



3.3 Tuning the gain

Control · Robot club · about 20 min

Name _____

Class _____

Date _____

What this lesson is about

Sluggish, good, oscillating. Loop speed and driving speed.

- Too little
- Too much
- Why the loop speed matters
- Measure the sweep
- Speed and gain together

Questions

7 marks in all

1. With a gain of 1 on the curving robot, what happens? [1 mark]
☐ A The correction is too weak: the error grows and the robot ends well off the line
☐ B The robot snakes from side to side
☐ C The robot holds the heading perfectly
☐ D The robot spins on the spot
2. With a gain of 40, the robot snakes. What is that called? [1 mark]
☐ A Oscillation
☐ B Coasting
☐ C Drift
☐ D The dead band
3. Rotation is capped at 100. With a gain of 40, above what heading error is the controller just bang-bang again? Give the number of degrees. [1 mark]
4. What does this program print? [1 mark]

```
errors = [5, 2, -1, -3, 1, 4, -2]
worst, flips, last = 0, 0, 0
for error in errors:
    worst = max(worst, abs(error))
    if error * last < 0:
        flips += 1
    last = error
print("worst", worst, "and", flips, "sign changes")
```

5. Why is a high gain with a slow loop the worst combination? [1 mark]
- ☐ A A big correction keeps running for too long before the next look
 - ☐ B A slow loop makes the gain smaller
 - ☐ C The robot cannot drive while waiting
 - ☐ D The sensor stops working
6. In a sweep of gains, where is the good gain? [1 mark]
- ☐ A Just before the sign changes start climbing
 - ☐ B The highest gain you can type
 - ☐ C The lowest gain, 1
 - ☐ D Wherever the worst error is biggest
7. A gain works well at speed 50. What might happen at speed 100? [1 mark]
- ☐ A It may be sluggish, because the fault acts faster
 - ☐ B It will oscillate more, because speed makes the gain bigger
 - ☐ C Nothing, the gain does not care about speed
 - ☐ D The robot will drive backwards

The task: hold the heading, fast

The zone is narrower and you have six seconds. The starter's gain of 40 wobbles and wastes time, and its speed is too low. Tune both.

```
# the two lines every program starts with: the commands, then the robot
from bugbot import *
connect()

def wrapped(h):
    return (h + 180) % 360 - 180

while position()[1] < 72:
    error = wrapped(0 - heading())
    # forward, sideways, rotation: -100 to 100 each, until the next command
    drive(60, 0, error * 40)
    # pause 0.05 s (the robot keeps doing what it was told)
    wait(0.05)
# all motors off
stop()
```

Plan your program here, then type it in and press Run.



Do it on the robot

www.bugbotlab.com/learn/3-3-tuning-the-gain/

The simulator checks it and tells you when it passes. Nothing to install, no account.

Challenges

1. Find the largest gain that gives at most one sign change at speed 100.
2. Make the gain depend on the speed: $\text{gain} = 4 * \text{speed} / 70$.
3. Log the error every tick into a list and print the list at the end. Where does it peak?