Prefix, Number and Name of Course: ACM 632 Numerical Calculus

Credit Hours: 1
In Class Instructional Hours: 1 **Labs: 0** **Field Work:** 0

Catalog Description:
Prerequisite: MAT 162 *and* MAT 241
Numerical methods and algorithms for finding roots of non-linear equations, numerical integrals, Fourier series and Laplace transform.

Reasons for Addition or Revision:
To create a one-semester-hour core module for the graduate Professional Applied and Computational Mathematics program where students will study numerical methods and algorithms for finding roots of non-linear equations, evaluating integrals and performing fast Fourier and Laplace transforms that are commonly used to solve problems arising from applied mathematics, physics, optics, electrical engineering, control engineering, signal processing, and many other areas.

Student Learning Outcomes: Students will:	**Content References:**	**Assessment:**
1. solve non-linear equations.	I, V	Group work in class, individual homework assignments, exams, and computer projects.
2. perform integral evaluations using various methods.	II, V	Group work in class, individual homework assignments, exams, and computer projects.
3. construct Fourier and Laplace transforms using various numerical algorithms	III, IV, V	Group work in class, individual homework assignments, exams, and computer projects.
4. utilize computer software for diverse practical settings.	I-V	Group computer projects

Course Content:

I. Solve non-linear equations
   A. Specific algorithms
   B. Finding roots of polynomials
   C. Finding multiple roots
   D. Systems of non-linear equations

II. Numerical integrals
- A. Newton-Cotes formulas
- B. Gaussian quadratures
- C. Monte Carlo
- D. Sparse grids

III. Fourier series and Laplace transform
- A. Fourier series
- B. Fourier transform
- C. Laplace transform
- D. Inverse Laplace transform

IV. Selected applications
- A. Continuous-repayment mortgage
- B. Deriving the complex impedance for a capacitor
- C. NMR and MR imaging experiments
- D. Phase problem in X-ray crystallography
- E. Analog signal processing

V. Use of numerical analysis software

Resources:

Scholarships in the Field:

Bochner S. and Chandrasekharan K., *Fourier Transforms*. Princeton University Press, 1949. James, J. F., *A Student's Guide to Fourier Transforms* (2nd ed.), New York: Cambridge University Press, 2002

Campbell, G. and Foster, R., *Fourier Integrals for Practical Applications,* New York: D. Van Nostrand Company, Inc. 1948.

Curtis, F. G. and Wheatley, P. O., *Applied Numerical Analysis,* Addison-Wesley, 2008.

Davies, B., *Integral transforms and their applications* (Third ed.), New York: Springer, 2002.

Dym, H. and McKean, H., *Fourier Series and Integrals*, Academic Press, 1985.

Erdélyi, A., *Tables of Integral Transforms*, **1**, New Your: McGraw-Hill, 1954.

Gilat, A., *MATLAB: An Introduction with* Applications (2nd ed.). John Wiley & Sons, 2004.

Grafakos, L., *Classical and Modern Fourier Analysis*, Prentice-Hall, 2004.

Griffiths, D. V. and Smith, I. M., *Numerical Methods for Engineers*, CRC Press, 2006.

Kammler, D., *A First Course in Fourier Analysis*, Prentice Hall, 2000.

Korn, G. A., Korn, T. M., *Mathematical Handbook for Scientists and Engineers* (2nd ed.), McGraw-Hill Companies, 1967.

Leader, J. J., *Numerical Analysis and Scientific Computation*, Addison Wesley, 2004.

Pinsky, M., *Introduction to Fourier Analysis and Wavelets*, Brooks/Cole, 2004.

Polyanin, A. D., Manzhirov, A. V., *Handbook of Integral Equations*, Boca Raton: CRC Press, 1948.

Siebert, W. M., *Circuits, Signals, and Systems*, Cambridge, Massachusetts: MIT Press, 1986.

Stein, E. and Shakarchi, R., *Fourier Analysis: An introduction*, Princeton University Press, 2003.

Widder, D. V., *The Laplace Transform*, Princeton Mathematical Series, v.6, Princeton University Press, 1941.

Periodicals:

Advance in Numerical Analysis - An Open Access Journal
Electronic Journal of Boundary Elements
Electronic Transactions on Numerical Analysis
ESAIM: Mathematics Modeling and Numerical Analysis
IMA Journal of Numerical Analysis
International Journal of Numerical Analysis and Modeling
International Journal for Numerical Methods in Engineering
Journal of Numerical Analysis, Industrial and Applied Mathematics
Journal of Online Mathematics and its Applications
SIAM Journal on Numerical Analysis

Electronic and/or Audiovisual Resources:

Introduction to Numerical Analysis for Engineering (http://ocw.mit.edu/OcwWeb/Mechanical-Engineering/2-993JSpring-2005/CourseHome/).

Numericalmathematics.com (http://www.numericalmathematics.com).

Numerical analysis DMOZ category (http://www.dmoz.org/Science/Math/Numerical_Analysis/).

Numerical Analysis Project (http://math.fullerton.edu/mathews/numerical.html).

Numerical Computing Resources on the Internet (http://www.indiana.edu/~statmath/bysubject/numerics.html).

Numerical Methods Resources (http://www.onesmartclick.com/engineering/numerical-methods.html).

Numerical-methods.com (http://www.numerical-methods.com/).

Numerical Methods - Online Course (http://www.math.jct.ac.il/~naiman/nm/).

Numerical Recipes: The Art of Scientific Computing (third edition) (www.nr.com).

Electronic and/or Audiovisual Resources:

Electronic Journal of Statistics

Link to electronic journals web site (http://www.e-journals.org/)