EEL 4930/5934: <u>Autonomous Robots</u>
AH1: Analytical Homework #1 (Spring 2023)

Tasks Overview: The following problems are from Craig's book. Present your work in detail explaining your methodology at every step.

    A. Craig 2.17, 2.18

    B. Craig 2.27, 2.28
       Hints: Use Equation (2.3) to compute the rotational matrix, assign intermediate frames as necessary.

    C. Craig 2.35, 2.37

    D. Craig 3.3, 3.4, 3.9

    E. Craig 2.36, 3.16

Grading Breakdown

EEL 4930	EEL 5934
- Part A: 20% - Part B: 25% - Part C: 25% - Part D: 30% - Part E: extra! (not required, may get bonus points)	- Part A: 20% - Part B: 20% - Part C: 20% - Part D: 30% - Part E: 10%

<u>References:</u>
- Lecture 3-4 contents, and
- The relevant Chapter 2-3 contents from Craig's book.

<u>Submission:</u> [Through Canvas only; <u>Due</u>: Feb 24, 2023 by 11.55pm]
- A single PDF file with no more than 10MB size
  - If it is a scanned file of your handwriting, please make sure that is clear to see
- You can also submit your paper-based assignment in class
- Assignment more than 10 MB file size will get negative penalty (-10% to -50%)

<u>Bonus Point Question:</u> +1 point
- Derive the *equivalent angle-axis* formula for rotation matrix R(k, Θ)

$$R(k, \theta) = \begin{bmatrix} k_x^2(1-c\theta)+c\theta & k_x\,k_y(1-c\theta)-k_z s\theta & k_x\,k_z(1-c\theta)+k_y s\theta \\ k_x\,k_y(1-c\theta)+k_z s\theta & k_y^2(1-c\theta)+c\theta & k_y\,k_z(1-c\theta)-k_x s\theta \\ k_x\,k_z(1-c\theta)+k_y s\theta & k_y\,k_z(1-c\theta)+k_x s\theta & k_z^2(1-c\theta)+c\theta \end{bmatrix}$$

from Rodrigues' rotation formula.

$$v_{rot} = v\cos\theta + (1-\cos\theta)(k\cdot v)k + (k\times v)\sin\theta$$

<u>Reference:</u> see slides #27-#28 of Lecture-3