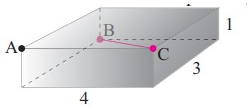
CP 214: Foundations of Robotics
Home Work 1

Due: 23rd Aug 2022

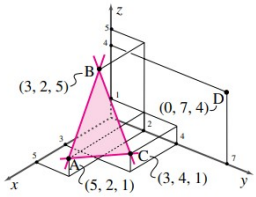
Note: All problems must be done in a step-by-step fashion. Credit will not be given for just putting the final answer without justification. Also the code of conduct will be strictly enforced:
https://www.csa.iisc.ac.in/aboutus/data/misconduct.pdf
https://www.csa.iisc.ac.in/newweb/wp-content/uploads/2020/10/misconduct_guidelines.pdf
https://www.iisc.ac.in/wp-content/uploads/2020/07/iisc_policy-for-academic-integrity-in-research_final.pdf

1. What is the shortest distance between the point A and the diagonal BC of the parallelepiped shown? (Use vector methods and don't use cross product.)



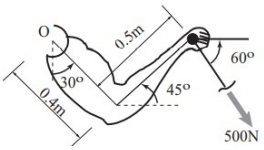
2. Given a force, $\vec{F_1} = (-3\hat{i} + 2j + 5k)$ N acting at a point P whose position is given by $r_{\vec{P/O}} = (-4\hat{i} + 2j + 7k)$ m, what is the moment about an axis through the origin O with direction $(\frac{2}{\sqrt{(5)}}\hat{i} + \frac{1}{\sqrt{(5)}}j)$?

3. 4 Points A, B, and C in the figure define an infinite plane. a) Find a unit normal vector to the plane. b) Find the perpendicular distance from point D to this infinite plane (not necessarily inside the triangle ABC). c) What are the coordinates of the point on the plane closest to point D? d) Is this point on or off the triangle used to define the plane?



4. During weight training, an athlete pulls a weight of 500 N with his arms pulling on a handlebar connected to a universal machine by a cable. Find the

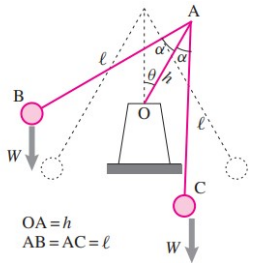
moment of the force about the shoulder joint O in the configuration shown



5. Are the following equations linearly independent?

$$x_1 + 2x_2 + x_3 = 30$$
$$3x_1 + 6x_2 + 9x_3 = 4.5$$
$$2x_1 + 4x_2 + 15x_3 = 7$$

6. Find the sum of moments due to the two weights of the teeter-totter when the teeter-totter is tipped at an angle θ from its vertical position. Give your answer in terms of the variables shown in the figure. [Note that AC is not vertical.]



Reference: http://ruina.tam.cornell.edu/Book/RuinaPratap-July-12-2019.pdf