# IMAT 5233 Intelligent Mobile Robotics

## Additional Maths Exercises Answers

**Question 1**

a) The robot has moved -0.8m in x and 1.2m in y. How far has the robot travelled?

b) The robot has moved 2.2m in x and -0.2m in y. How far has the robot travelled?

c) The robot has travelled 3.2m at a heading of 38°. How far has the robot travelled in x and y?

SOHCAHTOA
x is adjacent
y is opposite

d) The robot has travelled 1.9m at a heading of -72° from a starting position of (-2.1m, 1.9m). Where is the robot now?

e) The robot is positioned at (1.3m 1.6m). The robots sonar sensor detects an obstacle 2.1m away at a heading 35°. Where is the obstacle?

**Question 2**

a) Convert the following into radians:

| 180° | 270° | -34° | 326° |
|---|---|---|---|
| 3.14($\pi$) | 4.71(1.5 $\pi$) | -0.59 | 5.69 |

b) Convert the following into degrees:

| | | | |
|---|---|---|---|
| 1.75R | 2.68R | 0.5πR | 1.5πR |
| 100° | 154° | 90° | 270° |

**Question 3**

The robots position is (1.2, 3.6, 120°). The robots sonar sensor detects an obstacle 1.4m away at a heading of -85°. Where, in terms of the global co-ordinate space, is the obstacle?

**Question 4**

A robot helicopter has been programmed to maintain an altitude of 0.08m. The helicopter is fitted with a sonar sensor on the bottom which records distance to the ground in mm. Find the RMSE of the helicopters control performance given the data readings below:

| Time (s) | 65:26 | 65:39 | 65:51 | 66:03 | 66:12 | 66:24 | 66:37 | 66:50 | 67:01 |
|---|---|---|---|---|---|---|---|---|---|
| Sonar reading (mm) | 85 | 82 | 79 | 75 | 72 | 77 | 84 | 86 | 83 |
| Error | 5 | 2 | -1 | -5 | -8 | -3 | 4 | 6 | 3 |
| Squared error | 25 | 4 | 1 | 25 | 64 | 9 | 16 | 36 | 9 |

Mean squared error = 21

Root mean squared error = 4.58

**Question 5**

Fit a linear trend line to the data below:

| H Bridge Current (mA) | 42 | 36 | 41 | 22 | 34 | 28 | 38 | 24 | 26 |
|---|---|---|---|---|---|---|---|---|---|
| Motor Speed (RPM) | 31 | 26 | 32 | 19 | 29 | 24 | 30 | 19 | 22 |

| x | y | x2 | xy |
|---|---|---|---|
| 42 | 31 | 1764 | 1302 |
| 36 | 26 | 1296 | 936 |
| 41 | 32 | 1681 | 1312 |
| 22 | 19 | 484 | 418 |
| 34 | 29 | 1156 | 986 |
| 28 | 24 | 784 | 672 |
| 38 | 30 | 1444 | 1140 |
| 24 | 19 | 576 | 456 |
| 26 | 22 | 676 | 572 |

| | | | | |
|---|---|---|---|---|
| Sum | 291 | 232 | 9861 | 7794 |
| Mean | 32.33 | 25.78 | 1095.67 | 866.00 |

| x | y | x-xbar | y-ybar | x-xbar2 | x-xbar X y-ybar |
|---|---|---|---|---|---|
| 42 | 31 | 9.67 | 5.22 | 93.44 | 50.48 |
| 36 | 26 | 3.67 | 0.22 | 13.44 | 0.81 |
| 41 | 32 | 8.67 | 6.22 | 75.11 | 53.93 |
| 22 | 19 | -10.33 | -6.78 | 106.78 | 70.04 |
| 34 | 29 | 1.67 | 3.22 | 2.78 | 5.37 |
| 28 | 24 | -4.33 | -1.78 | 18.78 | 7.70 |
| 38 | 30 | 5.67 | 4.22 | 32.11 | 23.93 |
| 24 | 19 | -8.33 | -6.78 | 69.44 | 56.48 |
| 26 | 22 | -6.33 | -3.78 | 40.11 | 23.93 |

| | | | | | | |
|---|---|---|---|---|---|---|
| sum | 291.00 | 232.00 | 0.00 | 0.00 | 452.00 | 292.67 |

| | | |
|---|---|---|
| m | 0.65 | Equation in lecture notes |
| c | 4.84 | We know m, rearrange y=mx+c using x bar and y bar |

**Question 6**

Find the Pearson correlation coefficient for the data above.