EK 131/132 MB Introduction to Engineering: Bio-Aerial Locomotion

Fall 2012

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Syllabus

Course schedule

Monday & Wednesday, 3pm–5pm in room PSY B55

Course web resources

We will be using **Piazza** for class discussion. The system is designed to getting you help fast and efficiently from classmates and myself. Rather than emailing questions to the teaching staff, I encourage you to post your questions on Piazza. If you have any problems or feedback for the developers, email team@piazza.com.

Find our Piazza class page at: https://piazza.com/bu/fall2012/ek131mb/home

We will also use **Socrative**, for in-class student responses from your internet-enabled mobile device. Student login via http://m.socrative.com/student/ and join room number 75443.

The course has a **blog**, used by both instructor and students. We await to be assigned a URL by the BU IT department.

Prerequisite

Not applicable.

Catalog description: EK 131/132 Introduction to Engineering

Introduction to engineering analysis and/or design through a sequence of two modules or minicourses chosen from a selection of modules offered by participating engineering faculty. Each module presents students with key concepts and techniques relevant to an applied area of engineering. Limited to freshmen and sophomores (students with less than 64 credits toward degree requirements). 2 cr, either sem.

MB Module description

Human-designed flying devices are just over 100 years old, which is not very much in historical terms, and much less in evolutionary terms. In nature, flight has evolved quite efficiently, and at least four times (insects, pterosaurs, birds and bats). Moreover, many biological organisms maneuver in the air effectively, without flying, per se. In this course, we will discuss a selection of interesting cases of bio-aerial locomotion: falling and parachuting, gliding and flying. When falling, geckos are able to right themselves turning their body in mid-air, and always land safely on their feet. Some species of snakes can glide to the ground while slithering their body to adjust their shape; and samaras (winged seeds like the maple seed) slow their descent as they spin, so the wind will take them farther aiding dispersal of the tree species. Many birds can boost their glide by efficiently exploiting thermal currents in the air, and small birds and insects can hover in the air via flapping flight. All these examples, among others, are inspiring engineers today to design new devices suchas micro-air vehicles and robots that perform impressive feats. In this course, you will get a glimpse of the modern activity of bio-inspired engineering, in particular in its relation to the fields of aeronautics and robotics.

Textbook

There is no required textbook for this course. Readings will be distributed by the instructor.

Course aims

This course aims to motivate the subject of *bio-inspired engineering*, characterized by seeking examples in the biological world of the desired function in the engineered creation. In particular, we seek examples of aerial locomotion in the increasingly sophisticated forms of: falling, parachuting, gliding and flying.

Learning objectives

Students will ...

i. become familiar with examples in the biological world of effective falling, parachuting, gliding and flying;

ii. gain basic understanding of how engineering analysis can be used to study these examples of aerial locomotion and extract the principles that underlie them;

iii. learn about the basic forces involved in aerial locomotion and flight;

iv. think creatively about adopting the principles of bio-aerial locomotion for engineering design of devices that fall, glide, or fly mimicking nature;

v. gain experience documenting and presenting engineering principles observed in nature.

Assessment policies

Assessment is based on student participation in class discussions, both oral and online (both on Piazza and the course blog), assigned work and quizzes. Collaboration is encouraged, but written course contributions must be personal and original. Written assignments are to be posted on the course blog, and will be open to comments from the rest of the class. There are no exams.

Academic conduct & plagiarism

Quoting from the Undergraduate Student Handbook, p. 42:

Dishonesty in representing one's academic work is a serious ethical violation.

Among the examples of academic misconduct, plagiarism is of particular relevance for this course, which is assessed with students' written work. The definition in the Handbook reads:

Plagiarism is any attempt by a student to represent the work of another as his or her own. This includes […] copying or substantially restating the work of another person or persons in any oral or written work without citing the appropriate source (including web sources).

For this course, what this means is that you have to write your assignments yourself, simple as that. You should *never* copy text verbatim from other sources, unless it is a quote which is properly marked as such and properly attributed. In your work, you must always include references to any sources you used.

The instructor for this course will not be using any magical plagiarism-detection tool. But your honor is on the line. Your assignments for this course consist of blog posts, which are public and open to commentary from your classmates. Your peers will likely censure any misuse or misattribution of sources. The course penalty for plagiarism is a zero on that assignment.

Course content

This plan is subject to changes, but approximately, we will cover the following subjects:

1. Introduction to the course. Overview of natural flight
2. Dynamics of drag and lift; basic science of flight. Overview of flying animals; wing loading and other design features
3. Flapping: powered flight in birds, bats and insects; "SmartBird"
4. Swifts and morphing wings; "RoboSwift"
5. Hovering: hummingbirds and insects.
6. Parachuting and gliding in snakes, squirrels and other animals and insects. The canopy ants.
7. Leading-edge vortex: autorotation of samaras; "Samarai"
8. Falling: how lizards employ their tails to right themselves as they fall; "RoboGecko"