Course	**BMEN 6388 Nonlinear Dynamics in BME**
Professor	Lan Ma
Term	Spring 2012
Meetings	Mon & Wed, 1:00-2:15pm, ECSN 2.110

Professor's Contact Information

Office Phone	972-883-4752
Office Location	ECSS 3.906
Email Address	lan.ma@utdallas.edu
Office Hours	Mon 2:30-4:00pm

Prerequisites: MATH 2419 (Calculus II)

Course Description: A graduate-level course that provides introduction to the theory and analysis methods for nonlinear dynamical systems, with applications to biology. Topics include concepts, theory and analysis of nonlinear dynamical systems represented by ordinary differential equations, such as equilibrium point and limit cycle, local linearization and stability analysis, phase space analysis, limit cycles, bifurcation analysis and chaos. Representative nonlinear biological systems will be discussed. Students will be expected to complete a final project to review cutting edge problems emerged from biological systems.

Learning outcomes:

Students are expected to develop the following skills:

- Master key concepts related to nonlinear dynamical systems.
- Understand fundamental dynamical systems theory, including local linearization and stability analysis, phase space theory and bifurcation theory.
- Apply analytical and computational methods to study dynamical behaviors and properties of general nonlinear system
- Learn to uncover special features emerged from dynamical biological systems.

Required Textbook and Materials:

- Textbook: Steven H. Strogatz: "Nonlinear Dynamics and Chaos: with Applications to Physics, Biology, Chemistry, and Engineering", Westview Press, 2001.
- Access to MATLAB (personal copy or VPN access via UTD gateway)
- Hand-held calculator (PDA apps are not acceptable, see below)

Suggested Further Reading Materials:

- Eugene M. Izhikevich: "Dynamical systems in Neuroscience", the MIT Press, 2010. Available at MIT CogNet (http://cognet.mit.edu/library/books/view?isbn=0262090430) or as an eBook (http://site.ebrary.com/lib/utdallas/docDetail.action?docID=10173655).
- Other assigned or recommended readings, including journal articles, as appropriate.

Assignments & Academic Calendar

- Homework assignments 20%

  (Homework assignments will be collected at the beginning of the class period when it is due. HW that is not reasonably neat and readable, or not bound, will be marked down. **Late HW will not be accepted.** HW will be due about one week after it is assigned. It may not be returned to you until a week after it is due, which means you may not have it back for a problem-solving session, or to use

in studying for an exam. **If you want to have it available at these times, you will have to make a photocopy of it before you turn it in.)**

- Mid-term Exam (90 minutes) 30% Wednesday, March 7, 1:00-2:30pm
- Final Exam (90 minutes) 30% Friday, May 11, 11:00am-12:30pm
- Project (about one month period) 20%

Class schedule Spring 2012:

Week	Date	Topic	Date	Topic	Course Material
1			1/18	Intro to nonlinear dynamical systems & applications	Strogatz, Ch1
2	1/23	One-dimensional systems: graphical analysis of fixed points	1/25	One-dimensional systems: graphical analysis of fixed points (cont'd)	Strogatz, Ch2
3	1/30	One-dimensional systems: bifurcation theory	2/1	One-dimensional systems: bifurcation theory (cont'd);	Strogatz, Chs 2 &3
4	2/6	One-dimensional systems: bifurcation theory (cont'd);	2/8	Example of one-dimensional biological systems: logistic equation	Strogatz, Ch3
5	2/13	Example of one-dimensional biological systems: electrophysiological system	2/15	Two-dimensional systems: local linearization, stability analysis	Izhikevich, Ch2; Strogatz, Ch5
6	2/20	Two-dimensional systems: phase space, nullcline, vector field	2/22	Two-dimensional systems: phase space, nullcline, vector field (cont'd)	Strogatz, Ch6
7	2/27	Two-dimensional systems: phase space, nullcline, vector field (cont'd)	2/29	Two-dimensional systems: limit cycles	Strogatz, Chs. 6 & 7
8	3/5	**Mid-term review**	3/7	**Mid-term exam** (covers all material up to 2/29)	
9	3/12	Spring break (no class)	3/14	Spring break (no class)	
10	3/19	Two-dimensional systems: limit cycles (cont'd)	3/21	Two-dimensional systems: bifurcation theory	Strogatz, Chs. 7 & 8
11	3/26	Two-dimensional systems: bifurcation theory (cont'd)	3/28	Examples of two-dimensional biological systems	Strogatz, Chs. 7 & handout
12	4/2	Examples of two-dimensional biological systems (cont'd)	4/4	Examples of two-dimensional biological systems	handout
14	4/9	Examples of Higher-dimensional biological systems	4/11	Examples of Higher-dimensional biological systems (cont'd)	handout
15	4/16	Examples of Higher-dimensional biological systems (cont'd)	4/18	Examples of Higher-dimensional biological systems (cont'd)	handout
16	4/23	Chaos theory: Lorenz equations	4/25	Chaos theory: logistic map	Strogatz, Chs. 9&10
17	4/30	**Project presentation**	5/2	**Final review**	
18			5/11	**Final Exam** (covers material from 10/17 to 11/30). Note exam is at 11:00 AM.	

Course Policies

Make-up Exams	No make-up exams will be given.
Extra Credit	No extra credit work will be assigned.
Late Work	No late assignments and exams.
Special Assignments	At instructors discretion.
Class Attendance	Students are encouraged to attend every class. If you miss a class, please discuss with your classmates to find out the lecture notes.
Classroom Citizenship	Professional at all times. As courtesy to classmates and instructor, electronic devices should be turned off during class, except when permitted by the instructor
Field Trip Policies	**N/A**
Student Conduct and Discipline	The University of Texas System and The University of Texas at Dallas have rules and regulations for the orderly and efficient conduct of their business. It is the responsibility of each student and each student organization to be knowledgeable about the rules and regulations which govern student conduct and activities. General information on student conduct and discipline is contained in the UTD publication, *A to Z Guide*, which is provided to all registered students each academic year. The University of Texas at Dallas administers student discipline within the procedures of recognized and established due process. Procedures are defined and described in the *Rules and Regulations, Board of Regents, The University of Texas System, Part 1, Chapter VI, Section 3*, and in Title V, Rules on Student Services and Activities of the university's *Handbook of Operating Procedures*. Copies of these rules and regulations are available to students in the Office of the Dean of Students, where staff members are available to assist students in interpreting the rules and regulations (SU 1.602, 972/883-6391). A student at the university neither loses the rights nor escapes the responsibilities of citizenship. He or she is expected to obey federal, state, and local laws as well as the Regents' Rules, university regulations, and administrative rules. Students are subject to discipline for violating the standards of conduct whether such conduct takes place on or off campus, or whether civil or criminal penalties are also imposed for such conduct.
Academic Integrity	The faculty expects from its students a high level of responsibility and academic honesty. Because the value of an academic degree depends upon the absolute integrity of the work done by the student for that degree, it is imperative that a student demonstrate a high standard of individual honor in his or her scholastic work. Scholastic dishonesty includes, but is not limited to, statements, acts or omissions related to applications for enrollment or the award of a degree, and/or the submission as one's own work or material that is not one's own. As a general rule, scholastic dishonesty involves one of the following acts: cheating, plagiarism, collusion and/or falsifying academic records. Students suspected of academic dishonesty are subject to disciplinary proceedings. Plagiarism, especially from the web, from portions of papers for other classes, and from any other source is unacceptable and will be dealt with under the university's policy on plagiarism (see general catalog for details). This course will use the resources of turnitin.com, which searches the web for possible plagiarism and is over 90% effective.
Email Use	

	The University of Texas at Dallas recognizes the value and efficiency of communication between faculty/staff and students through electronic mail. At the same time, email raises some issues concerning security and the identity of each individual in an email exchange. The university encourages all official student email correspondence be sent only to a student's U.T. Dallas email address and that faculty and staff consider email from students official only if it originates from a UTD student account. This allows the university to maintain a high degree of confidence in the identity of all individual corresponding and the security of the transmitted information. UTD furnishes each student with a free email account that is to be used in all communication with university personnel. The Department of Information Resources at U.T. Dallas provides a method for students to have their U.T. Dallas mail forwarded to other accounts.
Withdrawal from Class	The administration of this institution has set deadlines for withdrawal of any college-level courses. These dates and times are published in that semester's course catalog. Administration procedures must be followed. It is the student's responsibility to handle withdrawal requirements from any class. In other words, I cannot drop or withdraw any student. You must do the proper paperwork to ensure that you will not receive a final grade of "F" in a course if you choose not to attend the class once you are enrolled.
Student Grievance Procedures	Procedures for student grievances are found in Title V, Rules on Student Services and Activities, of the university's *Handbook of Operating Procedures*. In attempting to resolve any student grievance regarding grades, evaluations, or other fulfillments of academic responsibility, it is the obligation of the student first to make a serious effort to resolve the matter with the instructor, supervisor, administrator, or committee with whom the grievance originates (hereafter called "the respondent"). Individual faculty members retain primary responsibility for assigning grades and evaluations. If the matter cannot be resolved at that level, the grievance must be submitted in writing to the respondent with a copy of the respondent's School Dean. If the matter is not resolved by the written response provided by the respondent, the student may submit a written appeal to the School Dean. If the grievance is not resolved by the School Dean's decision, the student may make a written appeal to the Dean of Graduate or Undergraduate Education, and the deal will appoint and convene an Academic Appeals Panel. The decision of the Academic Appeals Panel is final. The results of the academic appeals process will be distributed to all involved parties. Copies of these rules and regulations are available to students in the Office of the Dean of Students, where staff members are available to assist students in interpreting the rules and regulations.
Incomplete Grades	As per university policy, incomplete grades will be granted only for work unavoidably missed at the semester's end and only if 70% of the course work has been completed. An incomplete grade must be resolved within eight (8) weeks from the first day of the subsequent long semester. If the required work to complete the course and to remove the incomplete grade is not submitted by the specified deadline, the incomplete grade is changed automatically to a grade of **F**.
Disability Services	The goal of Disability Services is to provide students with disabilities educational opportunities equal to those of their non-disabled peers. Disability Services is located in room 1.610 in the Student Union. Office hours are Monday and Thursday, 8:30 a.m. to 6:30 p.m.; Tuesday and Wednesday, 8:30 a.m. to 7:30 p.m.; and Friday, 8:30 a.m. to 5:30 p.m. The contact information for the Office of Disability Services is:

	The University of Texas at Dallas, SU 22 PO Box 830688 Richardson, Texas 75083-0688 (972) 883-2098 (voice or TTY) Essentially, the law requires that colleges and universities make those reasonable adjustments necessary to eliminate discrimination on the basis of disability. For example, it may be necessary to remove classroom prohibitions against tape recorders or animals (in the case of dog guides) for students who are blind. Occasionally an assignment requirement may be substituted (for example, a research paper versus an oral presentation for a student who is hearing impaired). Classes enrolled students with mobility impairments may have to be rescheduled in accessible facilities. The college or university may need to provide special services such as registration, note-taking, or mobility assistance. It is the student's responsibility to notify his or her professors of the need for such an accommodation. Disability Services provides students with letters to present to faculty members to verify that the student has a disability and needs accommodations. Individuals requiring special accommodation should contact the professor after class or during office hours.
Religious Holy Days	The University of Texas at Dallas will excuse a student from class or other required activities for the travel to and observance of a religious holy day for a religion whose places of worship are exempt from property tax under Section 11.20, Tax Code, Texas Code Annotated. The student is encouraged to notify the instructor or activity sponsor as soon as possible regarding the absence, preferably in advance of the assignment. The student, so excused, will be allowed to take the exam or complete the assignment within a reasonable time after the absence: a period equal to the length of the absence, up to a maximum of one week. A student who notifies the instructor and completes any missed exam or assignment may not be penalized for the absence. A student who fails to complete the exam or assignment within the prescribed period may receive a failing grade for that exam or assignment. If a student or an instructor disagrees about the nature of the absence [i.e., for the purpose of observing a religious holy day] or if there is similar disagreement about whether the student has been given a reasonable time to complete any missed assignments or examinations, either the student or the instructor may request a ruling from the chief executive officer of the institution, or his or her designee. The chief executive officer or designee must take into account the legislative intent of TEC 51.911(b), and the student and instructor will abide by the decision of the chief executive officer or designee.
Off-Campus Instruction and Course Activities	Off-campus, out-of-state, and foreign instruction and activities are subject to state law and University policies and procedures regarding travel and risk-related activities. Information regarding these rules and regulations may be found at http://www.utdallas.edu/BusinessAffairs/Travel_Risk_Activities.htm. Additional information is available from the office of the school dean.