CE 202 Dynamics Solution
Spring 2021 Quiz 2 - 804

A particle starts from rest and travels along a straight line with a velocity of $v = (4t - 3t^2)$ m/s, where t is in seconds.

a. Determine the position of the particle when $t = 5$ s. –75.0 m

b. Determine the acceleration of the particle when $s = -75$ m. –26.0 m/s^2

Solution

Acceleration not given, but velocity given as function of time so derive with respect to time:

$^d/_{dt}[v = (4t - 3t^2)] \Rightarrow a = 4 - 6t$, a function of time, so non-constant acceleration.

Need to find position, so use $v = ds/dt$:

$v = (4t - 3t^2) = ds/dt$

Rearrange to get all ts on one side (multiply both sides by dt)

$(4t - 3t^2)dt = ds$

Setup semidefinite integral, setting initial position $s_0 = 0$ when initial velocity $t_0 = 0$:

$$\int_{t_0=0}^{t} (4t - 3t^2)dt = \int_{s_0=0}^{s} ds$$

Integrate

$2t^2 - t^3 = s$

When $t = 5$ s

$s = 2 \cdot 5^2 - 5^3 = \boxed{-75.0 \text{ m}}$

Since $s = -75$ m when $t = 5$ s, and we've already calculated acceleration as function of time, just plug $t = 5$ s into that expression:

$a = 4 - 6 \cdot 5 = \boxed{-26.0 \text{ m/s}^2}$