

Homework Set 5 – Root Finding (30 points)

Due date: Monday 17 July

The purpose of this project is to do a parameter study involving a root finding method.

Recall Problem 4 on Homework 3, which is taken from Applied Numerical Methods with MATLAB, Chapra, 3e, 2008. The upward velocity of a rocket is

$$v = u \ln \left( \frac{m_0}{m_0 - qt} \right) - gt$$

where  $v$  is the upward velocity (m/s),  $u$  is the velocity at which fuel is expelled relative to the rocket (m/s),  $m_0$  is the initial mass of the rocket (kg),  $q$  is the fuel consumption rate (kg/s), and  $g = 9.812$  is the gravitational constant (m/s<sup>2</sup>).

As in the homework problem, use the bisection method with  $v = 750$  m/s,  $m_0 = 160,000$  kg, and  $tol = 1e-4$  to determine the time  $t$  it takes for the rocket to reach a speed of  $v = 750$  m/s. Now, however, let  $q$  vary between 2000 and 3000 kg/s (with an increment of 10), and generate a plot showing  $t$  versus  $q$ .

The easiest way to structure the code is to use embedded functions. Set up a loop for the  $q$  values using  $i$  as the index:

```
q = 2000:10:3000;
N = length(q);
for i=1:N
    define the function using q(i)
    use bisection to find the root; call it t(i)
end
```

**What to submit.** Turn in a copy of your code and the plot of  $t$  as a function of  $q$ .