The Mathematical Sciences Initiative

and

The Engineering Calculus Stream
The Mathematics Sciences Initiative

Incorporates MTH, STT, and CMSE

**Diversify Curriculum**: Identify streams of students and adapt course content to the needs of the stream, even across disciplinary boundaries.

**Diversity Pedagogy**: Have small sections of courses that experiment with pedagogical approaches.

**Build instructional teams**: Groups of disciplinary faculty, continuing instructors, educators, and target discipline faculty that manage course content and strive for continual pedagogical improvement.
## Four Major Streams

<table>
<thead>
<tr>
<th>Course</th>
<th>Enrollment</th>
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<tbody>
<tr>
<td>Intermediate/College Algebra</td>
<td>3000 students/year</td>
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<tr>
<td>Quantitative Literacy</td>
<td>est. 1000 students/year</td>
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<tr>
<td>Bio-Business Calculus</td>
<td>2000 students/year</td>
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<tr>
<td>Nat Sci - Engineering Calculus</td>
<td>2000 students/year</td>
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The Bio-Business Calculus Stream

**MTH 124** (3 credits/3 hours): Study of limits, continuous functions, derivatives, integrals and their applications.

**MTH 126** (3 credits/3 hours): Application of partial derivatives, integrals, optimization of functions of several variables and differential equations.

**Limitations**

The material is far removed from applications, especially for Biology based students.

Curriculum is not well designed for actual needs

Few biology students take MTH 126, most follow up with Statistics course.
The Biology Stream

**MTH 124(bio)** (3 credits/3 hours): Use limits and derivatives to graphically, numerically, and analytically understand functions. Curriculum developed in consultation with biology faculty.

**STT 231** (3 credits/3 hours): new course (TBD) tailored to biology needs.

**Modifications**

Two lectures per week, hour-long active learning labs based on fixed teams of 3-4 students. Targeted on a biologically motivated application of the week’s lesson.

Introduce basic statistical tools into MTH 124, and incorporate into active learning labs
The Calculus Stream

MTH 132 (3 credits/3 hours): Limits, continuous functions, derivatives and their applications. Integrals and the fundamental theorem of calculus.


MTH 234 (4 credits/4 hours): Vectors in space. Functions of several variables and partial differentiation. Multiple integrals. Line and surface integrals. Green's and Stokes's theorems.

The Calculus Stream – Limitations

- Concepts introduced without connection to physical intuition and practical applications, this limits initial comprehension and also long-term retention.

- MTH 133, especially the sequence and series material, is a significant barrier for students. DWF rate with grade below 1.5 runs at 25-30%

- Introduce vector functions of several variable without significant linear algebra background

- No significant use of computational tools nor modeling applications.
Proposal: Engineering Calculus

MTH 132 (3 credits/3 hours): Limits, continuous functions, derivatives and their applications. Integrals and the fundamental theorem of calculus.

MTH 133comp (4 credits/5 hours): Add an extra meeting hour that introduces Matlab and engages in active learning and team-work on group projects.

MTH 235LinAlg (4 credits/4 hours): Run a linear algebra heavy introduction to differential equations, introduce vectors of one variable (systems of ODEs) before vector functions of several variables. Make extensive use of MATLAB, replace recitation with numerical/modeling team-based labs.

MTH 234comp (4 credits/5 hours): Same content, use ‘lab’ class for intensive modeling and computational problems.
Time Cost: Engineering Calculus

The revised format adds one credit and two-semester hours of class time. ABET requirements and time-to-degree provide little room to increase teaching load. There are various ways to partially recoup added class time.

- Assimilate EGR 102 into the lab portions of EGR stream. Co-teach labs with EGR faculty.

- Remove lower priority content from EGR Calc stream to accommodate labs without increase in contact hours

- Incorporate programming language, as in CMSE 201, into laboratory activities

- While not a requirement, many EGR students take MTH 309 (Linear Alg), this can be eliminated
Textbooks: Differential Equations with Linear Alg.

Ordinary Differential Equations and Linear Algebra, by Todd Kapitula, SIAM (2016)

Differential Equations and Linear Algebra, by Gilbert Strang. Wellesley-Cambridge (June 4, 2014)


Differential Equations and Linear Algebra, by C. Henry Edwards and David Penny; Pearson; 3 edition (October 20, 2008)
**Time Lines**

Run pilot of MTH133comp in Fall 2016
Run pilot of MTH 235LinAlg in Spring 2017
Run full sequence pilot starting Fall 2017

<table>
<thead>
<tr>
<th>Fall 2017</th>
<th>Spring 2018</th>
<th>Fall 2018</th>
<th>Spring 2019</th>
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<tbody>
<tr>
<td>MTH 132</td>
<td>MTH133comp</td>
<td>MTH 235LA</td>
<td>MTH234comp</td>
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