APM 598 – Topics in Applied Mathematics: Dynamics, Computation and Statistics in Biosciences (Spring 2018)
Lecture Schedules*: Tuesdays and Thursdays 4.30 am–5:45 am in WXLRA TBD*
Office hours: *Tuesdays and Thursdays 1 –2 pm and by appointment*

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Overview: The mathematical modeling of real-life phenomena in the natural, engineering and social sciences often involve having to solve systems of differential equations. These systems are inherently complex. They are typically large and nonlinear, hence their exact solution are difficult (if at all feasible) to obtain. Hence, these systems are studied using a combination of asymptotic analysis (on the associated dynamical systems) and the design of suitable numerical methods to obtain their (approximate) solutions. Furthermore, these systems typically contain numerous parameters, which need to be (realistically) estimated using available data. Issues pertaining to uncertainties in the estimates of such parameters need to be taken into account in the modeling process, in particular determining the impact of such uncertainties on the simulation results obtained. Other related issues, such as determining the parameters that have the most impact on the dynamics of the model system, are also relevant. In other words, the study of realistic models arising from phenomena in the natural, engineering and social sciences generally requires a multi-faceted and multi-disciplinary approach. This course is based on using techniques, tools and theories from applied nonlinear dynamical systems, computational mathematics and statistical sciences (data analytics) to gain qualitative and quantitative insight into dynamical systems arising from the mathematical modeling of real-life phenomena in the aforementioned sciences. Emphasis will be on application in biological sciences (particularly disease ecology, epidemiology and immunology)**.** The course will cover diverse topics, such as:

1. **Continuous-time and discrete-time dynamical systems** (existence and stability of solutions; bifurcations; chaos dynamics etc.).

2. **Numerical solutions of differential equations** (with emphasis on the design of numerical methods (finite-difference methods) that are dynamically-consistent with the continuous-time models being solved).

3. **Mathematical ecology, epidemiology and immunology:** this entails the design, analysis (dynamical and numerical) and simulations of dynamical systems arising from the modeling of phenomena in ecology, epidemiology and immunology. Some of the models that may be discussed include those for: the spread and control of emerging and re-emerging diseases, within-host (immunological) dynamics, coupling within- and between-hosts dynamics, assessing the impact of climate change on the spread of vector-borne diseases and social and molecular epidemiology.

4. **Statistical data analytics**: parameter estimation, uncertainty and sensitivity analysis, fitting models to data, optimal control analysis etc.

The course is open to senior undergraduate and graduate mathematics students. Biology students with appropriate background in mathematics can also enrol.

References:

1. Mostly based on research papers
2. Introduction to Applied Nonlinear Dynamical Systems and Chao by Wiggins, Second Edition, 2003.
3. Differential Equations and Dynamical Systems by L. Perko, 2000.
4. Nonlinear Dynamics and Chaos by Steven H. Strogatz, 1994.
5. Dynamical Systems and Numerical Analysis by Stuart and Humphries, 1998.
6. Mathematics of Continuous and Discrete Dynamical Systems. AMS Contemporary Mathematics, 2014. A. Gumel, Editor.
7. Nonstandard Finite-difference Models of Differential Equations by Ronald E. Mickens, 1994.

Tentative Assessment Formula: Class participation (30%) and projects (70%)

Attendance is required. Missing more than six times will result in a grade of EN, failure due to nonattendance. Students absent for university sponsored events must make arrangements for making up the work they will miss. Makeup tests are allowed only with a written note from a Doctor/Nurse or employer, etc. You are encouraged to discuss homework problems with each other. However, the actual writeup should be in your own words and based on your own understanding of the problems. No credit will be given for exactly similar writeups.

Absences

The conditions under which assigned work or tests can be made up, including:

1. The instructor's general policy on absences.
2. Information on excused absences related to religious observances/practices that are in accordance with ACD 304–04 "Accommodations for Religious Practices."
3. Information on excused absences related to university sanctioned events activities that are in accord with ACD 304–02 "Missed Classes Due to University-Sanctioned Activities."

Disability Accommodations: Students who feel they will need disability accommodations in this class but have not registered with the Disability Resource Center (DRC) should contact DRC immediately. The DRC Tempe office is located on the first floor of the Matthews Center Building. DRC staff can also be reached at: (480) 965-1234 (V) or (480) 965-9000 (TTY). For additional information, visit: www.asu.edu/studentaffairs/ed/drc. All efforts will be made to ensure you have equal opportunity to succeed in the course.

The Grade of XE: A grade of XE is reserved for "failure due to academic dishonesty." The

grade goes on the student's transcript and usually remains there permanently. Examples of academic dishonesty are signing an attendance sheet for another student or asking another student to sign an attendance sheet on your behalf, accessing unauthorized help while taking an exam, and attempting to influence a grade for reasons unrelated to academic achievement. Asking for a higher grade than the one you have earned because you need a higher grade to maintain a scholarship, or to satisfy your own or someone else's expectations constitutes academic dishonesty.

ASU Academic Honesty Policy: *Academic honesty is expected of all students in all examinations, papers, laboratory work, academic transactions and records. The possible sanctions include, but are not limited to, appropriate grade penalties, course failure (indicated on the transcript as a grade of E), course failure due to academic dishonesty (indicated on the transcript as a grade of XE), loss of registration privileges, disqualification and dismissal. For more information, see* **http://provost.asu.edu/academicintegrity**

Expected Classroom Behavior: *Be sure to arrive on time for class. Excessive tardiness will be subject to sanctions. Under no circumstances should you allow your cell phone to ring during class. Any disruptive behavior, which includes ringing cell phones, listening to your mp3/iPod player, text messaging, constant talking, eating food noisily, reading a newspaper will not be tolerated. The use of laptops (unless for note taking), cell phones, MP3, IPOD, etc. are strictly prohibited during class.*

Policy Against Threatening Behavior: *All incidents and allegations of violent or threatening conduct by an ASU student (whether on-or off campus) must be reported to the ASU Police Department (ASU PD) and the Office of the Dean of Students. If either office determines that the behavior poses or has posed a serious threat to personal safety or to the welfare of the campus, the student will not be permitted to return to campus or reside in any ASU residence hall until an appropriate threat assessment has been completed and, if necessary, conditions for return are imposed. ASU PD, the Office of the Dean of Students, and other appropriate offices will coordinate the assessment in light of the relevant circumstances.*

Note: *This syllabus is tentative and should not be considered definitive. The instructor reserves the right to modify it (including the dates of the tests) to meet the needs of the class. It is the student responsibility to attend class regularly and to make note of any change. The Instructor also reserves the right to create class policies in regards to homework due date, late assignments, etc.*