MAE 544: Nonlinear Control (Fall 2017)

1 Course Information

- **Lectures:**
  Tuesday/Thursday (3:00pm - 4:20pm)
  Friend Center 306

- **Instructor:**
  Biswadip Dey (biswadip@princeton.edu)
  Von Neumann, Room # H-116

- **Office Hours:**
  Wednesday (5:00pm - 6:30pm)

- **Course Webpage:**
  `http://www.princeton.edu/~biswadip/Fall_2017_MAE544`

2 Grading

- **Homework - 25%**:
  This course will have 5 biweekly homeworks which will be due on Tuesdays by 3:00 pm (before the lecture). You are encouraged to collaborate on the homework problems. However, please turn in work that represents your own effort and understanding. Under emergency circumstances late submission will be allowed, but, it will require prior confirmation from the instructor.
  Tentative due-dates for homeworks: *September 26, October 10, October 24, November 21, December 7.*

- **Exam - 50%**:
  This course will involve 2 take-home exams (each carrying 25%) for which you will have to submit your answers within 3 days after the exams are given out. The 1st exam will be given out after Lecture#13 (tentatively on *November 6*), and the 2nd exam will be given out after Lecture#24 (tentatively on *December 11*).

- **Course Project - 25%**:
  Students will be required to submit a final report and give an oral presentation. We will discuss further details about the project later.

3 Core Topics

- Brief overview of relevant topics from linear algebra and advanced calculus
- Introduction to differential geometry - smooth manifolds and tangent/cotangent spaces, vector fields
- Lie groups and related concepts
- Lie bracket of vector fields
- Controllability properties of nonlinear systems
- Lyapunov stability theory and local stabilization
- Passivity and stabilization of dissipative systems
- Energy shaping and controlled Lagrangian
- Feedback linearization

4   References

1. Nijmeijer, H., van der Schaft, A. (1990) *Nonlinear Dynamical Control Systems*, Springer New York.
2. Isidori, A. (1995) *Nonlinear Control Systems*, Springer-Verlag London.
3. Sastry, S. S. (1999) *Nonlinear Systems: Analysis, Stability, and Control*, Springer-Verlag New York.
4. Schutz, B. F.(1980) *Geometrical Methods of Mathematical Physics*, Cambridge University Press.
5. Guillemin, V., Pollack, A. (Reprint, 2010) *Differential Topology*, American Mathematical Society.

5   Tentative Lecture Schedule

- **Lecture 1-2:** Background and A Brief Review of Linear Algebra and Calculus
- **Lecture 3-6:** Introduction to Differential Geometry
- **Lecture 7-8:** Lie-Groups and Control Systems
- **Lecture 9-11:** Nonlinear Controllability
- **Lecture 12-13:** Stabilization using Lyapunov Stability Theory
- **Lecture 14-17:** Passivity and Dissipative System
- **Lecture 18-20:** Control Lyapunov and Energy Shaping Methods
- **Lecture 21-24:** State and Output Feedback Linearization