September 11, 2015

METROPOLITAN STATE UNIVERSITY OF DENVER
Office of Academic and Student Affairs

REGULAR COURSE SYLLABUS

College of: Letters, Arts, and Sciences

Department: Mathematical and Computer Sciences

Prefix & Course Number: CS 3510 **Crosslisted With*:** _____

Course Title: Computer Graphics

Transcript Course Title (30 characters): Computer Graphics

Check All That Apply: Required for Major:_____ Required for Minor:_____ Specified Elective: _____

Required for Concentration: _____ Elective: X Service Course: _____

To receive Title IV financial aid funds, all institutions of higher education must comply with the federal definition of a credit hour. The Higher Learning Commission requires institutions to maintain policies and procedures for verifying compliance with this definition.

> ***Federal Credit Hour Definition:*** *A credit hour is an amount of work represented in intended learning outcomes and verified by evidence of student achievement that is an institutionally-established equivalency that reasonably approximates not less than:*
> *(1) one hour of classroom or direct faculty instruction and a minimum of two hours of out-of-class student work each week for approximately fifteen weeks for one semester or trimester hour of credit, or ten to twelve weeks for one quarter hour of credit, or the equivalent amount of work over a different amount of time; or (2) at least an equivalent amount of work as required in paragraph (1) of this definition for other activities as established by an institution, including laboratory work, internships, practica, studio work, and other academic work leading toward to the award of credit hours. 34CFR 600.2 (11/1/2010)*

Credit Hours: 4 (4+0) **Schedule Type:** L **Grade Mode:** L

Face-to-Face or Equivalent Hours per course:

Lecture 60 Lab _____ Internship _____ Practicum _____ Other: _____

Additional Student Work Hours per course: 120

Variable topics umbrella course: No X **Yes** _____ If Yes, number of credit hours allowed _____

Specified repeatable course: No X **Yes** _____

Prerequisite(s): CS 2050, MTH 1410, and MTH 2140 with grades of "C" or better, or permission of instructor.

APPROVED:

Clark Dollard — 10/1/2015
Department Curriculum Committee — Date

LBPacker — 10.1.2015
Department Chair **OR** Program Director — Date

Linda Lang-Peralta — 12-11-15
Dean **OR** Associate Dean — Date

Bernice Harris — 1-8-16
Associate VP, Academic Affairs — Date

*If crosslisted, attach completed Course Crosslisting Agreement Form

Prefix and Course Number: CS 3510 September 11, 2015

Corequisite(s): _____

Prerequisite(s) or Corequisite(s):

Banner Enforced Coding:
Prerequisite(s): CS 2050, MTH 1410, and MTH 2140 with grades of "C" or better
Corequisite(s): _____
Prerequisite(s) or Corequisite(s): _____

Registration restrictions: Level UG **Class** _____ **Program/Major** _____ **Student attribute** _____

Catalog Course Description:
This course is an introduction to computer graphics. It covers the mathematical background, algorithmic concepts, and software tools required to model a 3D scene with polygon meshes and interpolating surfaces, with lighting and materials and texture mapping, and then to render that scene at interactive speeds, using an appropriate graphics library, such as OpenGL, with shader programming.

Specific Variable Topics Course Description (if applicable, umbrella course description included above):

Required Reading and Other Materials will be equivalent to:
Steven J. Gortler, (2012). Foundations of 3D Computer Graphics. ISBN 978-0-262-01735-0: MIT Press

Specific, *Measurable* Student Behavioral Learning Objectives:
Upon completion of this course the student should be able to:

1. perform computations involving dot products, cross products, quaternions, matrices, and vectors
2. prove facts about dot products, cross products, and quaternions using basic algebra
3. create matrices to produce specified transformations
4. demonstrate how vertices of a triangle go through all the steps of the graphics pipeline to produce pixel colors
5. compute the color of a vertex, given specifications of the material properties of that vertex and light properties in a scene
6. write vertex and fragment shader programs to achieve desired effects
7. create an application program that models a scene using polygonal meshes and interpolating surfaces
8. create interpolating curves and surfaces given control points

Detailed Outline of Course Content (Major Topics and Subtopics):

I. Fundamental Graphics Concepts
   A. human visual system
   B. color models, especially RGB
   C. light models
   D. hardware for image production
   E. interactive vs. off-line rendering

II. Mathematical Background
   A. coordinate systems
   B. homogeneous coordinates
   C. dot product definition and properties
   D. cross product definition and properties
   E. quaternion definition and properties

F. linear and affine transformations
   1. rotation, scaling, translation
   2. perspective and orthogonal projection
   3. view transformations including "look at"

III. Algorithms
   A. rendering pipeline
   B. clipping
   C. rasterization (linear and perspective corrected)
   D. depth buffering
   E. viewport mapping
   F. ray tracing

IV. Modeling
   A. solid modeling
      1. constructive solid geometry
      2. boundary representation/Euler rule
   B. surface and curve modeling
      1. polygon meshes
      2. Bezier curves and surfaces
      3. subdivision surfaces
      4. non-uniform rational B-splines

V. Software Tools
   A. OpenGL vs. DirectX
   B. GLSL programming
   C. fixed-functionality pipeline
   D. vertex shaders
   E. fragment shaders
   F. implementing the classical lighting and materials model
   G. texture mapping
   H. shader programming examples
      1. lighting models
      2. shadow mapping
      3. fog
      4. blending and transparency
      5. ray tracing

Evaluation of Student Performance

Any combination of the following:

1. Homework and Programming Assignments
2. Quizzes and Examinations
3. Oral Presentations
4. Final Examination