Practice Test cap6930 Game Physics

Name:

IMPORTANT: If you need to make simple, reasonable assumptions to arrive at an answer, state any such assumption.
An answer 'yes' or 'no' is worth 0 points if it does not explain the reasoning.
Write answers cleanly on the space provided. Use the back of the previous page if more space is needed.

1 ODE basics

- Consider a box filled with n particles all of the *same charge*. There is no gravity. What formula(s) describes how the particles interact? [5 points]

- How can one avoid computing $n^2/2$ pairwise interactions of the charged particles when re-solving the interaction? [5 points]

2 Numerical treatment of ODE s

- Perform two explicit (forward) Euler steps of step length (time increment) $h = 1/10$ on the initial value problem $u'(t) = -u(t) + t + 1$ for t in the unit interval $[0..1]$ with starting value for u at $t = 0$ of 1. [15 points]

- Write $u''(t) + u(t) = t$ as a linear first-order system (where $'$ indicates derivative with respect to the only variable t). [5 points]

3 Collisons

- Can bounding box overlap testing prove that two objects do not intersect? Explain. [10 points]

- Draw the smallest 8-dop for a disk with radius 1 centered at the origin. [5 points]

- What are the barycentric coordinates of the point $(1, 1)$ with respect to the triangle with vertices $(0, 0)$ $(1, 0)$ $(0, 1)$? [5 points]

4 Collison Response

- Write the quaternion for rotating about the axis $(1, 0, 0)$ by $60°$. Write the corresponding Euler rotation matrix. [10 points]

- Object A with mass $m_A = 1$ collides fully elastic with object B of the same mass. At the time of impact, both had the same speed but opposite velocity travelling on the x-axis. What can be said about the velocity of A and B after collision? [10 points]

- How does the coefficient of restitution affect the colision? [5 points]

5 Explain concepts

In a sentence or two (or a good picture) explain [4 points each]

- Kinematics *vs* Dynamics.

- Conservation of momentum in collision and conservation of momentum in fluids.

- Fluid drag and friction.

- SPH and kernel

6 Fluids

- List the governing equations of fluid flow. [4 points]

- What numerical technique can one use to compute the fluid velocity at the next time step? [5 points]

- Contrast the two types of approaches of computing fluid flow. [5 points]

7 Elasticity – will not be on the in-class test

- What is a finite element? [5 points]

- What is a thin shell model? [5 points]

- Given a square as a standard domain, explain how an iso-parametric element is computed on the physical domain with vertices $\left[\begin{smallmatrix}0\\0\end{smallmatrix}\right], \left[\begin{smallmatrix}1\\0\end{smallmatrix}\right], \left[\begin{smallmatrix}2\\2\end{smallmatrix}\right], \left[\begin{smallmatrix}0\\1\end{smallmatrix}\right]$. [10 points]

- Compute the Green strain when twisting a cube in counterclockwise fashion about its x-axis. [10 points]

4