Tennessee Technological University
Mathematics Department

MATH 6460/CSC 6460: Computational Methods for Graphics and Modeling

I. COURSE DESCRIPTION FROM CATALOG: Mathematical methods for graphics and modeling. Topics such as: 3-D transformations, ray tracing, rendering, image processing, and compression. Lec. 3. Cr. 3.

II. PREREQUISITE(S): Consent of Instructor (previous coursework involving proofs and some programming experience are needed)

III. COURSE OBJECTIVE(S): To provide a mathematical introduction into various areas of computer graphics and modeling, such as 3-D transformations and 3-D object descriptions, computational solid geometry, and modern rendering techniques, such as ray tracing and radiosity.

IV. TOPICS TO BE COVERED:

Chapter 1 Subdivision: Functions as Fractals
- 1.1 Functions
  - 1.1.1 Piecewise Polynomials
  - 1.1.2 Bezier Curves
- 1.2 Fractals
  - 1.2.1 Iterated Affine Transformations
  - 1.2.2 The Sierpinski Triangle
  - 1.2.3 The Koch Snowflake
  - 1.2.4 Bezier Curves
- 1.3 Subdivision
  - 1.3.1 Piecewise Linear Splines
  - 1.3.2 Subdivision for Piecewise Linear Splines

Chapter 2 A Integral Approach to Uniform Subdivision
- 2.1 A Subdivision Scheme for B-Splines
  - 2.1.1 B-Spline Basis Functions via Repeated Integration
  - 2.1.2 A Refinement Relation for B-Spline Basis Functions
  - 2.1.3 The Associated Subdivision Scheme
- 2.2 A Subdivision Scheme for Box Splines
  - 2.2.1 B-Spline Basis Functions as Cross-sectional Volumes
  - 2.2.2 Box-spline Scaling Functions as Cross-sectional Volumes
  - 2.2.3 Subdivision for Box Splines
  - 2.2.4 Examples
- 2.3 B-splines and Box Splines as Piecewise Polynomials
  - 2.3.1 B-splines as combinations of Truncated Powers
  - 2.3.2 Box Splines as Combinations of Cone Splines
  - 2.3.3 Bivariate Examples

Chapter 4 A Differential Approach to Uniform Subdivision
- 4.1 Subdivision for B-splines
  - 4.1.1 A Differential Equation for B-splines
  - 4.1.2 A Finite Difference Equation for B-splines
  - 4.1.3 The Associated Subdivision Scheme
- 4.2 Subdivision for Box Splines

4.2.1 A Differential Equation for Box Splines
4.2.2 The Subdivision Scheme for Box Splines
4.3 Subdivision for Exponential B-splines
4.3.1 Discretization of the Differential Equation
4.3.2 A Subdivision Scheme for Exponential Splines
4.3.3 Exponential B-splines as Piecewise Analytic Functions
4.4 A Smooth Subdivision Scheme with Circular Precision
4.4.1 Splines in Tension
4.4.2 Mixed Trigonometric Splines
4.4.3 The Unified Subdivision Scheme
4.4.4 Convergence Analysis for Nonstationary Schemes

Chapter 7 Averaging Schemes for Polyhedral Meshes
7.1 Linear Subdivision for Polyhedral Meshes
7.1.1 Polyhedral Meshes
7.1.2 Topological Subdivision of Polyhedral Meshes
7.2 Smooth Subdivision for Quad Meshes
7.2.1 Bilinear Subdivision Plus Quad Averaging
7.2.2 Comparison to Other Quad Schemes
7.2.3 Weighted Averaging for Surfaces of Revolution
7.2.4 Averaging for Quad Meshes with Embedded Creases
7.3 Smooth Subdivision for Triangle Meshes
7.3.1 Linear Subdivision Plus Triangle Averaging
7.3.2 Comparison to Other Triangle Shemes
7.4 Other Types of Polyhedral Schemes
7.4.1 Face-splitting Schemes
7.4.2 Dual Subdivision Schemes

V. ADDITIONAL INFORMATION:

This course may be cross-listed as CSC 6460. Please ask departmental secretary to enter it as a cross-listed course in TTUMIS.

VI. POSSIBLE TEXTS AND REFERENCES:

Subdivision Methods for Geometric Design, 1st edition, by Warren and Weimer

VII. ANY TECHNOLOGY THAT MAY BE USED: