

# Computer Graphics (CS 543)

## Exam 1 Review

Prof Emmanuel Agu

*Computer Science Dept.  
Worcester Polytechnic Institute (WPI)*



# Exam 1 Overview



- Wednesday, September 26, in-class
- Will cover up to lecture 4 (Transforms)
- Can bring:
  - One page cheat-sheet, hand-written (not typed)
  - Calculator
- Will test:
  - Theoretical concepts
  - Mathematics
  - Algorithms
  - Programming
  - OpenGL/GLSL knowledge (program structure and some commands)



# What am I Really Testing?

- Understanding of
  - concepts (NOT only programming)
  - programming (pseudocode/syntax)
- Test that:
  - you can plug in numbers by hand to check your programs
  - you did the projects
  - you understand what you did in projects



# General Advise

- **Read your projects** and refresh memory of what you did
- **Read the slides:** worst case – if you understand slides, you're more than 50% prepared
- Try to **predict subtle changes** to algorithm.. What ifs?..
- **Past exams:** One sample midterm is on website
- All lectures have references. Look at refs to focus reading
- Do all readings I asked you to do on your own



# Grading Policy

- I try to give as much partial credit as possible
- In time constraints, laying out outline of solution gets you healthy chunk of points
- Try to write something for each question
- Many questions will be easy, exponentially harder to score higher in exam

# Introduction



- Motivation for CG
- Uses of CG (simulation, image processing, movies, viz, etc)
- Elements of CG (polylines, raster images, filled regions, etc)
- Device dependent graphics libraries (OpenGL, DirectX, etc)

# OpenGL/GLUT



- High-level:
  - What is OpenGL?
  - What is GLUT?
  - What is GLSL
  - Functionality, how do they work together?
- Sequential Vs. Event-driven programming
- OpenGL/GLUT program structure (create window, init, callback registration, etc)
- GLUT callback functions (registration and response to events)



# OpenGL Drawing

- Vertex Buffer Objects
- `glDrawArrays`
- OpenGL :
  - Drawing primitives: `GL_POINTS`, `GL_LINES`, etc (should be conversant with the behaviors of major primitives)
  - Data types
  - Interaction: keyboard, mouse (`GLUT_LEFT_BUTTON`, etc)
  - OpenGL state
- GLSL Command format/syntax
- Vertex and fragments shaders
- Shader setup, How GLSL works



# 2D Graphics: Coordinate Systems



- Screen coordinate system/Viewport
- World coordinate system/World window
- Setting Viewport
- Tiling, aspect ratio



# Fractals

- What are fractals?
  - Self similarity
  - Applications (clouds, grass, terrain etc)
- Mandelbrot set
  - Complex numbers:  $s$ ,  $c$ , orbits, complex number math
  - Dwell function
  - Assigning colors
  - Mapping mandelbrot to screen
- Koch curves, gingerbread man, hilbert transforms



# Points, Scalars Vectors

- Vector Operations:
  - Addition, subtraction, scaling
  - Magnitude
  - Normalization
  - Dot product
  - Cross product
  - Finding angle between two vectors
- Finding normal of plane using cross product, Newell method



# Building 3D Models

- Drawing Polygonal meshes
- Edge list
- Vertex List

# Transforms



- Homogeneous coordinates Vs. Ordinary coordinates
- 2D/3D affine transforms: rotation, scaling, translation, shearing
- Should be able to take problem description and build transforms and apply to vertices
- Matrix inverses
- 2D: rotation (scaling, etc) about arbitrary center:
  - $T(P_x, P_y) R(\theta) T(-P_x, -P_y) * P$
- Composing transforms
- 3D rotation:
  - x-roll, y-roll, z-roll, about arbitrary vector (Euler theorem) if given azimuth, latitude of vector or (x, y, z) of normalized vector
- Matrix multiplication!!