TEXT: MATHEMATICS FOR 3D GAME PROGRAMING \& COMPUTER GRAPHICS, by Eric Lengyel, Charles River Media. ISBN: 1584500379

## ESSENTIAL MATHEMATICS FOR COMPUTER GRAPHICS FAST, John Vince, Springer Verlag

Publisher ISBN: 1-85233-380-4

COURSE DESCRIPTION: Students will learn mathematical models that underlie the design and construction of game engines and the various interactions specific to animated computer games and the techniques of calculation needed to apply them. Topics include coordinate transforms, interpolation, illumination, visibility, collisions and elementary physics. Exercises in this course require the student to be able to implement classes in the $\mathrm{C}++$ programming language.

OBJECTIVES: Upon completion of this course the student will be able to:

1. To calculate transforms using rotation matrices and quaternions.
2. To implement calculations associated with the view frustum, to use interpolation for perspective and to project 3-deminsional scenes to 2-dimensional displays.
3. To apply ray tracing to generate light-maps, determine visibility and test for line of sight.
4. To implement various features of illuminations by using mathematical models.
5. To determine visibility by bounding volumes and by partitioning binary space.
6. To detect and resolve environmental and interobject collisions.
7. To apply polygonal modeling.
8. Utilities mathematical models from basic mechanics (elementary physics).

## COURSE OUTLINE:

## Topic(s) \& Class Activities

Week \#1 Analytic Geometry \& Linear Algebra
Review of vectors \& matrices
Week \#2 Linear Algebra \& Coordinate Transformations
Using matrices for coordinate transformations
Week \#3 Quaternions \& 3D Engines
Using quaternions for coordinate transformations Lines \& planes in 3-space, the view frustum, perspective-correct interpolation \& projection matrices

Week \#4 Interpolation \& Ray Tracing
Using linear \& non-linear techniques of interpolation; Finding roots; calculating normal, reflection \& transmission vectors.

Required Reading

Lengyel,: Ch. 1-2.3

Lengyel: Ch. 2.4-3.5

Lengyel: Ch 5

## Topic(s) \& Class Activities

| Week \#5 | Mid-term (Ch. 1-5) \& Illumination <br> Color, light sources \& diffuse lighting | Lengyel: Ch. 6-6.3 |
| :--- | :--- | :--- |
| Week \#6 | Illumination <br> Specularity, texture mapping, emission, shading, <br> bump mapping, reflection \& Cook-Torrance <br> illumination | Lengyel: Ch. 6.4-6.6 |
| Week \#7 | Determining Visibility <br> Constructing \& testing bounding volumes; <br> Spatial partitioning by trees; zones \& portals | Lengyel: Ch. 7 |
| Week \#8 | Collisions, Curves \& Patches <br> Detecting collisions between objects \& environment <br> \& between objects; B_zier curves, B-splines, <br> continuity \& surface patches | Lengyel: Ch 8 |
| Week \#9 | Polygonal Techniques <br> Depth-value offset, decals, bill boarding, stencils, <br> shadowing \& polygon reduction | Lengyel: Ch. 9 |
| Week \#10 | Test (Ch. 6-9) \& Linear Physics <br> Position functions, projectile motion, resistance, <br> terminal velocity \& friction | Lengyel: Ch 10.1, 10.3-10.5 |
| Week \#11 | Rotational Physics <br> Angular velocity, centrifugal \& Coriolis forces; <br>  <br> oscillatory motion | Lengyel: Ch. 11 |

INSTRUCTIONAL METHODS: Class sessions will consist of instructor lectures, demonstrations, hands-on exercises, and drawing projects. Students will be assigned reading from required texts and instructor provided hand-outs.

## EVALUATION METHODS:

All required assignments must be completed to obtain a passing grade in the course. All assignments are due on the date specified. Students must also have a satisfactory attendance record \& grades may be modified for classroom participation.

## MASTER SYLLABI

Students' grades will be based on the distribution of weights indicated below. The final grade for the course is based on the following percentages:

| Source | Weight | Score | Grade |
| :--- | :--- | :--- | :---: |
| Exercises: | $20.0 \%$ | $100-90 \%$ | A |
| Test 1 | 20.0 | $89-80 \%$ | B |
| Test 2 | 20.0 | $79-70 \%$ | C |
| Course Examination | $\underline{40.0}$ | $69-60 \%$ | D |
|  |  |  |  |
| Total | $\underline{100.0 \%}$ | $59 \%$ and lower | N/C |

