

NAME :



Massachusetts Institute of Technology

16.07 Dynamics

Problem Set 12

Out date: Nov. 21, 2007

Due date: Nov. 30, 2007

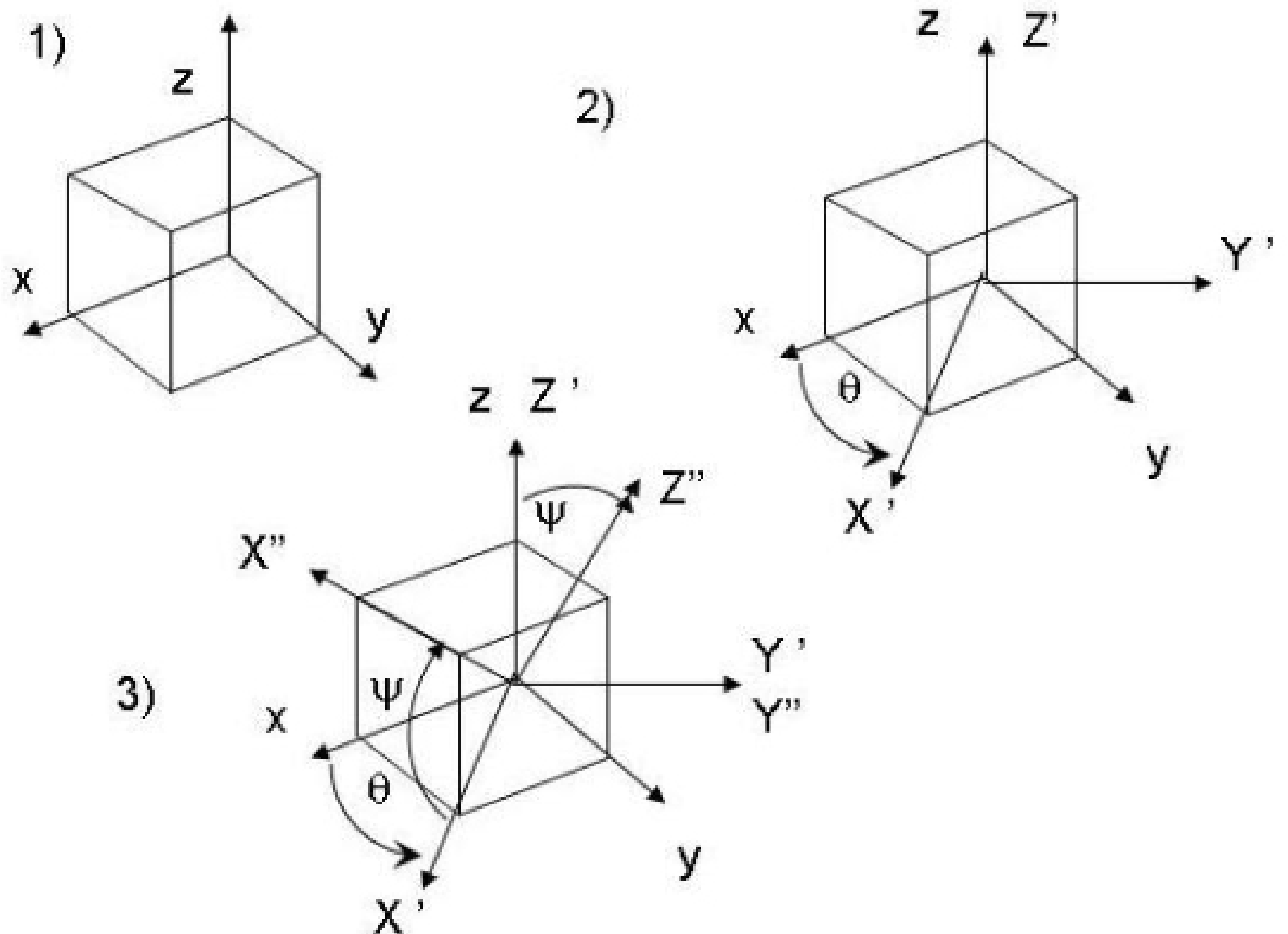
	Time Spent [minutes]
Problem 1	
Problem 2	
Study Time	

Turn in each problem on separate sheets so that grading can be done in parallel

MATLAB Problem 1 (20 points)

In problem set 2, you performed a coordinate transformation to align your coordinate system with the upper edge of a unit cube, the point 1,1,1. The transformation matrix was the product of the transformation matrices for each step in the process: counterclockwise rotation $\theta = \pi/4$ about z to obtain the $x'y'z'$; a clockwise rotation $\psi = \tan^{-1} \frac{1}{\sqrt{2}}$ about y' to obtain the $x''y''z''$ coordinate system. The final transformation matrix was

$$[T] = \begin{pmatrix} \cos\psi\cos\theta & \cos\psi\sin\theta & \sin\psi \\ -\sin\theta & \cos\theta & 0 \\ -\cos\theta\sin\psi & -\sin\psi\sin\theta & \cos\psi \end{pmatrix} = \begin{pmatrix} .5774 & .5774 & .5774 \\ -0.7071 & 0.7071 & 0 \\ -0.4082 & -0.4082 & 0.8165 \end{pmatrix} \quad (1)$$



The inertia matrix for a cube about the origin in the x, y, z system is

$$Mb^2 \begin{pmatrix} 2/3 & -1/4 & -1/4 \\ -1/4 & 2/3 & -1/4 \\ -1/4 & -1/4 & 2/3 \end{pmatrix} \quad (2)$$

a) Using MATLAB, apply the transformation matrix generated by the transformation to transform the inertia tensor/matrix of the cube. Show that the axes in the coordinate system x'', y'', z'' are principal axis. What is the inertia tensor in this coordinate system? What are the x'', y'', z'' vectors in terms of the original coordinate system x, y, z ?

b) Now apply the MATLAB eigenvalue process to the inertia matrix of the cube in the original x, y, z system. This process results in the eigenvalues, which are the inertias about the 3 principal axes, and the vectors which constitute the principal axes. Compare your results with those of part a).

Since the 2 inertias in the plane perpendicular to the diagonal of the cube are equal, any axis in the plane is a principal axis. Therefore your numerical results could differ from your analytical results but would produce two axis directions in the plane normal to the cube diagonal.

c) Sketch your results in 3 dimensions, showing the cube in the x, y, z coordinate system. Sketch the 3 principal axes obtained from both a) and b).