Tutorial 2 – Week 2

Aims:

Upon successfully completing these tutorial exercises, students should be able to:

- Answer problems relating to rectilinear motion of particles.

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Equations for constant acceleration:

$$v = v_0 + a_c t$$

$$s = s_0 + v_0 t + \frac{1}{2} a_c t^2$$

$$v^2 = {v_0}^2 + 2a_c(s - s_0)$$

General equations:

$$v = \frac{ds}{dt} \qquad a = \frac{dv}{dt} \qquad a = v\frac{dv}{ds}$$

If the question is constant velocity, set a_c=0.

Example1: Example 12.1 Text Book

The car on the left in the photo and in Fig. 12–2 moves in a straight line such that for a short time its velocity is defined by v = (3t2 + 2t) >s, where *t* is in seconds. Determine its position and acceleration when *t* = 3 s. When *t* = 0, *s* = 0.

Example 2: Example 12.2 Text Book

A small projectile is fired vertically *downward* into a fluid medium with an initial velocity of 60 m>s. Due to the drag resistance of the fluid the projectile experiences a deceleration of *a* = (-0.4v3) m>s2, where v is in m>s. Determine the projectile's velocity and position 4 s after it is fired.

Example 3: Example 12.3 Text Book

During a test a rocket travels upward at 75 m>s, and when it is 40 m from the ground its engine fails. Determine the maximum height *sB* reached by the rocket and its speed just before it hits the ground. While in motion the rocket is subjected to a constant downward acceleration of 9.81 m>s2 due to gravity. Neglect the effect of air resistance.

Example 4:

A bicycle moves along a road with a displacement which can be described by:

$$a = \begin{cases} t^2 \; for \; 0 \leq t \leq 10 \\ 20t - 100 \quad for \; t > 10 \end{cases}$$

Where s is in metres and t is in seconds. Manually sketch the graphs for displacement, velocity and acceleration versus time.

Section 2: For you to do:

Q 2.1

Starting from rest, a particle moving in a straight line has an acceleration of a=(2t-6) m/s^2, where t is in seconds. What is the particle's velocity when t=6 seconds and its position when t=11 seconds.

Manually sketch the graphs for displacement, velocity and acceleration versus time, over [0 12].

MATLAB Extension Question:

Draw the graphs for displacement, velocity and acceleration versus time, over [0 12].

Q 2.2

A car starting from rest moves along a straight track with an acceleration defined by:

$$a = \begin{cases} 0.8t \; for \; 0 \leq t \leq 10 \\ 8 \quad for \; t > 10 \end{cases}$$

Determine the time T required for the car to reach speed 50 m/s.

MATLAB Extension Question:

Construct the velocity versus time graph until time T.

Q 2.3 (2018 Exam paper)

A motorcycle moves along a straight line such that its position is defined by s = 2t3 - 18t2 + 48t where s is measured in meters and t is measured in seconds. Determine

1. Write an equation for velocity with respect to time and sketch the velocity-time graph
2. The minimum and maximum velocity of the particle over the time interval [0, 5]
3. The minimum and maximum acceleration of the particle over the time interval [0, 5]

Q 2.4 (2018 Exam paper)

A truck is traveling along a straight road at 6 m/s is at t=0 seconds. It increases its speed to 35 m/s over the following 15 seconds. If its acceleration is constant, determine the distance travelled from t=0 seconds until t=15 seconds.