CMSC 491/691 Final Exam (Spring 2016)

Instructions: Clearly write your name on this sheet. Answer each problem in the space provided. If you need extra space, clearly write your name and the problem number on an extra sheet of paper, write on extra sheet in the answer space on the exam paper, and turn in the extra sheet with your exam.

Write legibly. If the person grading the test cannot read something, s/he will simply assume that you meant the illegible portion as a note to yourself and they will ignore it. If you lose points because part of your answer could not be read, you will not be given the opportunity to explain what it says.!

Be clear and concise. The answers to most questions should be short. If you find yourself writing an excessively long response, you may want to think more carefully about the question. Long rambling answers generally get fewer points than short ones do because there are more opportunities to mark something wrong. **The purpose of short-answer questions is to determine if you know what you are talking about, a few key words can usually communicate this.**

You may use any notes you have written on **both sides** of a **single 8.5 x 11** inch sheet of paper. You may not ask questions of other students, look at another students exam, use a textbook, use a phone or calculator, or seek any other form of assistance. In summary: do not cheat. Persons caught cheating will be subject to disciplinary action.

Each question is marked with a number of points. There are 120 points total. You have 120 minutes. The test is designed with the same minutes as points, if you find yourself spending much more than a minute per point on a question, you might want to move on and come back to it at the end.

If something isnt clear, ask!

Good luck

Name: (2.5 pts) ____

GL Login: (2.5 pts) ____

DO NOT OPEN THE TEST UNTIL TOLD TO BEGIN

1. True/False and Fill in the Blank. 1 pt per response, one blank per word.

   (a) (1 pt) FLIP stands for ____________ ____________ ____________

   (b) (1 pt) PIC stands for ____________ ____________ ____________

   (c) (1 pt) MIC stands for ____________ ____________ ____________

   (d) (1 pt) FEM stands for ____________ ____________ ____________

   (e) (1 pt) SPH stands for ____________ ____________ ____________

   (f) (1 pt) BEM stands for ____________ ____________ ____________

   (g) (2 pts) When computing constraint forces the direction of the force must be in the direction of the ____________ of the constraint and the magnitude of the force is given by a ____________ ____________ .

   (h) (1 pt)

   (i) (1 pt)

   (j) (1 pt)

   (k) (1 pt)

   (l) (1 pt)

   (m) (1 pt)

   (n) (1 pt)

   (o) (1 pt)

   (p) (1 pt)

   (q) (1 pt)

   (r) (1 pt)

   (s) (1 pt)

   (t) (1 pt)

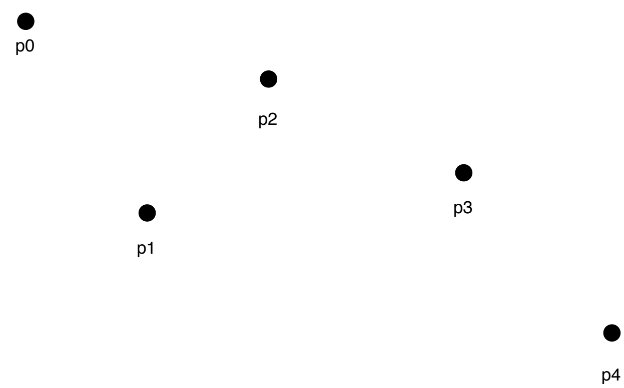
   (u) (1 pt)

(v) (1 pt)

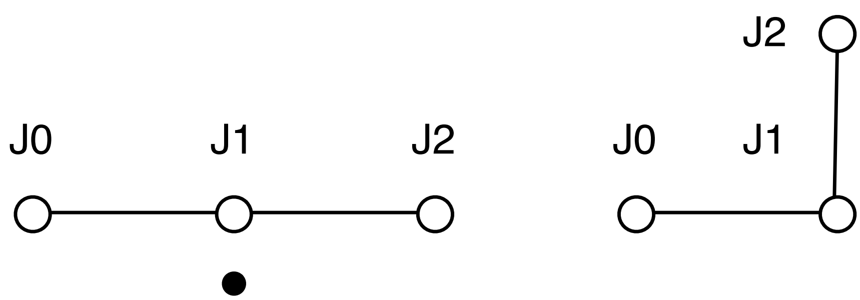
(w) (1 pt)

(x) (1 pt)

2. (10 pts) Draw a plausible approximation of a cubic Catmull-Rom spline through the points below. At key point draw the direction of the tangent. Use the same boundary conditions as for Assignment 1 (i.e. assume $p0$ and $p4$ are duplicated).

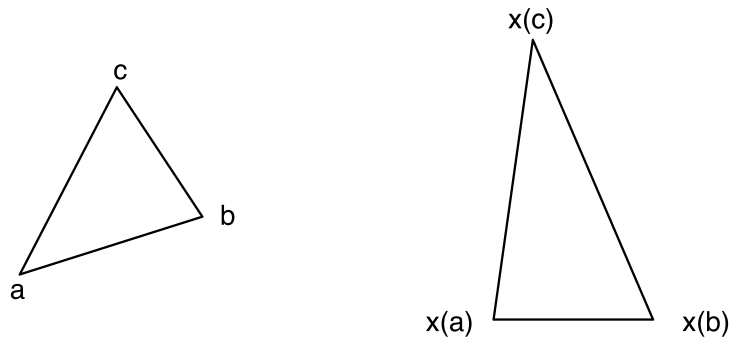


3. (10 pts) Consider the skeleton below. The bind pose is given on the right. Assume that in world space, there is a 90° rotation at J1 and all other joints are constant. Further assume that the skinning weights are equal for the black vertex are 1/3 for each of J0, J1, and J2. Draw the location of the vertex in world space. Also draw all relevent vectors in both the bind and world pose.



4. (10 pts) Assume in the above example, that, in rest space, J0 is at the origin and that the each bone has length 10. Assume that the position of the vertex in the bind pose is (10, -1). Calculate the location of the vertex in world space.

5. (10 pts) Assuming linear finite elements, give a formula for $x(u)$ for an arbitrary point u in triangle (a,b,c). See the figure below.

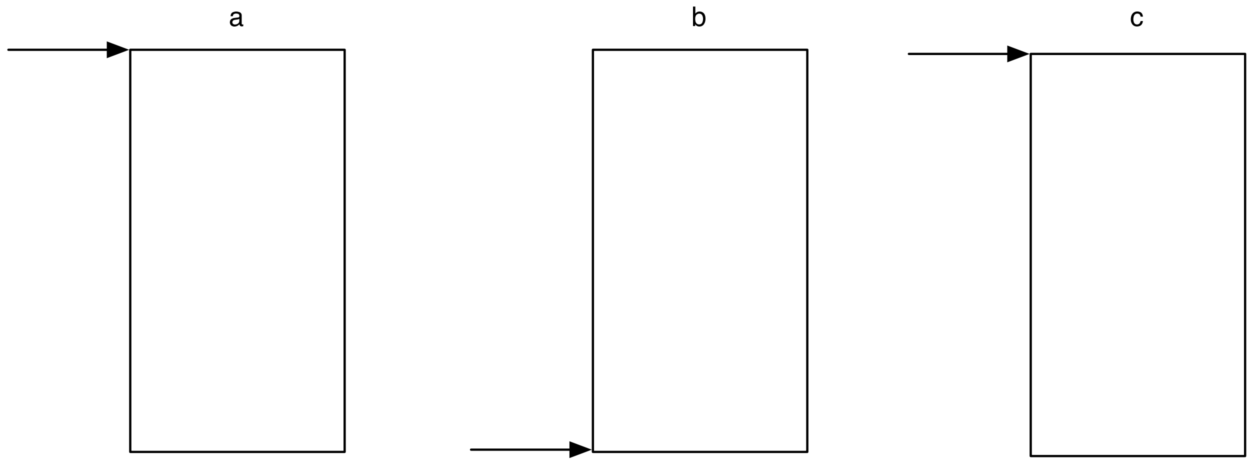


6. (5 pts) In the equation below, circle the advection term and draw a rectangle around the viscosity term.

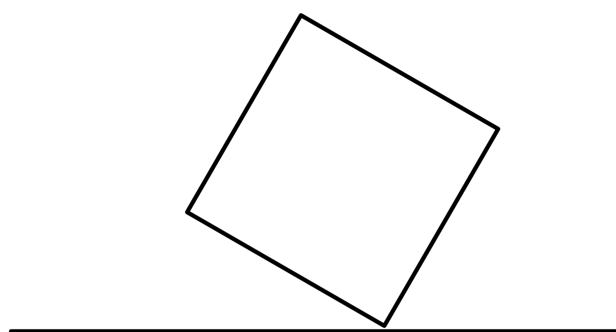
$$\frac{\partial \mathbf{u}}{\partial t} = -\left(\mathbf{u}^{\mathsf{T}}\nabla\right)\mathbf{u} - \frac{\nabla p}{\rho} + \frac{\mu_v}{\rho}\left(\nabla^{\mathsf{T}}\nabla\right)\mathbf{u} + \frac{\mu_e}{\rho}\nabla^{\mathsf{T}}\epsilon + \frac{\mathbf{f}}{\rho} \tag{1}$$

7. (10 pts) Assuming the velocity field after applying advection, viscosity, and external forces is v^*, derive the Poisson equation for projecting the velocity field onto the space of divergence-free fields.

8. (15 pts) Consider the rigid bodies below, with the applied forces. Add additional forces such that (a) there is a change in linear momentum, but not angular momentum, (b) there is a change in angular momentum, but not linear momentum, and (c) there is no change in momentum.



9. (10 pts) What impulse would be applied if the box below has a mass of 2 and hits the floor with a velocity of (3,-5). Assume the coefficient of restitution is 0.5.



10. (5 pts) Would the impulse in the previous question result in a torque being applied to the box? If so, would it cause the box to spin clockwise or counter-clockwise.

11. (5 pts) Which was your favorite project? Which was your least favorite?