1. Calculate the steady state points when
   a. In the absence of the applied currents
      * All sub-problems in part 1 refers to MATLAB code “Run_steadystate” and “MorrisLecarModel”. “Run_steadystate” is the main script that returns steady state points of V and w respectively, using the MATLAB built-in function “fsolve”.
        At \( I_{app} = 0 \):
        \( V \) steady state point = -60.8544 V
        \( w \) steady state point = 0.0149

   b. The applied current is 60 pA
        At \( I_{app} = 60 \):
        \( V \) steady state point = -36.7547 V
        \( w \) steady state point = 0.0702

   c. The applied current is 150 pA
        At \( I_{app} = 150 \):
        No steady state point is found; the time solution oscillates.

2. See MATLAB code “RungeKutta15”

4. Compare the solutions of V and w of the Morris-Lecar problem when applied current is 150 pA using the 2nd-order Runge-Kutta solver above and 4th-order Runge-Kutta solver. Create a table of comparison for V and w at times \( t = 0, t = 20, t = 40, t = 60, t = 80, t = 100, t = 120, t = 140, t = 160, t = 180, \) and \( t = 200 \) ms.
   *Corresponding MATLAB code is “Run_MorrisLecar” and “MorrisLecar”

<table>
<thead>
<tr>
<th>*T(ms)</th>
<th>T=0</th>
<th>T=20</th>
<th>T=40</th>
<th>T=60</th>
<th>T=80</th>
<th>T=100</th>
<th>T=120</th>
<th>T=140</th>
<th>T=160</th>
<th>T=180</th>
<th>T=200</th>
</tr>
</thead>
<tbody>
<tr>
<td>V(RK4)</td>
<td>0.1</td>
<td>-41.112</td>
<td>-9.678</td>
<td>14.745</td>
<td>-42.504</td>
<td>-24.234</td>
<td>24.990</td>
<td>-30.836</td>
<td>-32.045</td>
<td>35.135</td>
<td>0.9898</td>
</tr>
<tr>
<td>w(RK2)</td>
<td>0.7</td>
<td>0.2898</td>
<td>0.199</td>
<td>0.5373</td>
<td>0.382</td>
<td>0.199</td>
<td>0.467</td>
<td>0.5014</td>
<td>0.227</td>
<td>0.3312</td>
<td>0.5572</td>
</tr>
<tr>
<td>w(RK4)</td>
<td>0.7</td>
<td>0.2892</td>
<td>0.199</td>
<td>0.5398</td>
<td>0.377</td>
<td>0.197</td>
<td>0.475</td>
<td>0.4903</td>
<td>0.223</td>
<td>0.3496</td>
<td>0.5561</td>
</tr>
</tbody>
</table>
3. Solve the Morris-Lecar problem at three conditions above (3 values of applied current) with the 2nd-order Runge-Kutta solver given the time span 0 to 200 ms, initial conditions V0 = 0.1 and w0 = 0.7, and step size h = 2. Plot the solutions.
*Corresponding MATLAB code is “Run_MorrisLecar” and “MorrisLecar”
Boundary Value Problem

* Corresponding MATLAB code is “LinearHeatEqn”

System of 1\textsuperscript{st} Order ODE

\[
\frac{dT}{dx} = z \\
\frac{dz}{dx} = -16z - 13T
\]

* Corresponding MATLAB code is “Run_linearheat”

Initial Guess \(Z(0)=-40\) and \(Z(0)=-30\)

\[z(0) = -30 + \left(\frac{-40 + 30}{0.1609 - 0.4576}\right) \cdot (0.3 - 0.4576) = -35.31176\]

Two initial condition of the 1\textsuperscript{st} order system

\[T(0) = 3\]

\[
\frac{dT}{dx}(0) = -35.31176
\]