

NO CELL PHONES. NO HEADPHONES/BUDS. NO CALCULATORS. You may only have a pen or pencil with you and use this exam sheet for scratch paper. ONLY MATLAB MAY BE ACTIVE ON YOUR COMPUTER.

SAVE FREQUENTLY. A CRASH IS NO EXCUSE FOR ANYTHING. SAVE BEFORE PUBLISHING!!! REMAIN SEATED AT ALL TIMES.

After translation into mathematics, *only* Matlab may be used to solve the full problem *as posed*. Use the appropriate procedures as covered in the lectures. Use appropriate variable names that can be clearly understood by the grader. Use appropriate comments. Acrobat may only be open at the end, when you are ready except for publishing and actively looking at main.pdf with it.

1. Plot the two functions $\cos(x)$ and x^2 in the same graph from 0 to 2. Then find the positive root x_1 where the two functions are equal using the search interval method. The values of the end points of the interval you use must be integers, and you must check the end point function values for acceptability. Explain in the comments why your end values are acceptable. Print the root out formatted by Matlab as “The root is: *.123456”, i.e. 6 digits behind the decimal point and Matlab’s default number of print positions before the point. No hard-coding the number allowed.

Warning: Do not forget the point before the squaring operator in x^2 .

2. Consider the following measured data on the elongation dl of a linear spring versus the force it supports:

dl_m in:	0.32	0.65	0.97	1.30	1.62	1.95	2.27	2.60
F_m lbf:	9	20	29	37	49	57	67	73

- (a) Fit a straight line to the given data using linear regression. Use it to print the best value of the force at an elongation of 1.5.
 - (b) Plot both the data, as circles, and the straight line representation, as a continuous line, in the same graph with the vertical axis from 0 to 90, horizontal from 0 to 3. Title it “Best Force/Displacement Approximation”, and use axes labels “dl inch” and “F lbf”. Prevent the legend from crossing the line; put it in an empty spot in the plot.
3. Each corner of a car may be modeled as a mass attached to a spring and a damper (shock absorber). That produces the simplest vibrating system in mechanical engineering (and physics in general), the damped linear spring-mass system. Its vertical motion is described by

$$\frac{dx}{dt} = v \quad \frac{dv}{dt} = (-cv - kx)/m \quad (1)$$

where x is the vertical position of the corner measured from equilibrium, v its vertical velocity, m the effective mass, c the damping constant, and k the spring constant. Assume that $m = 2$ and $k = 8$ and that initially, the vertical position x is normal, so zero, but that there is a vertical velocity $v = 0.5$ due to hitting a speed bump. Find the position x for times $0 \leq t \leq 10$ for two cases; (a) $c = 8$, “good shocks”, and (b) $c = 1$, “bad shocks”. Plot the two curves in the same graph. Special requirements: use the same function file to do both cases (a) and (b). Call your function file ‘springMass.m’. Specify the time range as about 100 points from 0 to 10, not just [0 10], which would make the plot look horrible.