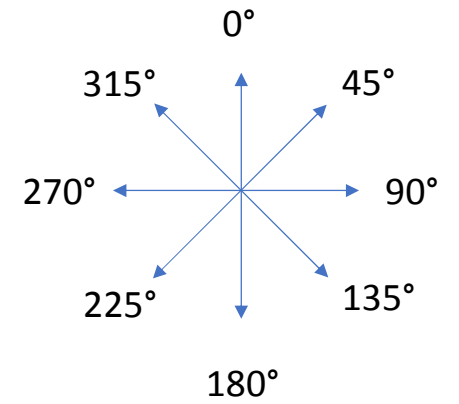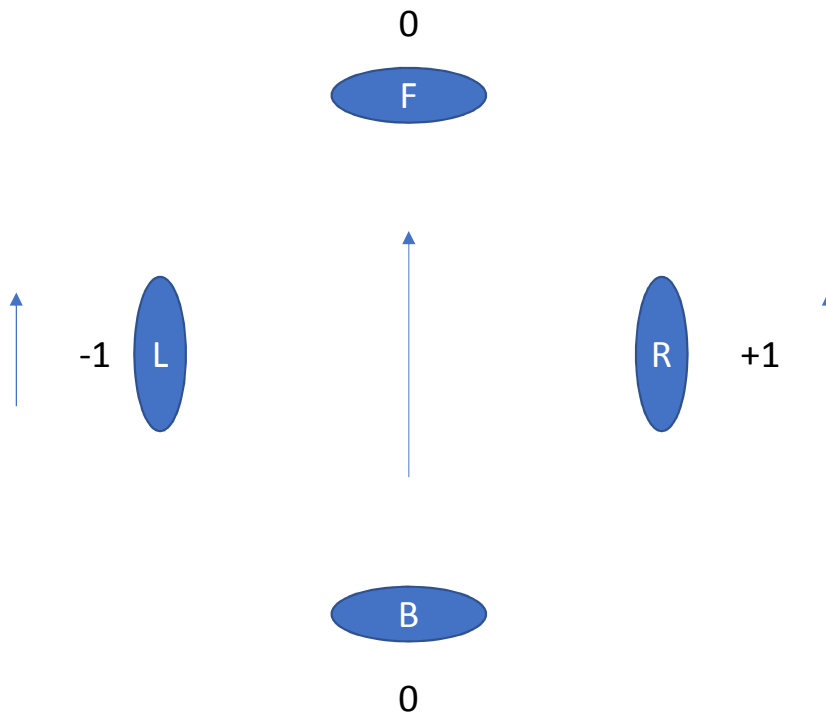# Force Analysis Of Holonomic Wheels

Wheel-Oriented Arrangement
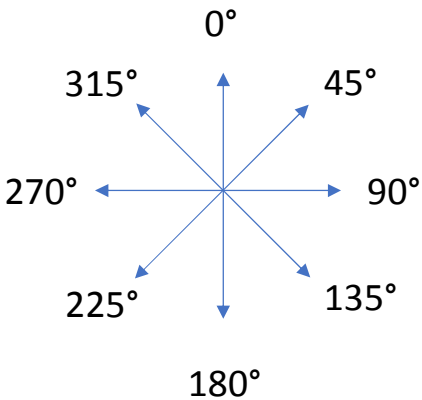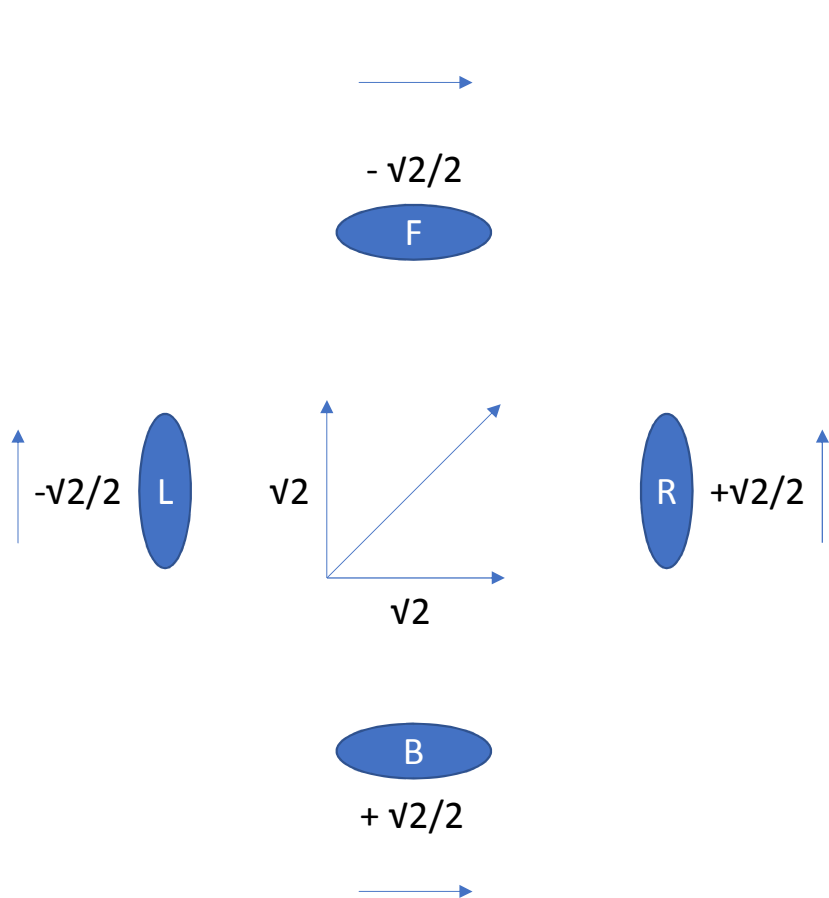
Bearing 0°
velocity 2
F: 0
R: +1
B: 0
L: -1

0

F

-1 L

R +1

B

0

0°

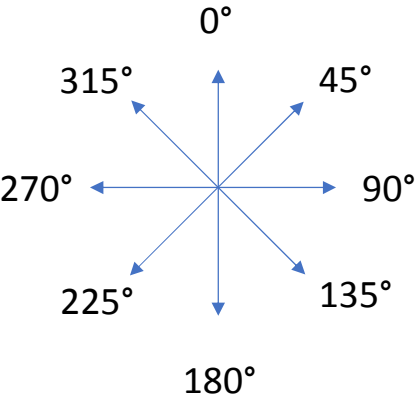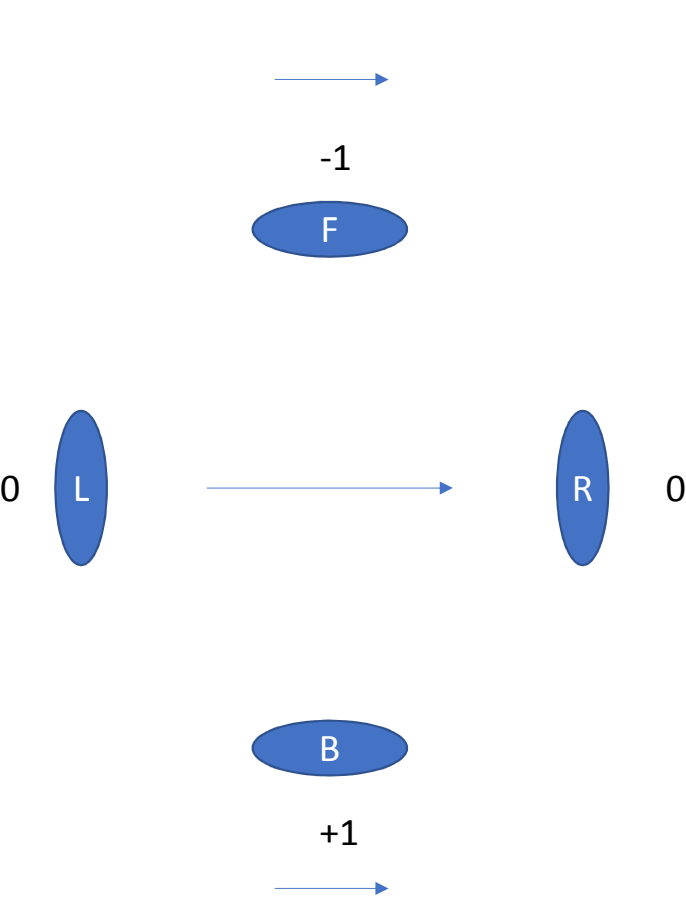315°   45°

270°   90°

225°   135°

180°

Clockwise rotation is positive (+1)
Counterclockwise is negative (-1)
Motion matches compass marks
Forward (north) is bearing 0°,
right (east) is 90°, back is 180°,
and left (west) is 270°.

Bearing 45°
velocity 2
F: -√2/2
R: +√2/2
B: +√2/2
L: -√2/2

- √2/2

F

-√2/2   L   √2

√2

R   +√2/2

B

+ √2/2

0°

315°   45°

270°   90°

225°   135°

180°

Bearing 90°
velocity 2
F: -1
R: 0
B: +1
L: 0

-1

F

0   L   R   0

B

+1

0°
315°   45°
270°   90°
225°   135°
180°

Bearing 135°
velocity 2
F: -√2/2
R: -√2/2
B: +√2/2
L: +√2/2

- √2/2

F

0°

315°   45°

270°   90°

225°   135°

180°

√2

√2

+√2/2   L   √2   R   -√2/2

B

+ √2/2

Bearing 180°
velocity 2
F: 0
R: -1
B: 0
L: +1
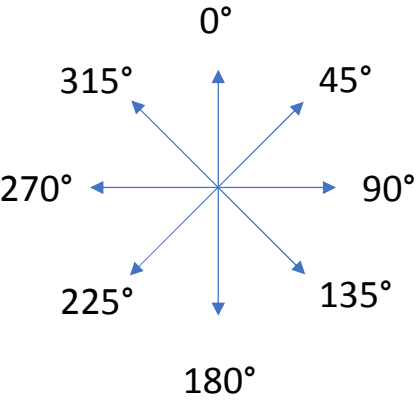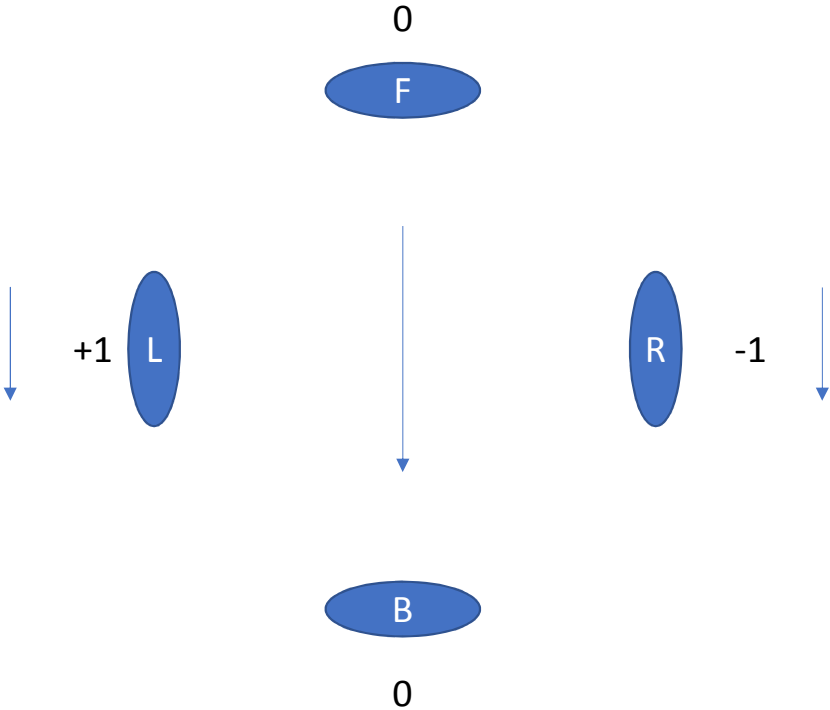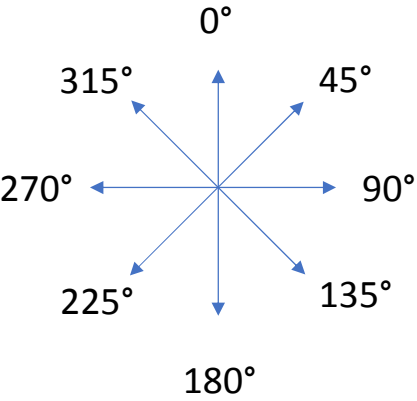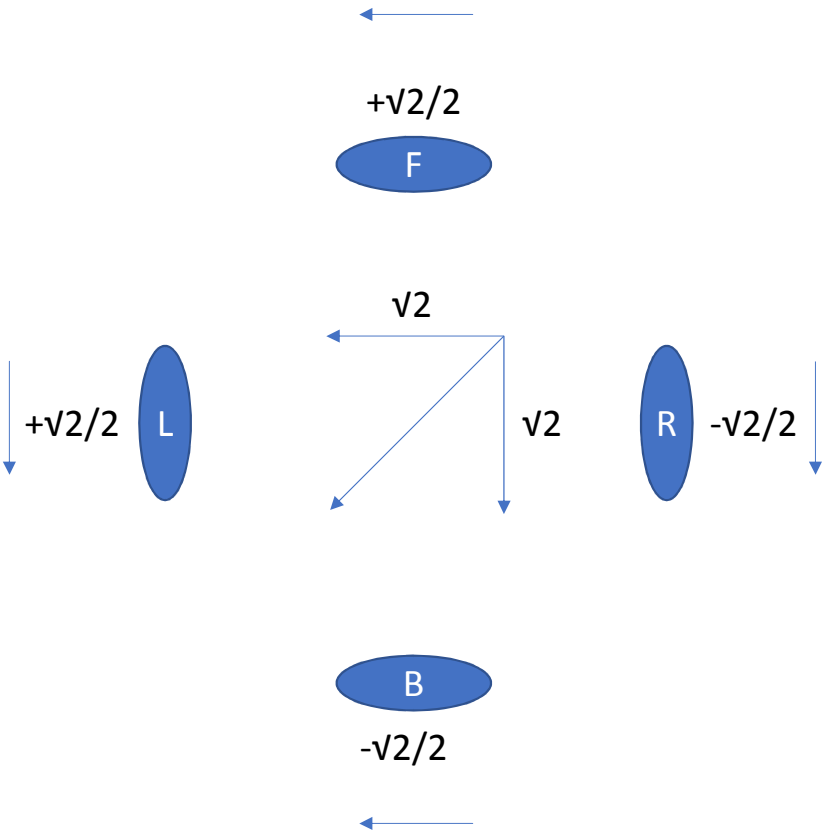
0

F

+1 L

R -1

B

0

0°

315°   45°

270°   90°

225°   135°

180°

Bearing 225°
velocity 2
F: +√2/2
R: -√2/2
B: -√2/2
L: +√2/2

+√2/2

F

+√2/2   L

√2

√2

R   -√2/2

B

-√2/2

0°

315°   45°

270°   90°

225°   135°

180°

Bearing 270°
velocity 2
F: +1
R: 0
B: -1
L: 0

0°

315°   45°

270°   90°
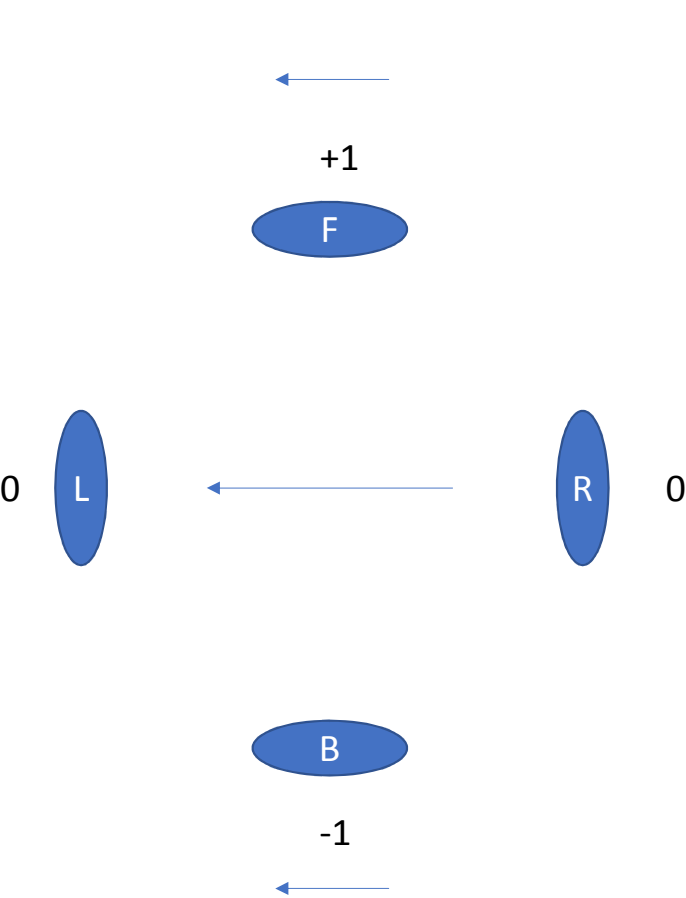
225°   135°

180°

+1

F

0   L   R   0

B

-1

Bearing 225°
velocity 2
F: +√2/2
R: +√2/2
B: -√2/2
L: -√2/2

+√2/2

F

-√2/2 L

√2

R +√2/2

√2

B

-√2/2

0°

315°   45°

270°   90°

225°   135°

180°
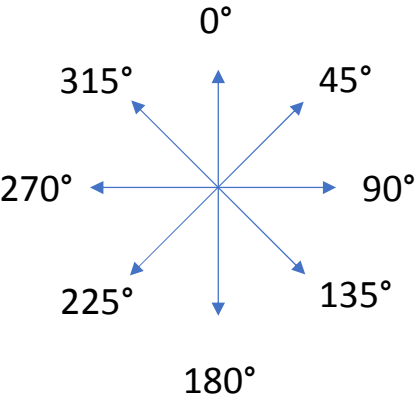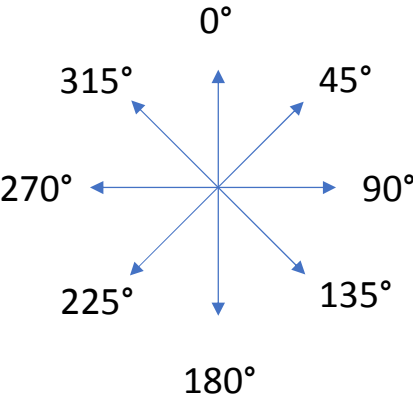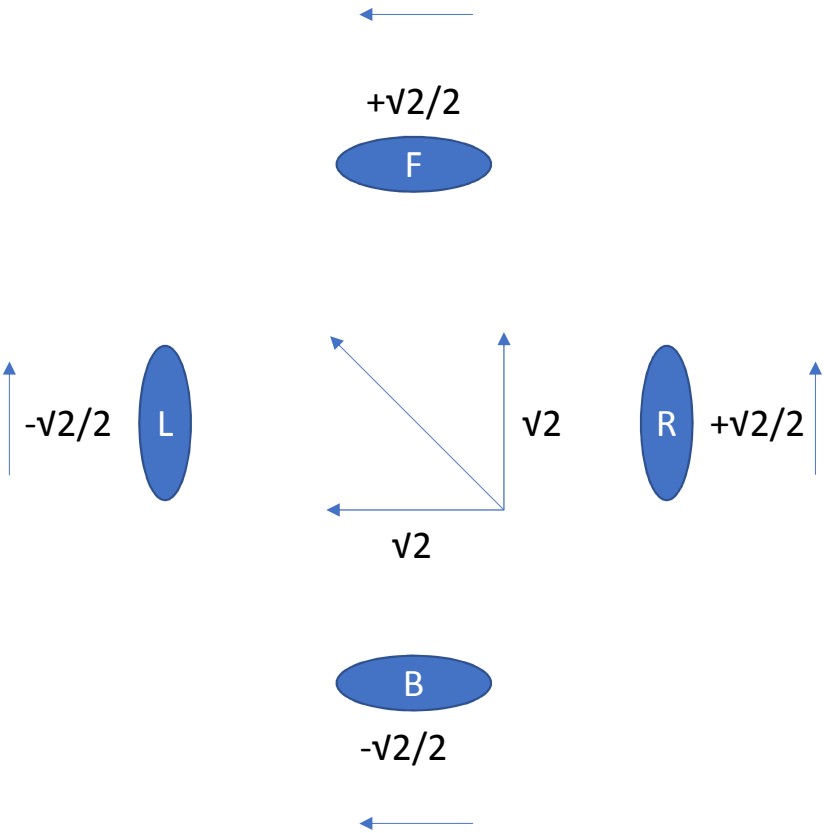
Bearing	0°	45°	90°	135°	180°	225°	270°	315°	
sin(b)	0	+√2/2	1	+√2/2	0	-√2/2	-1	-√2/2	
cos(b)	1	+√2/2	0	-√2/2	-1	-√2/2	0	+√2/2	
Front	0	-√2/2	-1	-√2/2	0	+√2/2	+1	+√2/2	-sin(b)
Right	+1	+√2/2	0	-√2/2	-1	-√2/2	0	+√2/2	cos(b)
Back	0	+√2/2	+1	+√2/2	0	-√2/2	-1	-√2/2	sin(b)
Left	-1	-√2/2	0	+√2/2	+1	+√2/2	0	-√2/2	-cos(b)

Frame-Oriented Arrangement

Bearing 0°
velocity 2
FL: -√2/2
FR: +√2/2
BR: +√2/2
BL: -√2/2
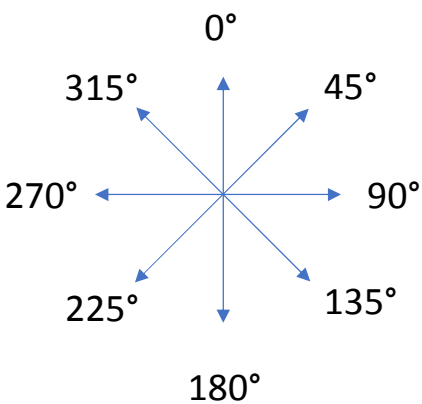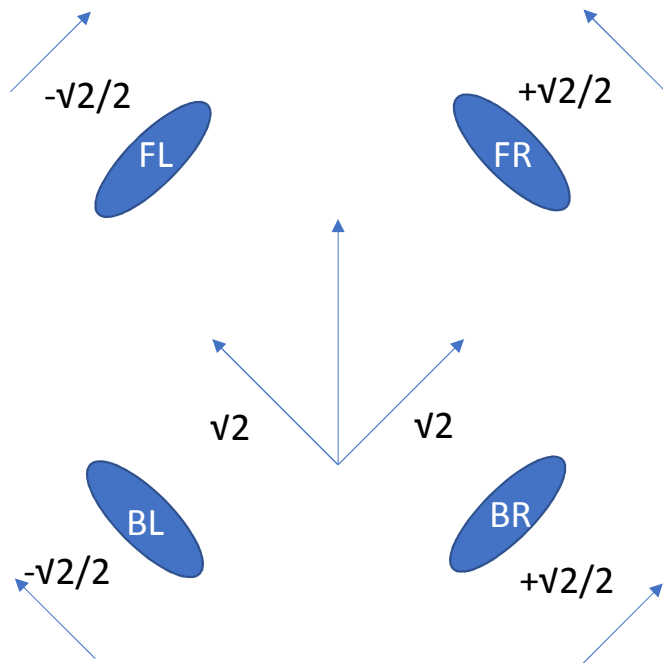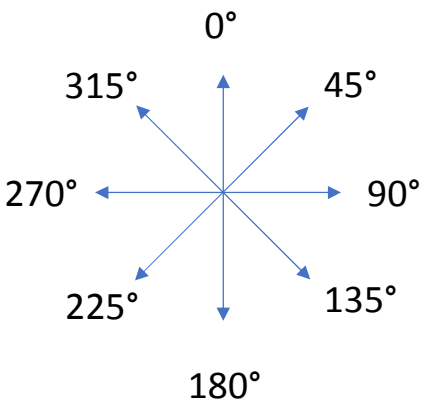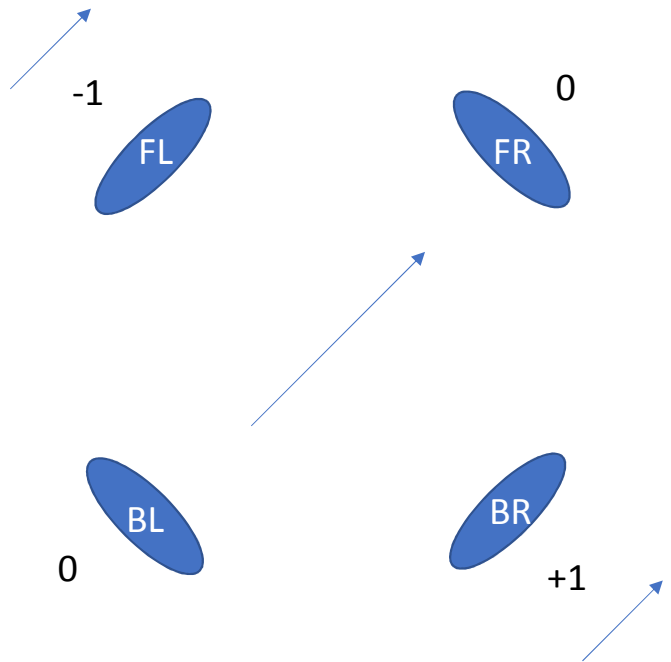
-√2/2

FL

+√2/2

FR

√2

√2

BL

BR

-√2/2

+√2/2

0°

315°

45°

270°

90°

225°

135°

180°

Bearing 45°
velocity 2
FL: -1
FR: 0
BR: +1
BL: 0

-1

FL

0

FR

BL

0

BR

+1

0°
315°   45°
270°   90°
225°   135°
180°

Bearing 90°
velocity 2
FL: -√2/2
FR: -√2/2
BR: +√2/2
BL: +√2/2

-√2/2

FL

-√2/2

FR

√2

√2

+√2/2

BL

BR

+√2/2

0°

315°   45°

270°   90°

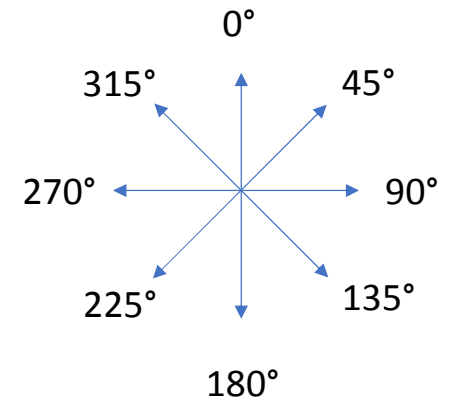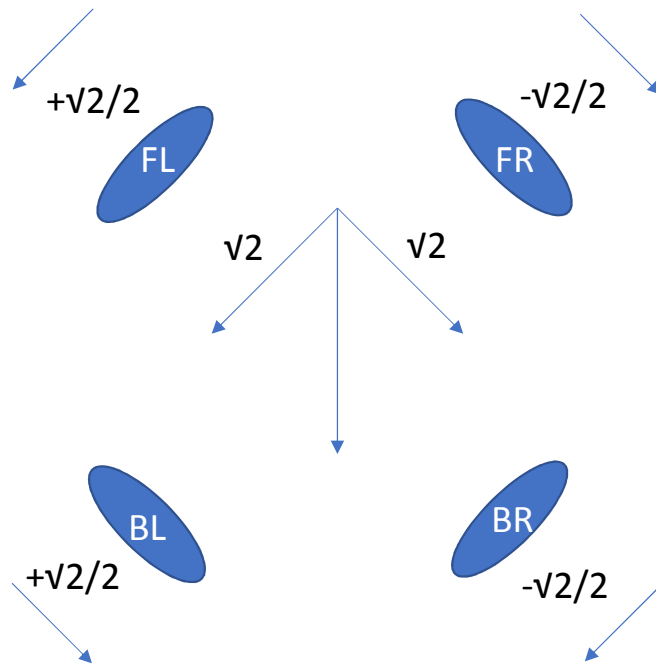225°   135°

180°

Bearing 135°
velocity 2
FL: 0
FR: -1
BR: 0
BL: +1

0

FL

-1

FR

+1

BL

BR

0

0°

315°

45°

270°

90°

225°

135°

180°

Bearing 180°
velocity 2
FL: +√2/2
FR: -√2/2
BR: -√2/2
BL: +√2/2

+√2/2

-√2/2

FL

FR

√2

√2

BL

BR

+√2/2

-√2/2

0°

315°

45°

270°

90°

225°

135°

180°

Bearing 225°
velocity 2
FL: +1
FR: 0
BR: -1
BL: 0

+1

FL

0

FR

0

BL

-1

BR

0°

315°   45°

270°   90°

225°   135°

180°

Bearing 270°
velocity 2
FL: +√2/2
FR: +√2/2
BR: -√2/2
BL: -√2/2

+√2/2

FL

FR

+√2/2

√2

√2

BL

BR

-√2/2

-√2/2

0°

315°

45°

270°

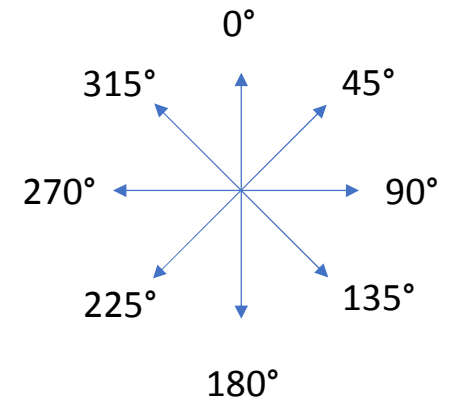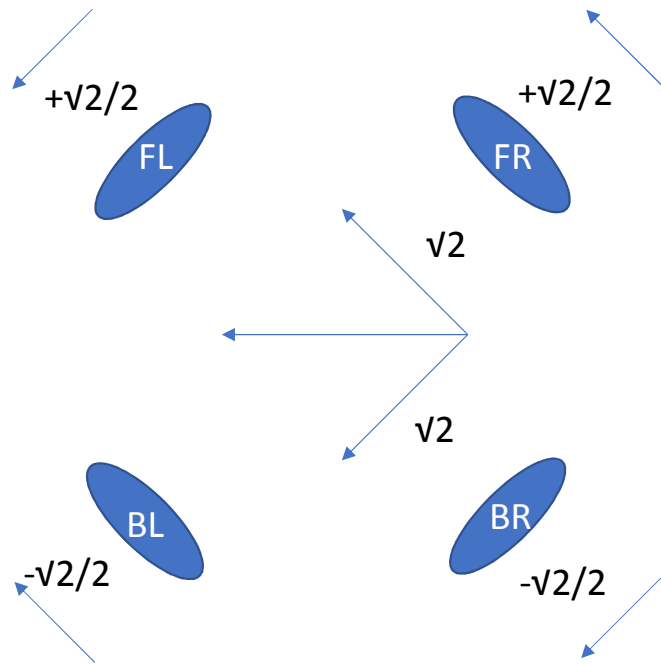90°

225°

135°

180°
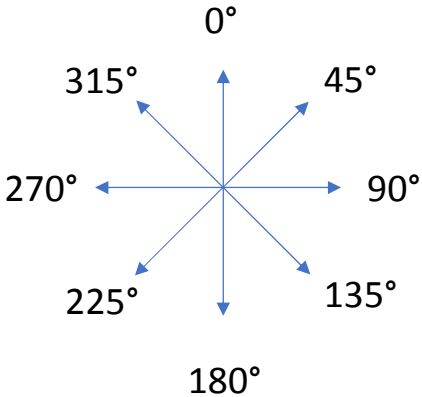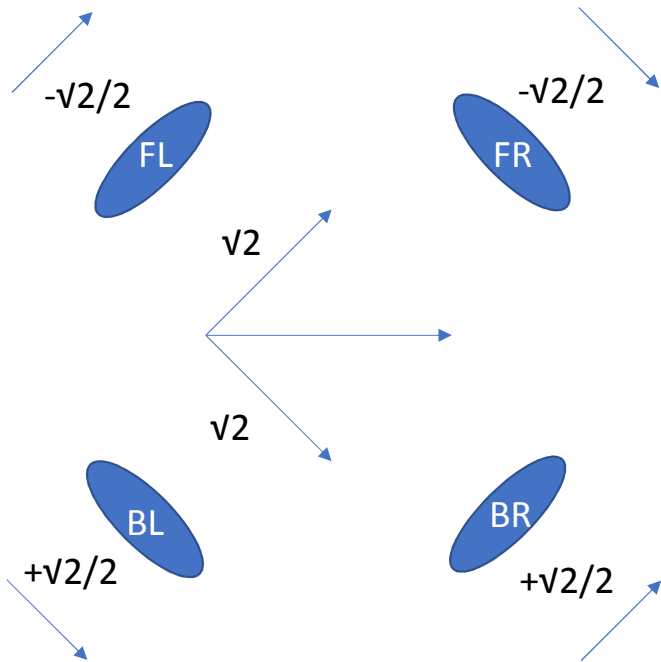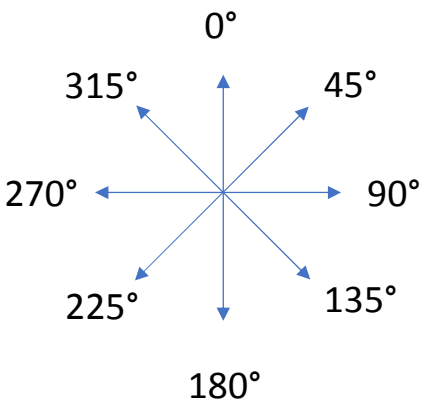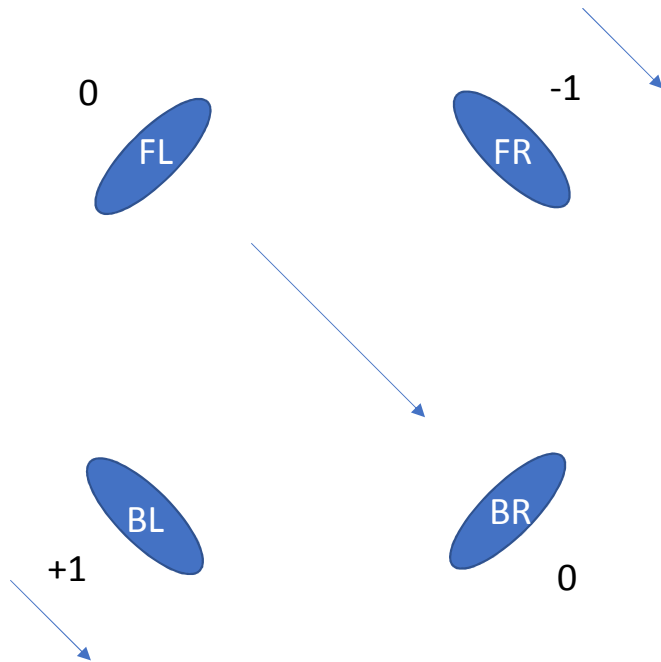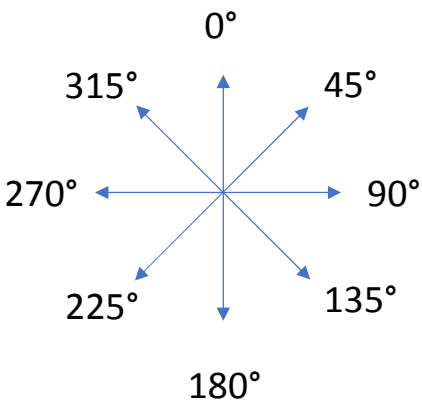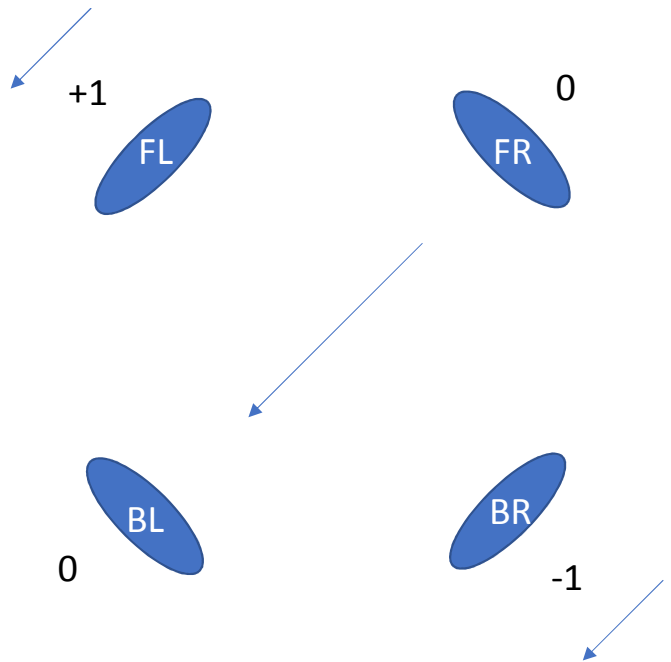
Bearing 315°
velocity 2
FL: 0
FR: +1
BR: 0
BL: -1

0   FL

+1   FR

-1   BL

BR   0

0°
315°   45°
270°   90°
225°   135°
180°
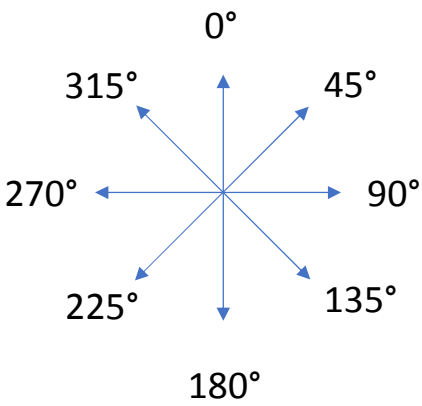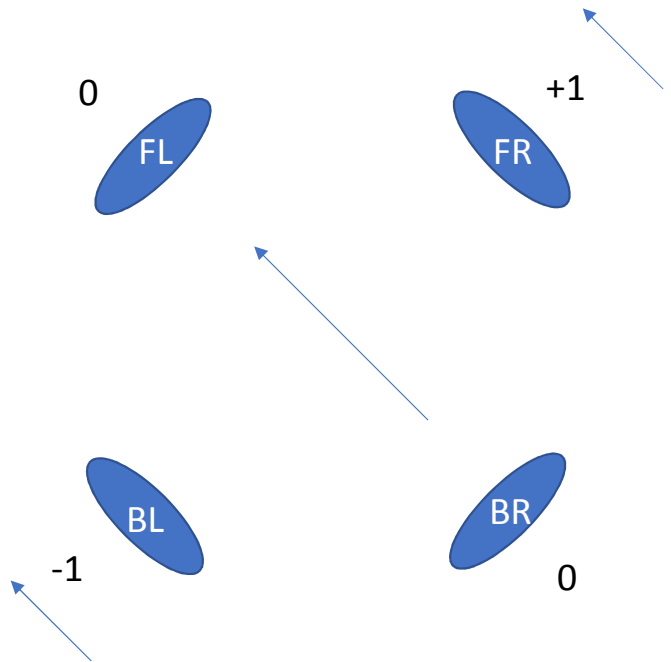
Bearing	0°	45°	90°	135°	180°	225°	270°	315°	
sin(b+45°)	+√2/2	+1	+√2/2	0	-√2/2	-1	-√2/2	0	
cos(b+45°)	+√2/2	0	-√2/2	-1	-√2/2	0	+√2/2	+1	
Front Left	-√2/2	-1	-√2/2	0	+√2/2	+1	+√2/2	0	-sin(b+45°)
Front Right	+√2/2	0	-√2/2	-1	-√2/2	0	+√2/2	+1	cos(b+45°)
Back Right	+√2/2	+1	+√2/2	0	-√2/2	-1	-√2/2	0	sin(b+45°)
Back Left	-√2/2	0	+√2/2	+1	+√2/2	0	-√2/2	-1	-cos(b+45°)

Rotation

Rotate Right
velocity 2
F: -1
R: -1
B: -1
L: -1

-1

F

-1   L

R   -1

B

-1

0°

315°   45°

270°   90°

225°   135°

180°
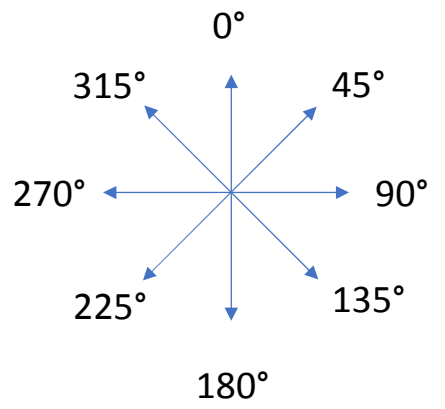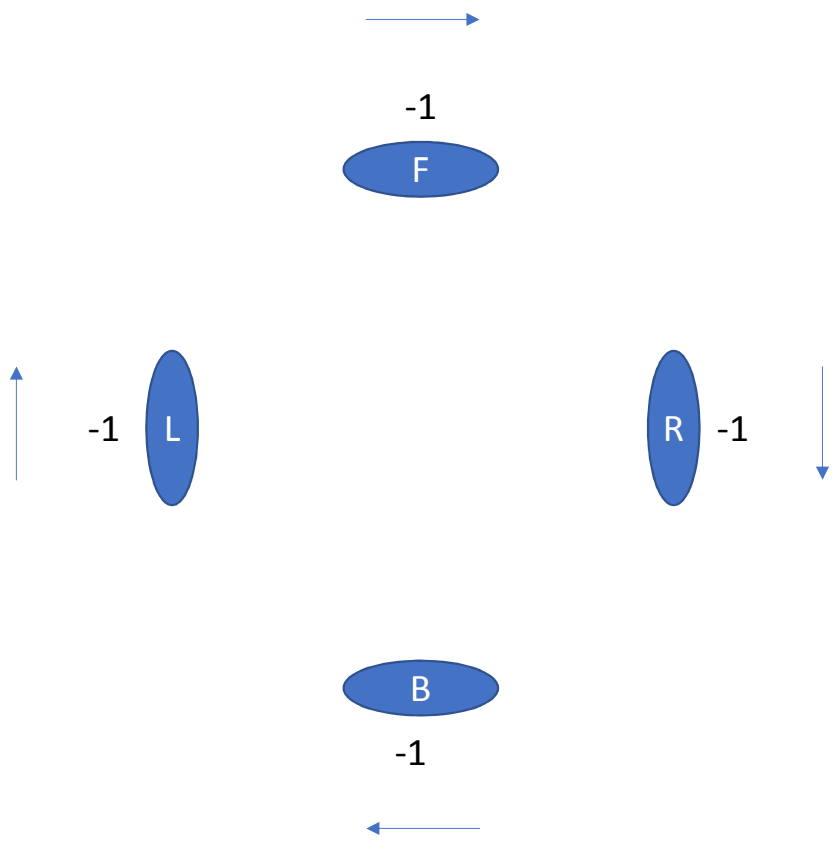
Rotate Left
velocity 2
F: +1
R: +1
B: +1
L: +1

+1

F

+1 L

R +1

B

+1

0°

315°

45°

270°

90°

225°

135°

180°
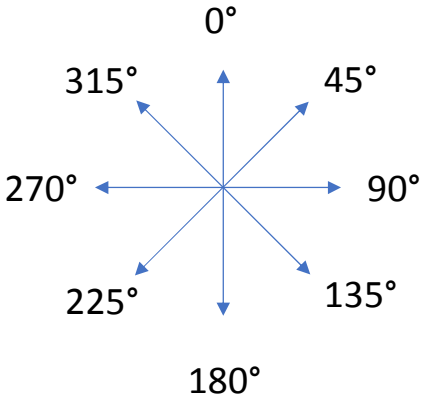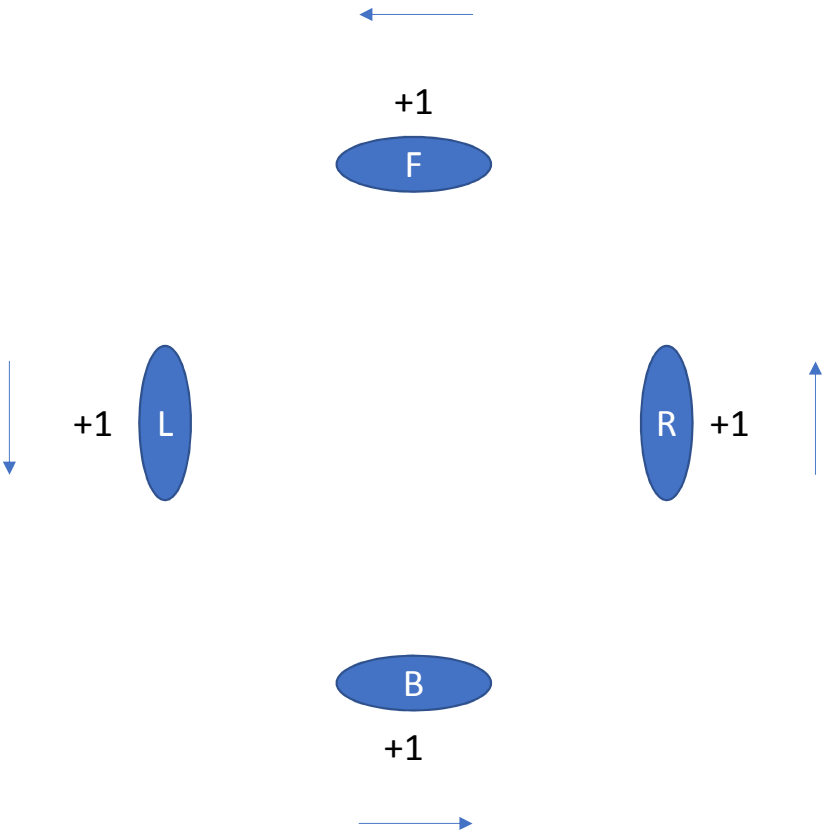
Joystick Calculations

7π/4   0   π/4

5π/4   3π/2   7π/4

+1.0

-1.0 ← x → +1.0

-1.0

Active

α

y   0   π/2

3π/2   π

Clipped

+1.0

3π/4   π/2   π/4

5π/4   π   3π/4

0°

315°   45°

270° ←   → 90°

225°   135°

180°
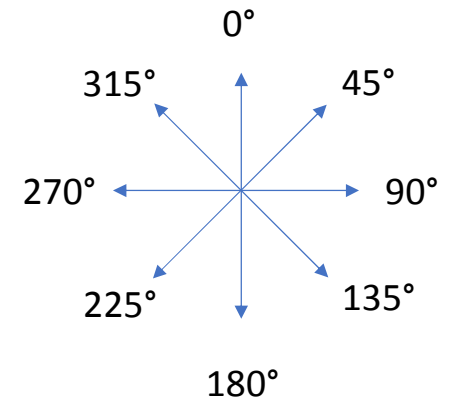
$\alpha = atan2(y, x)$
$bearing = \alpha + \pi/2$
$length = \sqrt{(x^2+y^2)}$
$r = min(length, 1.0)$

$FL = -r\ sin(\alpha + 3\pi/4)$
$FR = r\ cos(\alpha + 3\pi/4)$
$BR = r\ sin(\alpha + 3\pi/4)$
$BL = -r\ cos(\alpha + 3\pi/4)$