

EGA230 - MATLAB Coursework

Submission Deadline: 4pm 8th November 2019

Basic details

You are asked to submit your MATLAB solution to the problems specified below.

A professional presentation of your solution is required. This should contain:

1. A cover page giving your name and your student number and including the signed statement "I confirm that I have not received help from, or given help to, anyone else in constructing the solution to this assignment".
2. A brief description of the problem and of the process you have followed to produce your solution.
3. A complete documented listing of your actual MATLAB files (i.e. NOT retyped by you and NO screenshots).
4. A listing of the actual output from MATLAB giving the answers requested (i.e. NOT retyped by you and NO screenshots).
5. Appropriate referencing to any publication or web based material that you have used in constructing your solution.

The report should be saved as a single PDF document and submitted through Turnitin via Blackboard. Your student number should be written on each page.

Marking

Overall for this piece of coursework, marks will be awarded as follows:

1. The quality of the submitted report: 30%
2. The accuracy of the results: 50%
3. The MATLAB techniques used to obtain the solutions, the ease of understanding of the output and the quality of the documentation within the MATLAB files: 20%

Submission details

Coursework must be submitted to Blackboard **BEFORE** 4pm on Friday 8th November 2019

Work that is submitted late (after 4pm 8th November 2019) will be awarded zero marks.

Late submission due to certificated illness will be dealt with according to standard procedures.

PTO

Question 1:

Figure 1 shows the speed (mph) against time(s) graph of a Camaro car accelerating from a standing start. Over 25 seconds the car accelerates to nearly 150mph.

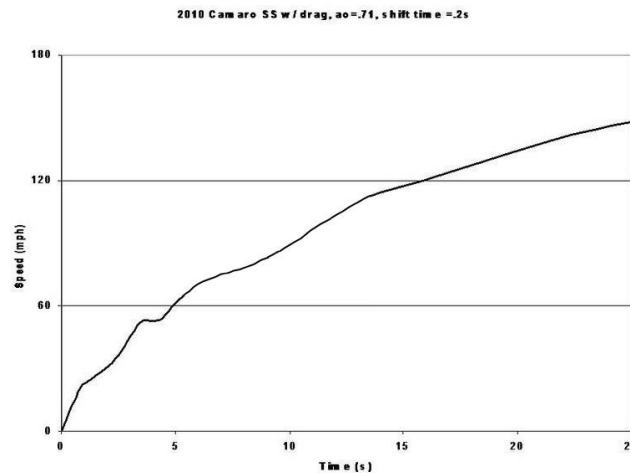


Figure 1: Speed (mph) vs. Time(s) graph of a 2010 Camaro's data measurements.

To reproduce the speed and time data from the image, combine equations (1), (2) and (3) using for loops and conditional statements.

When $t < 5$ s, the speed of the car in mph can be determined using Equation (1):

$$\text{Speed}(t) = 0.1553567(t^6) - 2.0416(t^5) + 9.1837(t^4) - 14.829(t^3) - 1.3703(t^2) + 32.821(t) - 1.3155 \quad (\text{Eqn. 1})$$

When $5s \leq t < 15.4s$, the speed of the car in mph can be determined using Equation (2):

$$\text{Speed}(t) = 0.003980879(t^5) - 0.2247(t^4) + 4.8682(t^3) - 50.442(t^2) + 254.67(t) - 430.66 \quad (\text{Eqn. 2})$$

When $t \geq 15.4s$, the speed of the car in mph can be determined using Equation (3):

$$\text{Speed}(t) = -0.073(t^2) + 6.1802(t) + 40.423 \quad (\text{Eqn. 3})$$

To determine the distance travelled by the Camaro, numerical integration can be used on the reproduced speed vs. time data, calculating the area under the curve.

Use the composite trapezoidal rule to obtain an approximation of the distance travelled by the Camaro in metres, with a relative error of less than 0.00002%. During the numerical integration calculations, if the relative error is not reached, double the number of separations used over the timespan in the calculations for the following calculation.

- (i) In the command window, display the integral value calculated for distance, the number of sections used in the numerical integration, and the relative error produced for each looped calculation using 'fprintf' and associated commands.

- (ii) Produce a single figure with two subplots, (1) showing the speed (m/s) vs. time (t) of the combined speed equations in one plot at a reasonable accuracy, and (2) a cumulative distance (m) graph of the Camaro over time(s) in the second subplot.
- (iii) Produce a figure showing the total distance calculated against the number of separations used in each numerical integration calculation; use a logarithmic x-axis scale on the resulting plot.

[25 Marks]

Question 2:

An undamped system is harmonically excited using an external forcing frequency ω , which produces vibration of the system. The displacement of the system over time ($x(t)$) can be calculated using Equation 4, when using the parameter values detailed in *Table 1*.

$$x(t) = \left(\frac{v_0}{\omega_n}\right) \sin(\omega_n t) + \left(x_0 - \frac{f_0}{\omega_n^2 - \omega^2}\right) \cos(\omega_n t) + \left(\frac{f_0}{\omega_n^2 - \omega^2}\right) \cos(\omega t) \quad (\text{Eqn. 4})$$

$$\text{where: } f_0 = \frac{F_0}{m}$$

Table 1: Parameter definitions, values and units of measure

Definition	Parameter	Value	Units
Stiffness	k	1007.564	N/m
Mass	m	98.668	kg
Applied Force Magnitude	F_0	108.764	N
Initial Displacement	x_0	-0.02	m
Initial Velocity	v_0	0.1	m/s
Time	t	4.54	s
Displacement	x	0.0386	m
Driving Frequency	ω	Unknown	Rad/s
Natural Frequency	ω_n	$\omega_n = \sqrt{\frac{k}{m}}$	Rad/s

The acting driving frequency ω however is unknown.

- (i) Use the bisection method to determine an approximation of the value of ω , with an absolute error of less than 1×10^{-6} ; when the displacement $x = 0.0386\text{m}$, at time $t = 4.54\text{s}$, limiting the useable values of ω between: $5.12 < \omega < 6.45$. Display the resulting value of ω , and the absolute error obtained.
- (ii) Produce a plot of the displacement $x(t)$, between $0 < t < 6\text{s}$, using the driving frequency ω calculated in part (i).

[25 MARKS]