**Bronx Community College**
**of the City University of New York**
**Department of Mathematics and Computer Science**

**Syllabus: MTH 35** *Selected Topics in Advanced Calculus and Linear Algebra* **(4 credits-4 hours)**
**Prerequisite: MTH 33- Calculus III**

Matrix algebra and vector calculus are essential to understanding modern physics and engineering. However, these topics are usually presented separately according to their own mathematical development. This course will present these topics within the overall context of an introduction to differential geometry. The student will become familiar with the tools of matrix algebra (for example, row-reduction, matrix operations and inverses, and determinants including applications to the classic eigenvalue problem and its application to ODEs) and the techniques of vector calculus like line integrals, surface integrals, and the versions of Stokes' Theorem. In addition, the student will see the derivative in its proper context as a linear transformation between tangent spaces. Finally, the student will become familiar with differential forms.

The course will be based on the text, "First Steps in Differential Geometry," which will be provided in class. In addition, students may refer to the following texts for supplementary explanation:

- Calculus (6th ed.), by James Stewart. Brooks/Cole. (Textbook for MTH 33)
- Elementary Linear Algebra (Applications Version, 10th ed.), by H. Anton and C. Rorres. Wiley, 2010. (Textbook for MTH 42)
- Differential Equations (3rd Ed.), by P. Blanchard, R. L. Devaney, G. Hall. Thomson Brooks Cole, 2006. (Textbook for MTH 34)
- Vector Calculus (5th ed.), by J. Marsden and A. Tromba. W.H. Freeman and Co, 2004. (On reserve in BCC library)
- Differential Forms and Applications, by Manfredo do Carmo. Universitext, 1994. (BCC Library)
- Calculus on Manifolds, by Michael Spivak. (BCC Library)

Grades will be based on 10 Homework Sets (20 points each), two in-class exams (100 points each), and a final exam (200 points). Review material for the final exam can be found on the City College Math Department website for Math 39200.

As a course designed for engineering students, the presentation will not emphasize proofs as much as techniques and methods of computation, along with applications of techniques to problems in physics. Students majoring in mathematics will benefit by reading the proofs of major theorems presented in this course.

Four classes will be considered "review sessions" and will not follow the standard class schedule. These classes will be scheduled based on the students' schedules and will be held in conjunction with the class exams and final.

| **Date** | **Topic** | **Suggested Reading** |
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| **Chapter 1.** | **Linear Algebra** | |
| Monday, Aug. 27<br>*Supplemental reading* | Euclidean spaces and their subspaces.<br>Anton/Rorres, 3.1, 3.2<br>Stewart, 13.1, 13.2, 13.5<br>Marsden/Tromba, 1.1,1.2,1.5 | Sec. 1.1–1.3 |
| Wednesday, Aug. 29<br>*Supplemental reading* | Linear independence, bases, and dimension.<br>Anton/Rorres, 1.2, 4.3–4.5 | Sec. 1.4 |
| Wednesday, Sept. 5<br>*Supplemental reading*<br>Problem set # 1 due | Linear transformations.<br>Anton/Rorres, 1.3, 3.4, 4.9, 4.10 | Sec. 1.5–1.6 |
| Monday, Sept. 10<br>*Supplemental reading* | Range and kernel, rank and nullity.<br>Anton/Rorres, 4.7–4.8 | Sec. 1.7 |

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| Wednesday, Sept. 12<br>*Supplemental reading*<br>Problem set # 2 due | Invertible linear transformations.<br>Anton/Rorres, 1.4–1.6, 4.6 | — |
| Wednesday, Sept. 19 | NO CLASS | |
| Monday, Sept. 24<br>*Supplemental reading* | The determinant.<br>Anton/Rorres, Chapter 2 | — |
| Monday, Oct. 1<br>*Supplemental reading*<br>Problem set # 3 due | The eigenvalue problem. I.<br>Anton/Rorres, 5.1 | — |
| Wednesday, Oct. 3 | The dual space and linear forms. | Sec. 1.8 |
| Wednesday, Oct. 10<br>Problem set # 4 due | EXAM ONE | |
| **Chapter 2.** | **Advanced calculus** | |
| Monday, Oct. 15<br>*Supplemental reading* | The derivative.<br>Marsden/Tromba, 2.3, 2.5<br>Spivak, pp. 15–34 | Sec. 2.1 |
| Wednesday, Oct. 17<br>*Supplemental reading* | The tangent space I.<br>Stewart, 14.1–14.2, 15.4, 17.6<br>Marsden/Tromba, 2.4, 4.1, 7.3 | Sec. 2.2–2.3 |
| Monday, Oct. 22<br>*Supplemental reading*<br>Problem set # 5 due | The tangent space II. The derivative as a linear map.<br>Stewart, 15.5–15.6 | Sec. 2.4–2.5 |
| Wednesday, Oct. 24 | NO CLASS | |
| Monday, Oct. 29<br>*Supplemental reading* | The inverse function and implicit function theorems<br>Marsden/Tromba, 3.5<br>Spivak, pp. 34–44. | Sec. 2.4 (cont.) |
| Wednesday, Oct. 31<br>*Supplemental reading*<br>Problem set # 6 due | Diffeomorphisms. Change of variables.<br>Stewart, 16.9<br>Marsden/Tromba, 6.2–6.3 | Sec. 2.6 |
| Monday, Nov. 5<br>*Supplemental reading* | Vector fields. Integral curves.<br>Stewart, 17.1<br>Marsden/Tromba, 4.3 | Sec. 2.7–2.8 |
| Wednesday, Nov. 7<br>*Supplemental reading*<br>Problem set # 7 due | The eigenvalue problem. II.<br>Stewart, 18.1<br>Blanchard/Devaney/Hall, Chapter 3 | — |
| Monday, Nov. 12<br>Problem set # 8 due | EXAM TWO | |

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| **Chapter 3.** | **Integration of differential forms** | |
| Wednesday, Nov. 14 | NO CLASS | |
| Monday, Nov. 19 | The algebra of linear forms. Operations. | Sec. 3.1–3.2 |
| Wednesday, Nov. 21 | NO CLASS | |
| Monday, Nov. 26 | Differential forms. Operations. | Sec. 3.3–3.4 |
| *Supplemental reading* | Marsden/Tromba, 8.6<br>do Carmo, Chapter 1 | |
| Wednesday, Nov. 28 | Integration of forms. I. | Sec. 3.5 |
| *Supplemental reading* | Stewart, 17.2–17.3<br>Marsden/Tromba, 7.2<br>do Carmo, Chapter 2 | |
| Problem set # 9 due | | |
| Monday, Dec. 3 | Integration of forms. II. | Sec. 3.5 (cont.) |
| *Supplemental reading* | Stewart, 16.4–16.9, 17.7<br>Marsden/Tromba, 7.4–7.5<br>do Carmo, 4.1 | |
| Wednesday, Dec. 5 | Stokes' Theorem. I. | Sec. 3.5 (cont.) |
| *Supplemental reading* | Stewart, 17.4<br>Marsden/Tromba, 8.1<br>do Carmo, 4.2<br>Spivak, pp. 122-126. | |
| Problem set # 10 due | | |
| Monday, Dec. 10 | Stokes' Theorem. II. | — |
| *Supplemental reading* | Stewart, 17.5, 17.8<br>Marsden/Tromba, 7.2<br>do Carmo, 4.2 | |
| Wednesday, Dec. 12 | Vector formulation of Stokes' Theorem | — |
| *Supplemental reading* | Stewart, 17.8–17.9<br>Marsden/Tromba, 8.2–8.3 | |