Written examination 9 January 2006, Course no. 31385

Course name: Autonomous Robot Systems.

Permitted help: All usual.

Name:

Signature:

Problem	1	2	3	4	5
Answer	4	1	4	1	5

The possible answers to each problem are numbered from 1 to 6. For each problem the number of the chosen answer must be written in the table above. If a wrong number is entered by mistake the wrong number must be crossed out and the correct number written below. If a correction is unclear the problem will be considered unanswered. ONLY THE FRONT PAGE SHOULD BE RETURNED FOR EVALUATION.

5 points are given for a correct answer and -1 for a wrong answer. Unanswered questions or answer no. 6 give 0 points. The point sum sufficient for passing the examination will be decided during final evaluation.

Remember to put your name and signature on the front page.

Problem 1.

Find the pose (x,y,θ) of the SMR at time t = 5 using the encoder values from the table below (the values are incremental not accumulated):

t	1	2	3	4	5
N_R	-1000	1000	1000	1000	1000
N_L	1000	1000	1000	-1000	1000

Tabel 1.

Initial pose is (x,y,θ) = (0,0,0). Use the kinematic equations from 'Where am I' page 20 where n = 1, D_n=0.067 m, C_e = 2000 og b = 0.268 m. θ is in radians.

1 (x,y,θ) = (0.0000, 0.0000, 0.000)

2 (x,y,θ) = (0.1488, 0.1488, 0.785)

3 (x,y,θ) = (0.1488, -0.1488, -0.785)

4 (x,y,θ) = (0.2540, -0.1488, 0.000)

5 (x,y,θ) = (0.2540, -0.1488,-0.785)

6 Don't know.

Problem 2.

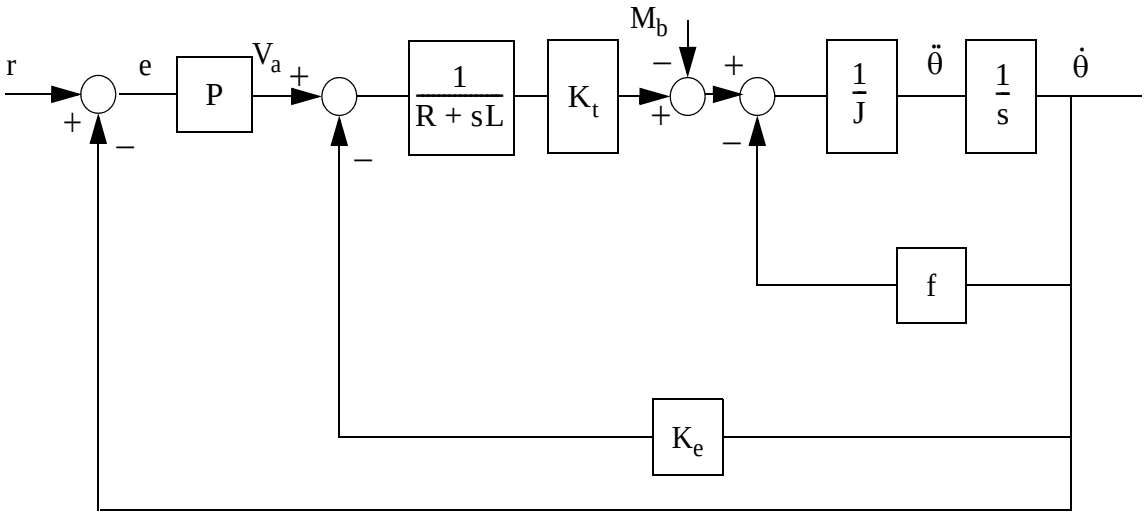


Figure 1. Motor model

For the model above is given:

R = 2, L = 0, K_t = 0.004, J = 0.5*10^{-4}, f = 0, K_e = K_t, P = 19*K_e, M_b = 0.008

All constants are given in SI units.

Find the stationary angular speed $\dot{\theta}$ when r = 500:

1 425

2 450

3 475

4 500

5 525

6 Don’t know.

Problem 3.

To calibrate the odometri of an SMR the vehicle is run through two square tracks with side-length 1 m. First run is clockwise, second run is counter clockwise. The resulting errors are:

x_{cw} = 0.20m y_{cw} = 0.20 m

x_{ccw} = 0.12 m y_{ccw} =-0.12 m

The nominal distance between the wheels is 0.26 m. Find the ratio between the wheel diameters E_d and the ratio between actual and nominal distance between the wheels E_b using both x- and y-values.(c.f. 'Where am I' chapter 6 p. 33-34)

1 E_d,E_b =(1.045, 1.000)

2 E_d,E_b =(0.9948, 0.977)

3 E_d,E_b =(0.9515,1.000)

4 E_d,E_b =(0.9948, 0.9515)

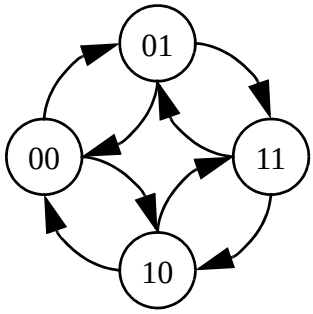
5 E_d,E_b =(1.009, 1.0598

6 Don't know.

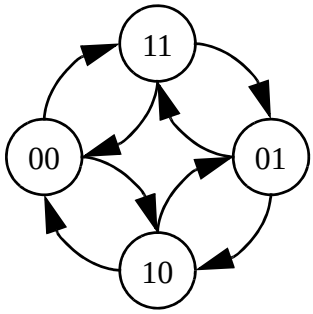
Problem 4.

An incremental encoder has two channels A and B that each can take the values 0 and 1. Which of the state diagrams below represents a correct functioning encoder?

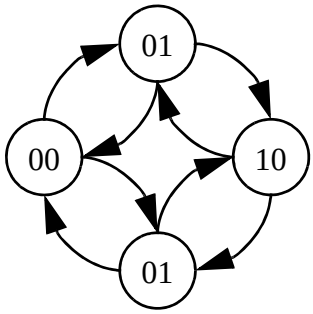
1



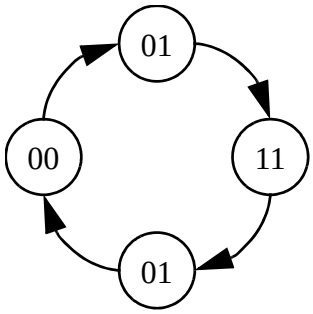
2



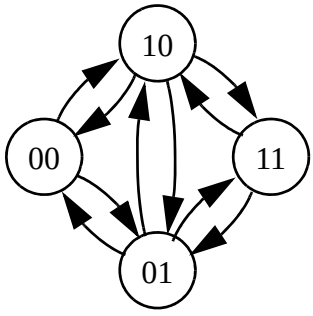
3



4



5



6 Don’t know.

Problem 5.

An SMR starts in (x,y,θ)=(0, 0, 0). The following SMR-CL program is run.

```
n=6
label “start”
fwd 1 @v0.3
turn 60
n=n-1
if (n>0) “start”
stop
```

What figure does the driven track form?

1	a triangle
2	a star
3	a square
4	a rectangle
5	a hexagon
6	Don’t know