Engsci 711

Qualitative analysis of differential equations

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Some references specifically from the 'dynamical systems' perspective

Nonlinear dynamics and chaos : with applications to physics, biology, chemistry, and engineering by Steven H. Strogatz.

- Great book, easy to read, lots of examples. A little on the wordy side. A math prof. once complained 'it's great but it doesn't mention the centre manifold theorem'. I didn't care at the time, though I have more sympathy for this complaint now. Often recommended as a supplement in more 'advanced' courses to give the 'big picture', also used in many introductory courses. We will mainly work at this sort of level, but introduce some material and definitions from the other books below.
- Two copies of the 1994 edition (the one I have!) are available in the main library. The 2005 Edition is available as online ebook through the library (you should be able to find it - if not, ask me).

Simulating, analyzing, and animating dynamical systems : a guide to XPPAUT for researchers and students by Bard Ermentrout.

- Bard wrote XPPAut, an interface to the AUTO and XPP dynamical systems software. Also known for his contributions to mathematical biology. Easy to read, great way to get some hands-on experience doing examples. If you wanted to use XPPAut for a real problem then this is a great place to start. My PhD supervisor used it to make many figures in his book 'Mathematical Physiology' and they don't look terrible.
- Available from general library and to read online through the library access to SIAM.

Stability, instability, and chaos : an introduction to the theory of nonlinear differential equations by Paul Glendinning

- Nice coverage, all the key theorems. For the more mathematically-inclined but still quite 'applied'. In the 'Cambridge Texts in Applied Mathematics' series. I used this when I took Maths 761 at Auckland, it really grew on me.

- Multiple copies available from main library, engineering library and short loan (since used for Maths 761 course?).

Introduction to applied nonlinear dynamical systems and chaos by Stephen Wiggins.

- Multiple copies/editions in both general and engineering library. Also available for free download through library access to Springer book. Another solid book, similar level to Glendinning. Probably more comprehensive.

Nonlinear systems by P. G. Drazin.

- Good broad coverage of both difference and differential equations. Has particularly good material on bifurcation theory. For the more mathematically-inclined. A bit less systematic than Glendinning but lots of good extra stuff in there. Also in the 'Cambridge Texts in Applied Mathematics' series. I used this when I TA'd a third-year applied mathematics course in the Oxford mathematics department.
- A copy in the main library and a copy in the engineering library.

Differential equations and dynamical systems by Lawrence Perko

- Good material on centre manifold theory, including simple examples!
- Available online through the main library (can download through Springer) and multiple hard copies in the general library.

Model Emergent Dynamics in Complex Systems by A. J. Roberts

- An attempt to present undergraduate mathematical modelling from the point of view of centre manifold theory and nonlinear coordinate transformations
- The theory is viewed as a way to derive emergent, simple models from more complex models (rather than just as a tool for analysing given models)
- Lots of interesting material and examples. Quite idiosyncratic presentation.
- Available online through the main library.

Nonlinear systems by Khalil

- Two copies, one in engineering one in general library. Focused on engineering applications but is a graduate-level text. Accessible material on centre manifold theory.

Nonlinear oscillations, dynamical systems, and bifurcations of vector fields by John Guckenheimer and Philip Holmes.

- Multiple copies available in general library and short loan (probably for Maths 761?). The classic, still really good, written by 'legends' of the

field. A little more advanced that the others. John Guckenheimer often visits/works with people in the Auckland math department, who are really strong on this stuff. If you like this area and wanna continue (e.g. do a Masters/PhD) then I can point you to them.

Elements of applied bifurcation theory by Y. A. Kuznetsov.

- Multiple copies in both engineering and main library. Similar level to Guckenheimer and Holmes but a surprisingly easy read for a fairly advanced book. Good material on 'practical' bifurcation analysis e.g. numerical methods. Yuri wrote (with others) 'MatCont' which is Matlab-based software for bifurcation analysis.

Other references

Almost all books on 'Advanced Engineering Mathematics' or (often 'Introduction to') 'Applied Mathematics' will have good condensed material on qualitative analysis (esp. phase plane analysis) of differential equations. They often also have some brief material on bifurcation theory.

- In the 'Advanced Engineering Mathematics' category I quite like Greenberg
- In the 'Applied Mathematics' category I quite like Logan.

Both are available in the engineering library.

These sorts of references might often be easier to quickly learn the basics from than the more comprehensive books exclusively focused on dynamical systems.