MAT106 Calculus I with Analytic Geometry
Prerequisite: College Trigonometry OR NCHS Precalculus AND teacher recommendation
5 Credit Hours (Lecture)
Course Length: 2 semesters
Instructor: Sharon Meyer
785-547-7085

Department:

Math / Science

Course Description:

Calculus I with Analytic Geometry is the first in the three-semester sequence in the rigorous study of calculus. This course consists of the study of algebraic functions of one variable, the use of modern technology to enhance calculus knowledge, limits including the study of L'Hopital's rule, differentiation and its various techniques, definite and indefinite integrals [including integration by substitution and logarithmic functions], and applications of the derivative and definite integral in geometry, science, engineering, business, medicine, and other fields. Other topics will be covered as time permits.

Course Competencies: Students will …

1. Be able to simplify and analyze functions of all types, including trigonometric functions, and be able to graphically represent them using graphing calculator technology.
2. Be able to find limits graphically, numerically, and analytically, and to determine the existence of limits and continuity of functions [including piece-wise varieties, one-sided limits, and infinite limits] by calculation and/or the analysis of graphs.
3. Be able to find derivatives for polynomials and rational functions of all types using various techniques and apply the derivative to application problems, including: finding maxima and minima, rates of change, and in graphing.
4. Be able to relate logarithmic and exponential functions to calculus, including derivatives, inverse functions, inverse trigonometric functions, L'Hopital's rule and other indeterminate forms, and implicit differentiation.
5. Be able to analyze graphs using the First and Second Derivative Tests and the Extreme Value Theorem and applying appropriate technology to interpret and analyze graphs.
6. Be able to apply the knowledge of derivatives to find relative extrema and absolute extrema and to use extrema to solve science, engineering, and business-related problems.
7. Be able to display knowledge of and utilization of Newton's Method, Rolle's Theorem, and Mean-Value Theorem to find solutions, and of differentials for approximation.
8. Be able to apply elementary techniques of the indefinite and definite integral [including a rigorous understanding of the Fundamental Theorem of Calculus and of Riemann Sums].
9. Be able to evaluate definite integrals by substitution, including application problems, and by the various numerical integration techniques.
10. Be able to use definite integrals to find the area between two curves and to find volumes by the disk method, shell method, and by utilization of cylindrical shells.

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11. Be able to use definite integrals to find length of a plane curve, to find the surface area of a plane curve, to find average value of a function, and physical sciences application problems such as Work, Fluid Pressure, and Force.
12. Be able to perform differentiation and integration with problems that have the natural logarithmic function, inverse function, exponential functions, and functions involving bases other than base e, including application problems of each.
13. Be able to perform differentiation and integration with problems that involve inverse trigonometric functions, including application problems.
14. Be able to perform differentiation and integration with problems that involve hyperbolic functions, including application problems.
15. Be able to either use a CAS such as Derive, Maple, or Mathematica to complete computer laboratories involving course material OR use many of the java applets that are available at http://archives.math.utk.edu/visual.calculus/ in the context of the Calculus I course.
16. Be able to demonstrate satisfactory writing skills in essay-style questions on examinations and/or quizzes or on written journals in response to questions about course content, to demonstrate their overall knowledge and upper-level critical thinking skills.

Course Content:

I. Chapter 1: Functions
   - A. Functions
   - B. Graphs of functions and operations
   - C. Combining Functions
     1. Shifting Graphs
     2. Scaling Graphs
   - D. Trigonometric Functions
   - E. Graphing skills
     1. Graphing with Calculators
     2. Graphing with Computers
   - F. Exponential functions
   - G. Inverse functions
     1. Algebraic
     2. Trigonometric
     3. Logarithmic

II. Chapter 2: Limits and Continuity
   - A. Rates of Change
   - B. Tangents to Curves
     1. Graphically
     2. By definition

C. Limits of a Function
D. Limit Laws
E. Rigorous Definition of a Limit [precisely, as it relates to calculus]
F. One-sided Limits
    1. Algebraic
    2. Trigonometric
G. Two-sided Limits
H. Continuity
    1. By definition
    2. Use of the Intermediate Value Theorem
    3. Composite functions and general limits
I. Limits that involve infinity
J. Asymptotes of graphs

III. Chapter 3: Differentiation
A. Tangents and the Derivative at a Point
B. The derivative as a function
C. Differentiation Rules
    1. Constant and exponential functions
    2. Power Rule
    3. Product Rule
    4. Quotient Rule
D. The Derivative as a Rate of Change
    1. Instantaneous rate of change
    2. Velocity [speed]/acceleration
    3. Application physics-type problems
E. Derivatives of Trigonometric Functions with applications
F. Derivatives utilizing Chain Rule and applications
G. Implicit Differentiation
H. Derivatives of Inverse Functions and Logarithms
    1. Logarithmic differentiation
    2. Inverse Functions / Logarithms / Exponentials
I. Inverse Trigonometric Functions
    1. Derivatives
    2. Limits
    3. Applications
J. Related Rates [applications]
K. Linearization and Differentials

IV. Chapter 4: Applications of Derivatives
    A. Extreme values of functions
        1. The Extreme Value Theorem
        2. Local maximums / minimums
        3. Critical points of all types
    B. The Mean Value Theorem and its applications
    C. Monotonic functions
        1. Increasing/decreasing functions
        2. First Derivative Test
        3. Techniques for identifying local extrema
    D. Concavity
        1. Identifying inflection points
        2. Second Derivative Test
        3. More advanced curve sketching techniques
    E. Indeterminate Forms
    F. L'Hopital's Rule for all seven Indeterminate Forms
    G. Applied Optimization
        1. General Mathematics problems
        2. General Physics problems
        3. Fermat's principle / Snell's Law & the Law of Refraction
        4. Business / Economics general problems
    H. Newton's Method
        1. Applications
        2. Convergence of the Approximations
    I. Introduction to Indefinite Integrals ["Antiderivatives"]
        1. General antiderivatives by basic rules
        2. Initial value problems
        3. Antiderivatives and motion
V. Chapter 5: Integration
    A. Area and estimating area with finite sums
        1. Riemann sums and partitions
        2. Distance traveled versus displacement
        3. Average value techniques
    B. Sigma Notation
    C. Limits and Values of Finite Sums
    D. The Definite Integral

1. Integrable and Nonintegrable functions
2. Rules of definite integrals
3. Area under a curve
4. Average value over an interval

E. The Fundamental Theorem of Calculus [or FTC]
1. Part 1 of Thm
2. Part 2 of Thm
3. Total Area
4. Techniques for finding area with FTC(2)

F. Indefinite Integrals and the Substitution Method
1. Techniques explored
2. Change of Limits Rule

G. Substitution and Finding Area
1. Area Between Curves with respect to x
2. Area Between Curves with respect to y

VI. Chapter 6: Applications of Definite Integrals

A. Volumes using Cross-Sections
1. Volumes by Disks
2. Volumes by Washers

B. Volumes by Cylindrical Shells

C. Other parts of Chapter Six as time permits [esp. Arc length, Surface Area, Work, & Fluid Force]

Learning Assessments:

Written examinations covering all materials emphasized should be expected, including a <u>REQUIRED, COMPREHENSIVE FINAL EXAMINATION.</u> Every student, without regards to grade status going into the Final Examination, should take the Final Exam. Excusing students from taking the Final Exam is not a practice HCC supports, as it can lead to transfer institutions not accepting our credits. The grade also involves regular hour-long examinations over the course competencies. Additionally, some assessment may also occur through any of the following at the discretion of the course instructor: regular collection of homework, occasional in-class work, quizzes [in-class or take-home], portfolios, and various projects.

Instructional Materials:

Textbook: CALCULUS : Early Transcendentals, 2nd Edition (2015), by William Briggs, Lyle Cochran, & Bernard Gillett; Pearson Education, Inc., Publishers.

Assignments, journals, class notes and videos can be accessed on the instructor's website at ncthunder.org/smeyer.

Policies:

- Grades and behavior will be governed in this course according to the policies outlined in the Nemaha Central High School Handbook.
- Grades will be assigned using the NCHS Grading Scale; however, grades will NOT be rounded.
- Students will receive 4 homework coupons each semester that exempt a student from an assignment. Only two may be used prior to Oct. 15/Mar. 15. At the end of the semester, unused homework coupons will earn 5 pts. of extra credit per coupon. Put them in the pocket of the striped file on the back table.
- Homework is required. If an assignment has 7 or more problems, two problems may be omitted. They cannot be consecutive problems nor 2 word problems. Assignments with 6 problems or less must have all problems thoroughly attempted. Homework credit is all or none!
- Credit for homework will be granted for legitimately attempting to do the problem, not for whether the correct answer was reached. Answers are provided for all homework problems. Work must be shown!
- Assignment penalties:
  - Short 1 problem = -20%
  - Skip 2 in a row = -20%
  - Short more than 1 problem = Fix & Resubmit
  - Late within one week = -20%
  - Late more than one week = -50%
- Students will be given 50/50 at the start of each semester. Each time a student fails to communicate with the teacher prior to a known absence five points will be deducted.
- Tests must be completed during class unless prior arrangements have been made. Don't ask to come back later. No retakes!

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Academic Integrity:

Highland Community College faculty and students have the responsibility to maintain high academic standards. Academic dishonesty by students, which includes, but is not limited to, cheating, fabrication, plagiarism, or facilitation of academic work, is reason for proper disciplinary action Students should submit their own academic work. Faculty should not facilitate or leave unreported academic dishonesty by the student. Submissions of work other than the student's own will result in a 0 for that assignment. A second offense will result in removal from the class.

Guidelines for Requesting Accommodations Based on Documented Disability or Medical Condition

It is the intention of Highland Community College to work toward full compliance with the Americans with Disabilities Act, to make instructional programs accessible to all people, and to provide reasonable accommodations according to the law.

Students should understand that it is their responsibility to self-identify their need(s) for accommodation and that they must provide current, comprehensive diagnosis of a specific disability or medical condition from a qualified professional in order to receive services. Documentation must include specific recommendations for accommodation(s). Documentation should be provided in a timely manner prior to or early in the semester so that the requested accommodation can be considered and, if warranted, arranged.

On-Campus Students: At enrollment, any on campus student may complete a form that will allow them to self-identify any disability.

Off-Campus Regional Students: Self-identify your disability and accommodation needs with the Regional Coordinator and/or instructor, preferably prior to the first class meeting.

Online Students: Self-identify your disability and accommodation needs by contacting the Disabilities Coordinator. Students must provide their own programs to allow accessibility on their home computer.

Any student may also identify their disability by completing an online form located on the HCC homepage under Students Services/Resources/Disabilities. Questions should be directed to the Disabilities Coordinator.