

## 2E2 Tutorial Sheet 16 Second Term<sup>1</sup>

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### Useful facts:

- Convert into  $y_1, y_2$  form.
- Find the stationary points, these are where  $y'_1 = y'_2 = 0$ .
- Approximate near the stationary points, drop squares and cubes, use  $\sin \theta \approx \theta$  for small  $\theta$ .
- The arrows will go left to right above the  $y_1$ -axis and right to left below it.
- For the trigonometry tables

$$\begin{aligned}\cos\left(\frac{\pi}{2} + \theta\right) &= -\sin \theta \\ \cos\left(3\frac{\pi}{2} + \theta\right) &= \sin \theta\end{aligned}\tag{1}$$

### Questions:

1. (4) By linearizing around the critical points, draw the phase plane portrait of

$$y'' + y - y^3 = 0\tag{2}$$

2. (4) By linearizing around the critical points, draw the phase plane portrait of

$$y'' = \cos 2y\tag{3}$$

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<sup>1</sup>Conor Houghton, [houghton@maths.tcd.ie](mailto:houghton@maths.tcd.ie) and <http://www.maths.tcd.ie/~houghton/2E2.html>