

Fundamental Mathematics for Robotics
Homework Set #07-1, Dr.T

[1] Evaluate the average speed V at $t = \tau$ over the time interval T .

- (a) $f(t) = 3t - t^2$
- (b) $f(t) = t^3 - 2$
- (c) $f(t) = \sqrt{2t}$
- (d) $f(t) = \frac{3}{t+2}$
- (e) $f(t) = \frac{3t-5}{t+3}$
- (f) (Extra) $f(t) = \sin t$
- (g) (Extra) $f(t) = \cos t$
- (h) (Extra) $f(t) = e^t$

[2] Compute and make a table of the average speed of a joint angle $\theta(t)$ given by $\theta(t) = (t - 1)^2$ at a time τ and over an interval T with the following specifications:

- (a) At $\tau = 1$ with $T = 1, 0.5, 0.1, 0.05, 0.01$ and 0.001
- (b) At $\tau = 0.5$ to 1.5 at 0.1 interval with $T = 0.1$

[3] Evaluate the expression $\Delta \triangleq \frac{f(x) - f(x-h)}{h}$ for the following functions $f(\cdot)$. Can you cancel h from the numerator and the denominator of the fraction?

- (a) $f(x) = -2x + x^2$
- (b) $f(x) = \sqrt{3x}$
- (c) $f(x) = \frac{2x-3}{x+4}$
- (d) (Extra) $f(x) = x^3 - 2x$

[4] Find the instantaneous speed v at $t = t_0$ using the limit operation. (Hint: In Problem [3], you already have computed the expression $\Delta \triangleq \frac{f(x) - f(x-h)}{h}$ of some of the following functions and cancelled h from the numerator and the denominator.)

- (a) $f(t) = -2t + t^2$
- (b) $f(t) = \sqrt{3t}$
- (c) $f(t) = \sqrt{3}\sqrt{t}$
- (d) $f(t) = \frac{2t-3}{t+4}$
- (e) (Extra) $f(t) = \frac{3}{(t+2)^2}$