SENIOR RESEARCH PROJECTS

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Experience has shown that the most successful senior theses are ones that are tightly focused. For a term of 13 or 14 weeks it is probably a good idea to have a project carefully defined by the end of the first week.

Below one finds a list of articles from recent math publications. They are both readable and accessible in terms of the background of an RPI senior math major. From each of them one can extract an uninvestigated related question; these questions can form the basis of projects for a senior thesis. The publications are available online from our library.

At the end of the list are two research questions, both of which I have spent a good bit of time thinking about but not written about. Both of them are suitable for senior theses, however they are not as straightforward as those represented by the listed papers.

AMERICAN MATHEMATICAL MONTHLY
Vol. 115, #1, January, 2008

A Novel Way to Generate Fractals, by M. Previte and S. Yang, p.13

Ultrafilters, by P. Komjáth and V. Totik, p.33

A Note on Tarski's Note, by S Ucsnay, p.66

AMERICAN MATHEMATICAL MONTHLY
Vol. 115, #2, February, 2008

A Peculiar Connection Between the Axiom of Choice and Predicting the Future, by C.S. Hardin and A.D. Taylor, p.91

Fair Majority Voting (or How to Eliminate Gerrymandering), by M. Balinski, p.97

Bounds on the Zeros of the Derivative of a Polynomial with All Real Zeros, by A. Melman, p.145

Qualitative Analysis of a Differential Equation of Abel, by U. Elias, p.147

Closed Curves on Spheres, by W. Holsztynski, J. Mycielski, and G.C. O'Brien, p.149

On Ordering the Natural Numbers or The Sharkovski Theorem, by K. Ciesielski and Z. Pogoda, p.159

AMERICAN MATHEMATICAL MONTHLY
Vol. 115, #5, May, 2008

Sodoku, Gerechte Designs, Resolutions, Affine Space, Spreads, Reguli, and Hamming Codes, by R.A. Bailey, P.J. Cameron and R. Connelly, p.383

When Is a Periodic Function the Curvature of a Closed Plane Curve?, by J. Arroyo, O. J. Garay and J. J. Mencía p. 405

Rearing Its Ugly Head: The Cosmological Constant and Newton's Greatest Blunder, by H.D. Nguyen, p.415

Extreme Palindromes, by K. Q. Ji and J. S. Wilf, p.447

Thin Sets with Fat Shadows: Projections of Cantor Sets, by F. Mendivil and T. D. Taylor, p.451

Derivatives of Eulerian Numbers, Bu G. Rzadkowski, p. 458

AMERICAN MATHEMATICAL MONTHLY
Vol. 115, #6, June-July, 2008

Periodic Orbits for Billiards on an Equilateral Triangle, by A. M. Baxter and R. Umble, p.479

The Freshman's Approach to Conway's Napkin Problem, by N. Eriksen, p.492

Edge Detection Using Fourier Coefficients, by S. Engelberg and S. A. Ali, p.514

Summing a Curious, Slowly Convergent Series, by T. Schmelzer and R. Baillie, p.525

Cycles in Graphs and Groups, by W. M. Kantor, p.559

A substantial number of other papers have been identified; each suitable for a starting point of a senior thesis. They are not listed here, but available on request.

TWO ADDITIONAL PROBLEMS

Discrete Brachistochrone Problem. The solution to the classical brachistrochrone problem is well known. The curve is an arc of a cycloid. If instead of searching the differentiable real-valued functions for the curve of minimum time, one searches the piecewise linear functions, one encounters a yet unsolved problem. There are a handful of papers addressing the problem, but good understanding seems to be elusive There are some first-principle questions involved; each of which would serve as a good topic for a senior thesis. It is anticipated that a good bit of (Matlab) computing will be needed for initial experiments.

Straight Lines in an Octagonal Tiling of the Plane. One selects two hexagons in a hexagonal tiling of the plane and looks for a way to identify other hexagons (between them) so that the resulting set is, in some sense, a discrete chord. The corresponding problem for a square tiling has been successfully addressed. There seems to be no similar literature for the hexagonal tilings. (Recall that triangles, squares and hexagons are the only possible regular tilings of the plane.) Learning to geometrically model biological growth serves as motivation for this problem. This topic will serve well for a senior thesis, but may be more time demanding than some of the others. It is anticipated that a good bit of (Matlab) computing will be needed for initial experiments.