Mandatory 2

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1 Exercise 1

NR3's implementation of `newt` from "roots_multidim.h" is used as a base for solving the non-linear system of equations.

The vector function is set up as follows:

```cpp
// Material constants:
const double v = 120.0;              // kg
const double k = 2.5;                // m
const double w = 4.0;                // kg/m
const double alpha = 2.0 * pow(10, -7); // kg^-1

// Other constants:
const double d = 30.0; // m
double n = 5.0;        // m (Updated in main)

VecDoub vecfunc(VecDoub_I q) {
  assert(q.size() == 8);

  // q=[L0, L, p, x, theta, phi/varphi, a, H]
  // Zero vectors
  VecDoub f(8);
  f[0] = (q[6] * (cosh(q[3] / q[6]) - 1.0)) - q[2];
  f[1] = (2.0 * q[6] * sinh(q[3] / q[6])) - q[1];
  f[2] = (2.0 * q[3] + 2.0 * k * cos(q[4])) - d;
  f[3] = (q[2] + k * sin(q[4])) - n;
  f[4] = (sinh(q[3] / q[6])) - tan(q[5]);
  f[5] = ((1.0 + (v / (w * q[0]))) * tan(q[5])) - tan(q[4]);
  f[6] = (q[0] * (1.0 + alpha * q[7])) - q[1];
  f[7] = ((w * q[0]) / (2.0 * sin(q[5]))) - q[7];

  return f;
}
```

1.1

For $n = 5$:

$$L_0 = 27.5233$$
$$H = 124.541$$

using starting guess:

$$L_0 = 29 \quad L = 29.1 \quad p = 5 \quad x = 15 \quad \theta = 1 \quad \varphi = 0.5 \quad a = 40 \quad H = 100$$

1.2

For $n = 2$:
$$
\begin{aligned}
L_0 &= 25.4565 \\
H &= 294.733
\end{aligned}
$$

using starting guess:

$$L_0 = 27 \quad L = 27.1 \quad p = 2 \quad x = 14 \quad \theta = 1 \quad \varphi = 0.5 \quad a = 40 \quad H = 100$$

1.3

For $n = 1$:
$$
\begin{aligned}
L_0 &= 25.114 \\
H &= 587.781
\end{aligned}
$$

using starting guess:

$$L_0 = 26 \quad L = 26.1 \quad p = 1 \quad x = 13 \quad \theta = 0.5 \quad \varphi = 0.5 \quad a = 40 \quad H = 100$$

1.4

For $n = 0.5$:
$$
\begin{aligned}
L_0 &= 25.0235 \\
H &= 1174.94
\end{aligned}
$$

using starting guess:

$$L_0 = 26 \quad L = 26.1 \quad p = 0.5 \quad x = 13 \quad \theta = 0.2 \quad \varphi = 0.1 \quad a = 40 \quad H = 100$$

1.5

For $n = 0.2$:
$$
\begin{aligned}
L_0 &= 24.99 \\
H &= 2936.27
\end{aligned}
$$

using starting guess:

$$L_0 = 25.5 \quad L = 25.6 \quad p = 0.2 \quad x = 12 \quad \theta = 0.1 \quad \varphi = 0.05 \quad a = 40 \quad H = 100$$

1.6

For $n = 0.1$:
$$
\begin{aligned}
L_0 &= 24.9719 \\
H &= 5869.9
\end{aligned}
$$

using starting guess:

$$L_0 = 25.5 \quad L = 25.6 \quad p = 0.1 \quad x = 12 \quad \theta = 0.1 \quad \varphi = 0.05 \quad a = 40 \quad H = 100$$