, at most, in any given topic. Such variations should be as few and as small as possible.

Notes:

1. Students beginning this course should have completed satisfactorily the algebra, trigonometry and analytic geometry which constitutes what is frequently called pre-calculus mathematics. The course assumes a good knowledge of various curves and their characteristic skill in algebraic manipulation; the definition of tangent to a curve as the limiting position of a secant through  $P_1$  and  $P_2$  as  $P_2 \rightarrow P_1$ .
2. Sufficient time is allowed for a good treatment of differentiation using the delta method. Formulas should be introduced only after thorough understanding through practice in the process of differentiation with much reference to its limiting aspect.
3. Formulas should be proved (some as exercises by the students) and then through use become part of each student's mathematical make-up. Formulas for differentiation (24) and for integration (IB) of common types should be memorized.
4. Instructors should look upon this course as an opportunity to build a solid foundation through understanding and skill development for more advanced courses in the calculus. Practical applications from major subject fields should be used whenever possible.
5. The topics number systems and Boolean Algebra have applications in digital computers (electronics) and computer programming. They should be presented at the beginning of the semester.
6. For the Electrical/Electronics students, use should be made of the student's book "Digital Principles and Applications" for the number systems and Boolean Algebra topic exercises, etc.
7. For the Aviation Technology students special emphasis is to be given to more complex interpolation techniques in tabulated data, and to the use of layout of graphical performance charts. Emphasize the mathematics of these areas and limit the aviation centered uses to a few practical problems.
8. The instructor should take note that there is insufficient time in this semester to cover all the topics indicated for the Electrical Electronic and Aviation classes. Therefore:
  - a) Mechanicals, taking MTH 554, should cover the whole course
  - b) Electrical/Electronic, taking MTH 551-4, should cover all indicated topics to the end of topic II.
  - c) Aviation, taking MTH 554, should cover all indicated topics to the middle of topic 10.Topics not covered should be included at the beginning of the next semester course. (MTH 577-4, MTH 578-4)

TOPICAL OBJECTIVES:

MTH 551-4 Number Systems: (to be accomplished in approx. 2 periods)

The student is to be introduced to and become familiar with the binary, octal and binary coded decimal number systems and their relationship to our normal base ten system. The student is to be able to change a number of one system, into its equivalent in any other system.

The student will be able to carry out the mathematical operations of adding, subtracting, multiplying and dividing in the binary system.

The student is to be able to understand and use addition and multiplication tables in the binary system.

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Empirical Equations (Aviation only)

The student will be expected to take experimental data involving two variables, organize it and make a graph of it and use various techniques to arrive at an empirical equation for the resulting curve. These curves may yield a linear equation, parabolic, polynomial relation or a power function.

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Boolean Algebra: (to be accomplished in approx. 8 periods)

The student will be able to:

- a) define 2 elements and 2 operators
  - b) understand and use truth tables
  - c) derive simple identities
  - d) use negation - the not operator
  - e) apply the above to elementary logic and switching circuits
- a) The student will be expected to understand the mechanics of basic interpolation and recognize the trend of the parameters in a given table i.e. (as one parameter increases, the other parameter may increase or decrease thus affecting the interpolation procedure).
  - b) Use of the aviation CR-3 or (4) computer to evaluate interpolation proportions is to be included as a interpolation aid.
  - c) The student will then be required to enter a more complex table, organize a multi-interpolation problem, where altitude, temperature, and power settings required are not directly listed, and determine such parameters as; R.P.M. and/or manifold pressure settings, expect airspeed, fuel consumption rate and aircraft range.
  - d) various practical problems on any facet of flight planning are then to be assigned.

- (e) the student will be expected to apply the above knowledge and procedures to solving practical hypothetical problems from charts "that he has not been ureviously exposed to".

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Graphical Performance Charts (Aviation only)

The student will be expected to:

- (a) read various aviation performance graphs, paying attention to multiple line/axis situations•and interpolate between lines when necessary.
- (b) read into take off and landing charts from various directions to determine missing parameters, interpolating when necessary,
- (c) apply procedures and knowledge learned in the above to solve practical flight planning problems using graphs that he has not previously been exposed to.

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Graph Preparation (Aviation only)

- (a) the student will be given several graph assignments, of increasin complexity. He will be given a tabular performance chart and required to translate the total data into a graphical presentatio
- (b) The student will be expected to plot winds aloft reports on a CR-3 type computer and interpolate for any desired result.
- (c) The student will be expected to learn several ways to plot; label and arrange numerical data into a graph and to determine which arrangement to employ when several options could be conside
- (d) The student will be expected to read direct and interpolate resul from his/her own various graphs.

Introduction to Differential Calculus:

(all groups)

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The student is expected to learn the meaning of a function, functional notation, the limit of a function, the delta process of differentiativ and its application to various common functions.

Differentiation by Rule: (all groups)

The student will be required to derive and use differentiation formulae such as:

- (a) the Power Rule (power of a variable)
- (b) the Chain Rule (power of a polynomial in one variable)
- (c) the Product Rule
- (d) the Quotient Rule

The student will be required to find derivatives of;

- (a) a function by inversion
- (b) an implicit function

Practical Applications of Differentiation: (all groups)

The student will be required to use the various ways of finding derivatives in order to further find:

- (a) gradients or slopes of curves at specified points
- (b) equations of tangents to any curve at a specified point
- (c) maximum and minimum points on a curve whose equation is known, using the slope test, 2nd derivative test and/or the ordinate test to confirm the type of point
- (d) a maximum or minimum quantity using the technique of part "C" above is specified
- (e) the solutions to related subject area problems by utilizing any of the above methods.

Further Differentiation:

The student will be required to:

- (a) find 2nd, 3rd and higher order derivatives using the rules of topic 1
- (b) use differentiation to solve problems in linear velocity and acceleration, and problems in angular velocity.
- (c) define instantaneous velocity and acceleration
- (d) define a differential "dx" and "dy" and solve practical problems using differentials.

Introduction to Integration:

The student will be required to know:

- (a) that integration is anti-differentiation, and how to use the integration power rules.
- (b) the meaning of an indefinite integral and how to find it:  $I(x)$ , and a particular integral and how to find it:  $P(x)$
- (c) how to apply integration techniques to acceleration, velocity and distance problems
- (d) how to use integration to solve electronic problems (El students only)

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Periods

Topic Description

Refer

Number Systems (Electrical  
& Electronic only)

Binary, Octal, binary coded  
decimal systems  
Change of base  
Addition & Multiplication table:  
Alaebra of elements

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text oi  
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Leach  
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Boolean Algebra (Electrical  
s Electronic only)

Definitions of 2 elements &  
2 operations  
Truth tables  
Derivation of simple identities  
Negation - the not operator  
Application to logic & switches

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Empirical Ecuations (Aviation  
Only)

Linear empirical ecuations  
Non-linear empirical equations

Rice a:  
Knight  
2nd''Ed:  
Ch. 6 •  
P. 131|  
Ch. 14  
P.. 334-

Xnterpolation (Aviation only)  
(tabulated performance charts)

Review basic interpolation  
trends in tabulated data  
(4 place Logarithm « natural  
trig tables)  
Use of Aviation CR-3 type computers  
in interpolation (proportions)

Any 4 i  
log & •  
table

Multiple interpolation procedures-- Cessna  
Practical Problems in assorted Cessna  
performance tables Cessna  
take-off landing, clij  
cruise oerformance  $ch^{\wedge}$

Graphical (Performance Charts)  
(Aviation only)

Reading graphical charts  
Normal critical path through  
multiple graph charts  
Reverse path through multi- .  
graph charts given conditions  
Practical problems

Cessna



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Periods

Topic Description

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Graph Preparation (Aviation Only)

Procedures for making engineering graphs

Selection of axis, names labeling techniques

Multiline graphs from tabulated performance charts

Interpolation in multiline graphs

Winds aloft graph on CR-3 computer

Practical assignments

Cessna

Piper  
Comanc

Graphical Methods of Calculus

Gradients of curves, rate of change

Slopes of graphs "of linear & non-linear functions

Average & instantaneous rates of change

Rice S  
Knight:  
Ch. 24

Introduction to Differential Calculus

Functional notation

Limiting value of a function

Differentiation-delta method

Practical applications-rectiline motion

V^ashin

p. 45-

Blakel

Ch.3

p. 31-

Per.son

8,9,10

12

Differentiation by Rule

Differe"ntiation formulas

Composite function & the chain rule

Implicit differentiation

Electrical Applications

Successive differentiation

Washin

p.64-8

Blakel

Ch. 5

p. 80-

- Person

Ch. 13

15

10

10

Practical Application of Differentiation

Gradients

Tangents to curves

Maxima and minima

(Aviation should finish the semester here)

Related' rate problems

Washin

p. 85-

Blakel

Ch. 4

p. 54-

Person

Ch. 16

18

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Topic Number	Suggested Periods	Topic Description	Reference
11	5	<u>Differential and Integral</u> (for Mechanical, give more application time) -differential formulas -applications of differential -integration as anti-differentiation -applications of indefinite integration -algebraic substitution -Electrical/Electronic should finish the semester here	Wash. p.113-12' Blakely Ch. 7 p.11'..-12 Person 2 23
12	9	<u>Definite Integration</u> -areas under a curve -fundamental theorem of integral calculus -computations with definite integrals -application to areas, volume, motion electrical problems -Mechanicals should finish the semester here	Wash. p.128-15 Blakely p. 121-  i Person C 25,26 * .