

**Task 1X** (20 extra points)

Try to write the time evolution operator for the our hand of a mechanical watch. Suppose the direction of the hour hand at the start time  $t = 0$  is given by the unit vector  $\hat{u}(t = 0) = \cos \theta_0 \hat{e}_x + \sin \theta_0 \hat{e}_y$ . Give a reason why the (modulus of the) angular velocity of the hour hand is

$$\omega_0 = \frac{\pi}{1800} \text{ s}^{-1}, \quad (1)$$

where s (not sec!) is the unit symbol for the second. Write the time evolution operator  $\mathbb{U}(t)$  (a  $2 \times 2$  matrix) which gives the direction  $\hat{u}(t)$  of the hour hand at a later time  $t$ ,

$$\hat{u}(t) = \mathbb{U}(t) \cdot \hat{u}(t = 0), \quad (2)$$

where  $\hat{u}(t)$  points into the direction of the hour hand at time  $t$ . Take into account that the hour hand moves clockwise, not anti-clockwise. *Give a complete and detailed reasoning for your result, do not just write an expression for  $\mathbb{U}(t)$ !*

**Task 2X** (extra, unmarked)

Re-familiarize yourself with the gradient, the divergence, and the curl operators, in three dimensions. Use Cartesian coordinates. Then, try to think how these three operators should look like in two as opposed to three dimensions. Maybe, you can express your thoughts in full English sentences. I will have a look at your essay, but it will not be marked.

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The tasks are due Thursday, 29–JAN–2020.