# Fundamental Mathematics for Robotics
# Homework Set #08-1, Dr.T

[1] Recall that we have computed the end-effector position of the two-link manipulator in Fig. 1 in Recitation Set #02.

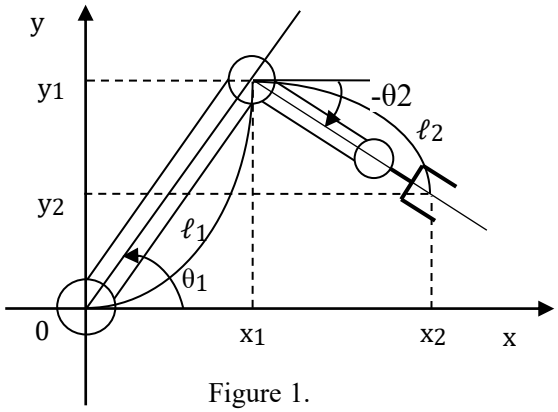

Figure 1.

(a) Compute the partial derivatives $\partial x_1/\partial\theta_1$ and $\partial y_1/\partial\theta_1$.

(b) Compute the partial derivatives $\partial x_1/\partial\theta_2$ and $\partial y_1/\partial\theta_2$.

(c) Compute the partial derivatives $\partial x_2/\partial\theta_1$ and $\partial y_2/\partial\theta_1$.

(d) Compute the partial derivatives $\partial x_2/\partial\theta_2$ and $\partial y_2/\partial\theta_2$.

(e) Compute the $x$ and $y$ directional speeds $dx_2/dt$ and $dy_2/dt$ of the end-effector.

[2] (Extra) Can you find the acceleration of the end-effector of the manipulator in Problem [1]?

[3] Compute the indicated partial derivatives of the given function:

$$g(x, A, \alpha, \beta, \omega) = Ae^{\alpha x}\cos(\omega x + \beta),$$

where the variables *x, A, α, β,* and *ω* are independent.

(a) $\partial g/\partial x$ (b) $\partial g/\partial A$ (c) $\partial g/\partial\alpha$ (d) $\partial g/\partial\beta$ (e) $\partial g/\partial\omega$

[4] Repeat [3] for the following function where $x, y, z$ are variables but *A, α, β,* and *ω* are constant parameters this time:

$$h(x, y, z) = Ae^{\alpha\sqrt{x^2+y^2}}cos(\omega z + \beta)$$