This week: aim to cover

• inhomogeneous linear first order systems

• applications to population models, circuits, mixing
Inhomogeneous linear first order systems.

Now cover

\[ \dot{x} = Ax + b(t) \]

As for ODEs, we only deal with certain kinds of functions \( b(t) \). For each kind, look for solution with suitable form.

<table>
<thead>
<tr>
<th>RHS ( b(t) )</th>
<th>try ( y_p = )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( a )</td>
<td>( A )</td>
</tr>
<tr>
<td>( at + b )</td>
<td>( A t + B )</td>
</tr>
<tr>
<td>( a e^{kt} )</td>
<td>( A e^{kt} )</td>
</tr>
<tr>
<td>( a \sin mt ) or ( b \cos mt ) or both</td>
<td>( A \sin mt + B \cos mt )</td>
</tr>
</tbody>
</table>

As for 2nd order DEs, complications if RHS solves homogeneous DE — not for us!
End of Lecture 29
Applications of first order linear systems

We do examples of:

1. population models (not very realistic)

2. mixing

3. electric circuits

Example
Population models

Realistic ones are nonlinear, which we can’t do!

→ look at local behaviour near some equilibrium population values

⇒ linear behaviour nearby

 البنויんどアクセスンリアルシオストンライ的意见, どせがれんかんたん！

→ ローカルな行動を観察して、いくつかの平衡人口値を見つけること。

⇒ リニアな行動が近くにあること。
Mixing

2 tanks → 2 amounts $x_1, x_2$ with flows in/out

Straightforward generalization of previous examples

→ linear 1st order systems naturally

Example
End of Lecture 30
Electric circuits

Example Parallel RL circuits

→ circuit has 2 ‘loops’

Use:

- Kirchoffs Voltage Law in each loop
  → 1st order DE for each loop

- Kirchoffs Current Law at loop junctions
  → linear relationships between various currents

- → linear 1st order systems

Example
End of Week 11

Notes §9.4–10.3

Now do Sheet 11