

# ME:4140 Modern Robotics & Automation

## Homework #3

Due: see ICON

Make sure to upload any supporting documents, e.g., hand work, codes, sketches, etc.

### Instructions (READ THESE FIRST!)

- To complete this homework, you can use an **Adobe** pdf reader or **Google Chrome** (after completing make sure to download with changes).
- Answer all questions by typing or selecting radio buttons in this document.
- Upload your completed document and any supporting documents, code, sketches, etc., to ICON.
- Round all values to 3 decimal places.

Example #1: what is the value of Pi? Answer: 3.142

Example #2: what is  $100/3$ ? Answer: 33.333

**Name:**

First

Last

Student ID

1. The orientation of frame  $\{b\}$  has undergone a rotation (15)

$$R = Rot(\hat{z}, 45^\circ)Rot(\hat{x}, 60^\circ)Rot(\hat{y}, 30^\circ)$$

relative to the space frame  $\{s\}$ .

Determine the following:

- (a)  $R_{sb}$

- (b) The exponential coordinates that describe the orientation, i.e.,  $\hat{\omega}\theta$ .

- (c) If the angular velocity  $\omega_s = (1, 2, 3)$ , what is  $\omega_b$ ?

2. Given the rotation axis  $\hat{\omega} = (0.267, 0.535, 0.802)$  and distance  $\theta = 45^\circ$ , determine the (10)  
following:

- (a) The exponential coordinates that describe the orientation, i.e.,  $\hat{\omega}\theta$ .

- (b) The rotation matrix resulting from the rotation.

3. Given  $R = \text{Rot}(\hat{y}, \pi/2) \text{Rot}(\hat{z}, \pi) \text{Rot}(\hat{x}, \pi/2)$ , find: (15)

(a) The rotation axis  $\hat{\omega}$

(b) Angle  $\theta$

(c) The exponential coordinates.

4. Calculate the rotation matrix corresponding to the exponential coordinates of rotation  $\hat{\omega}\theta = (1, 2, 1)$ . (10)