

## Chapter 2

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# Calculus of Variations and Optimal Control

Solution to Problem 2.1

The performance index is

$$\begin{aligned} J &= \int_0^2 [2x^2(t) + \dot{z}^2(t)] dt, \\ &= \int_{t_0}^{t_f} V(x(t), \dot{z}(t)) dt \end{aligned}$$

where

$$V = 2x^2(t) + \dot{z}^2(t), \quad t_0 = 0, \quad t_f = 2.$$

Using the Euler-Lagrange equation (2.3.15)

$$\begin{aligned} \left( \frac{\partial V}{\partial x} \right)_* - \frac{d}{dt} \left( \frac{\partial V}{\partial \dot{x}} \right)_* &= 0 \longrightarrow \\ 4x^*(t) - \frac{d}{dt} (2\dot{z}^*(t)) &= 0 \longrightarrow \\ \dot{z}^*(t) - 2x^*(t) &= 0. \end{aligned}$$

Solving the previous equation

$$x^*(t) = C_1 e^{\sqrt{2}t} + C_2 e^{-\sqrt{2}t}$$

# Optimal Control Systems Solution Manual

**Stanley M. Shinnars**



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