Name:

Student ID:

CS 130 Final

You may not ask any questions during the test. If you believe that there is something wrong with a question, write down what you think the question is trying to ask and answer that.

1 Multiple Choice (1pt each)

For each multiple choice choose, the one correct answer.

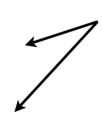
______1. Paint (real world paint, not MS Paint) uses $\boxed{\text{A)}}$ additive color B) subtractive color C) CMYK D) any of the above E) none of the above

______2. The z-buffer approach to rendering $\boxed{\text{A)}}$ selects which fragment to draw based on its depth B) orders triangles from back to front C) orders triangles based on the average z-values of their vertices D) selects which vertices to clip based on their z-values E) B and C only

______3. How many degrees of freedom does a rigid body in <u>two</u> dimensions have? A) 2 $\boxed{\text{B)}}$ 3 C) 4 D) 5 E) 6

______4. How many degrees of freedom does a rigid body in <u>three</u> dimensions have? A) 3 B) 4 $\boxed{\text{C)}}$ 6 D) 8 E) 9

______5. What is true the two vectors depicted below? $\boxed{\text{A)}}$ their dot product is positive B) their dot product is negative C) their dot product is zero D) none of the above



______6. What is the correct order of operations of the OpenGL graphics pipeline? $\boxed{\text{A)}}$ modelview transformation, projection transformation, divide by w, viewport transform B) projection transformation, modelview transformation, divide by w, viewport transform C) modelview transformation, divide by w, projection transformation, viewport transform D) modelview transformation, viewport transform, divide by w, projection transformation

______7. When doing physical simulation, the advantage of having a small timestep(h) is that it: A) reduces computation time $\boxed{\text{B)}}$ reduces the effects of errors due to numerical integration in time C) prevents rigid bodies from non-physically deforming D) there is no advantage; any nonzero timestep will do.

______8. When doing physical simulation, the advantage of having a large timestep(h) is that it: $\boxed{\text{A)}}$ reduces computation time B) reduces the effects of errors due to numerical integration in time C) prevents rigid bodies from non-physically deforming D) there is no advantage; any nonzero timestep will do

______9. The midpoint (or Bresenham) algorithm for rasterizing lines is optimized relative to the DDA algorithm in that it A) avoids a round operatrion B) is incremental C) uses only integer arithmetic $\boxed{\text{D)}}$ all of the above E) A and B only

______10. Perspective transformations A) keep parallel lines parallel B) are affine transformations C) all of the above $\boxed{\text{D)}}$ none of the above

______11. Orthographic transformations A) keep parallel lines parallel B) are affine transformations $\boxed{\text{C)}}$ all of the above D) none of the above

______12. If a curve is C^0 continuous, then $\boxed{\text{A)}}$ it can have sharp corners B) its tangent vectors are continuous C) A and B D) none of the above

______13. If a curve is C^1 continuous, then A) it can have sharp corners $\boxed{\text{B)}}$ its tangent vectors are continuous C) A and B D) none of the above

______14. Given a ray tracing algorithm, if we add small random perturbations to each view ray, how will that change the resulting image? $\boxed{\text{A)}}$ it will blur the image B) the image will be distorted beyond recognition C) it will appear grainy D) it will increase aliasing artifacts

______15. Texture mapping A) adds detail by increasing geometric complexity $\boxed{\text{B)}}$ is supported by the OpenGL graphics pipeline C) will change object silhouettes D) none of the above E) both C and D

2 True/False (1pt each)

You get 1 point for answering a question correctly. You get -0.25 points for answering the question incorrectly and 0.5 points for leaving it blank. (It is statistically to your advantage to answer only if you are at least 60 percent confident that your answer is correct)

______1. ($\boxed{\text{T}}$/F) If a function is linear then it is also affine.

______2. (T/$\boxed{\text{F}}$) If a 3×3 matrix is orthogonal it is a rigid body transformation.

______3. ($\boxed{\text{T}}$/F) All rotation matrices are invertible.

______4. ($\boxed{\text{T}}$/F) Any rotation in 3D space can be described using an angle and an axis.

______5. (T/$\boxed{\text{F}}$) OpenGL sorts triangles to determine visibility.

______6. ($\boxed{\text{T}}$/F) In the fixed-function OpenGL pipeline, vertices are processed independently of other vertices.

______7. ($\boxed{\text{T}}$/F) Pipelining increases throughput and latency.

______8. ($\boxed{\text{T}}$/F) Texture mapping is applied during the fragment processing step of the graphics pipeline.

______9. ($\boxed{\text{T}}$/F) Texture mapping with mipmapping consumes more memory than texture mapping without mipmapping.

______10. ($\boxed{\text{T}}$/F) Texture mapping adds detail without increasing the polygon count.

______11. (T/$\boxed{\text{F}}$) Bump mapping can be used to give the object a bumpy appearance in the interior polygons of an object by perturbing vertex positions.

______12. ($\boxed{\text{T}}$/F) Bilinear filtering reduces aliasing artifacts in texture mapping.

______13. (T/$\boxed{\text{F}}$) Diffuse reflections are view-independent.

______14. ($\boxed{\text{T}}$/F) Specular reflections are view-independent.

______15. (T/$\boxed{\text{F}}$) Moving from flat shading to Gouraud shading improves the appearance of the object's silhouette.

______16. (T/$\boxed{\text{F}}$) Gouraud shading requires more computation than Phong shading.

______17. (T/$\boxed{\text{F}}$) A Bezier curve interpolates its control points.

______18. ($\boxed{\text{T}}$/F) An n^{th} order polynomial is uniquely determined by $n+1$ distinct control points.

______19. ($\boxed{\text{T}}$/F) Piecewise polynomial curves are preferable to high order polynomials because interpolating a large number of points with a single high order polynomial can create a very oscillatory curve.

______20. ($\boxed{\text{T}}$/F) Blending functions provide a convenient basis for expressing curves in terms of the control points.

______21. ($\boxed{\text{T}}$/F) Shadow rays point from an intersection point to a light source.

______22. (T/$\boxed{\text{F}}$) Reflection rays always point from an intersection point to the eye.

______23. ($\boxed{\text{T}}$/F) Ray tracing is generally better suited for global illumination effects than the OpenGL 3D rendering pipeline.

______24. ($\boxed{\text{T}}$/F) Rigid bodies have both angular and linear components of their state, whereas particles only have linear components.

______25. ($\boxed{\text{T}}$/F) The Navier-Stokes equations are a special case of Newton's Second Law that applies to fluids.

3 Written Response (15pts total)

1. (5 pts) Consider a set of control points $\mathbf{p}_{ij}$, and the associated Bezier surface patch defined by

$$\mathbf{p}(u,v) = \sum_i \sum_j b_i(u) b_j(v) \mathbf{p}_{ij}.$$

   Develop an algorithm for calculating the normal vector to the patch at any point $\mathbf{p}(u,v)$.

2. (5pts) Write out the equation for the Phong reflectance model. What parameter values would you use to model a matte material (like carpet)? What parameter values would you use to model a glossy material (like plastic)? Would increasing the shininess exponent increase or decrease the size of the specular highlight?

3. (5 pts) Given a particle with mass m, with state $\mathbf{x}$,$\mathbf{v}$ (position, velocity), and forces $\mathbf{F}$ on the particle, describe an algorithm for advancing the particle state to the next time step(the step size is h).

4. (5 pts) Consider a ray with endpoint $\mathbf{a}$ and a normalized direction $\mathbf{u}$,

$$\mathbf{p}(t) = \mathbf{a} + t\mathbf{u}, \quad t \geq 0,$$

and a sphere of radius r, centered at the origin. The implicit equation is given as follows:

$$\mathbf{p} \cdot \mathbf{p} - r^2 = 0$$

Describe geometrically in what ways can the ray intersect/not intersect with the sphere(when is there exactly one intersection, when is there two intersections, and when are there no intersections), and what does each of those cases says about the value of t. Come up with an algorithm that finds all of the intersection points of the ray and sphere, if any.
hint: Solve for t
hint: Dot product is distributive $a \cdot (b + c) = a \cdot b + a \cdot c$
hint: The solution to: $ax^2 + bx + c = 0$ is $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$