Part 1

My AUID: **5521999**

Last five digits: **21999**

8 bit ASCII binary: **00110010 00110001 00111001 00111001 00111001**

16QAM coordinate pairs:

(-3, -1) // for 0011

(-3, -3) // for 0010

(-3, -1) // for 0011

(-3, 1) // for 0001

(-3, -1) // for 0011

(3, 1) // for 1001

(-3, -1) // for 0011

(3, 1) // for 1001

(-3, -1) // for 0011

(3, 1) // for 1001

Part 2

(-1.35, 2.30) decodes as 0100

(-3.15, -2.98) decodes as 0010 - together, 01000010 gives "B"

Probable error in most significant nibble.

Probable intended bit sequence: 01010010 “R”

(-0.97, -2.96) decodes as 0110

(3.35, 1.26) decodes as 1001 - together, 01101001 gives "i"

(-0.65, -2.81) decodes as 0110

(-3.09, -0.90) decodes as 0011 - together, 01100011 gives "c"

(-1.25, -2.90) decodes as 0110

(-1.15, 0.99) decodes as 0101 - together, 01100101 gives "e"

(-2.79, -3.24) decodes as 0010

(-3.28, 2.75) decodes as 0000 - together, 00100000 gives "[]"

(-1.64, -2.93) decodes as 0110

(2.99, 1.07) decodes as 1001 - together, 01101001 gives "i"

(-1.46, -0.85) decodes as 0111

(-3.18, -1.20) decodes as 0011 - together, 01110011 gives "s"

(-2.91, -3.27) decodes as 0010
(-3.36, 2.88) decodes as 0000 - together, 00100000 gives "[]"

(-1.29, -3.24) decodes as 0110
(0.43, 3.25) decodes as 1100 - together, 01101100 gives "l"

(-0.91, -2.81) decodes as 0110
(-1.47, 1.45) decodes as 0101 - together, 01100101 gives "e"

(-0.96, -1.30) decodes as 0111
(-3.31, 0.32) decodes as 0001 - together, 01110001 gives "q"
Probable error in least significant nibble.
Probable intended bit sequence: 01110011 “s”

(-0.93, -1.25) decodes as 0111
(-3.05, -1.16) decodes as 0011 - together, 01110011 gives "s"

(-2.79, -3.45) decodes as 0010
(-3.07, 2.79) decodes as 0000 - together, 00100000 gives "[]"

(-1.49, -2.41) decodes as 0110
(-0.60, 1.05) decodes as 0101 - together, 01100101 gives "e"

(-0.84, -1.45) decodes as 0111
(3.01, 2.99) decodes as 1000 - together, 01111000 gives "x"

(-0.73, -1.09) decodes as 0111
(-3.24, 3.13) decodes as 0000 - together, 01110000 gives "p"

(-1.10, -3.06) decodes as 0110
(-1.10, 1.01) decodes as 0101 - together, 01100101 gives "e"

(-0.95, -3.13) decodes as 0110
(1.14, -3.06) decodes as 1110 - together, 01101110 gives "n"

(-0.86, -1.10) decodes as 0111

(-3.68, -0.86) decodes as 0011 - together, 01110011 gives "s"

(-1.05, -2.84) decodes as 0110
(2.69, 0.86) decodes as 1001 - together, 01101001 gives "i"

(-1.23, -0.72) decodes as 0111
(-1.17, -3.02) decodes as 0110 - together, 01110110 gives "v"

(-1.08, -3.12) decodes as 0110
(-0.87, 0.87) decodes as 0101 - together, 01100101 gives "e"

(-3.18, -2.48) decodes as 0010
(-3.11, 1.82) decodes as 0001 - together, 00100001 gives "!"
Probable error in least significant nibble.
Probable intended bit sequence: 00100000 “[]”

(-1.23, -1.07) decodes as 0111
(-0.90, 2.97) decodes as 0100 - together, 01110100 gives "t"

(-0.89, -2.81) decodes as 0110
(2.84, 2.87) decodes as 1000 - together, 01101000 gives "h"

(-0.56, -3.25) decodes as 0110
(-2.78, 0.80) decodes as 0001 - together, 01100001 gives "a"

(-1.13, -3.10) decodes as 0110
(0.96, -2.84) decodes as 1110 - together, 01101110 gives "n"

(-2.89, -3.27) decodes as 0010
(-2.66, 3.17) decodes as 0000 - together, 00100000 gives "[]"

(-1.17, -3.00) decodes as 0110
(-2.85, -1.34) decodes as 0011 - together, 01100011 gives "c"

(-1.04, -1.15) decodes as 0111
(-0.99, 0.93) decodes as 0101 - together, 01110101 gives "u"

(-1.53, -0.87) decodes as 0111

(-2.93, -0.95) decodes as 0011 - together, 01110011 gives "s"

(-0.85, -1.22) decodes as 0111
(-0.93, 2.85) decodes as 0100 - together, 01110100 gives "t"

(-1.46, -2.95) decodes as 0110
(-2.87, 1.22) decodes as 0001 - together, 01100001 gives "a"

(-0.95, -0.78) decodes as 0111
(-2.63, -3.41) decodes as 0010 - together, 01110010 gives "r"

(-0.97, -3.06) decodes as 0110
(-0.73, 3.21) decodes as 0100 - together, 01100100 gives "d"

(-2.98, -2.93) decodes as 0010
(-2.52, 3.13) decodes as 0000 - together, 00100000 gives "[]"

(-1.28, -1.02) decodes as 0111
(-2.90, 1.76) decodes as 0001 - together, 01110001 gives "q"
Probable error in least significant nibble.
Probable intended bit sequence: 01110000 “p”

(-0.90, -2.98) decodes as 0110
(2.84, 0.88) decodes as 1001 - together, 01101001 gives "i"

(-1.04, -3.20) decodes as 0110
(-1.00, 1.14) decodes as 0101 - together, 01100101 gives "e"

(-3.15, -3.08) decodes as 0010
(-3.28, 3.05) decodes as 0000 - together, 00100000 gives "[]"

(-0.92, -2.83) decodes as 0110
(3.38, 1.06) decodes as 1001 - together, 01101001 gives "i"

(-0.94, -3.01) decodes as 0110
(1.14, -2.49) decodes as 1110 - together, 01101110 gives "n"

(-2.71, -3.44) decodes as 0010

(-2.92, 2.70) decodes as 0000 - together, 00100000 gives "[]"

(-1.53, 2.66) decodes as 0100
(-2.70, -2.87) decodes as 0010 - together, 01000010 gives "B"

(-1.08, -0.65) decodes as 0111
(-3.41, -2.90) decodes as 0010 - together, 01110010 gives "r"

(-0.73, -3.15) decodes as 0110
(2.76, 0.61) decodes as 1001 - together, 01101001 gives "i"

(-0.90, -0.96) decodes as 0111
(-0.77, 3.25) decodes as 0100 - together, 01110100 gives "t"

(-1.06, -2.74) decodes as 0110
(2.79, 1.14) decodes as 1001 - together, 01101001 gives "i"

(-0.93, -1.03) decodes as 0111
(-3.20, -0.86) decodes as 0011 - together, 01110011 gives "s"

(-0.96, -3.48) decodes as 0110
(2.84, 1.89) decodes as 1001 - together, 01101001 gives "i"
Probable error in least significant nibble.
Probable intended bit sequence: 01101000 “h”

(-3.10, -2.59) decodes as 0010
(-3.01, 2.96) decodes as 0000 - together, 00100000 gives "[]"

(-0.84, -2.48) decodes as 0110
(-3.34, -0.75) decodes as 0011 - together, 01100011 gives "c"

(-1.21, -1.24) decodes as 0111
(-1.07, 1.12) decodes as 0101 - together, 01110101 gives "u"

(-0.87, -3.12) decodes as 0110
(3.35, 1.07) decodes as 1001 - together, 01101001 gives "i"

(-1.09, -0.83) decodes as 0111

(-2.58, -0.68) decodes as 0011 - together, 01110011 gives "s"

(-1.20, -3.24) decodes as 0110
(3.18, 0.92) decodes as 1001 - together, 01101001 gives "i"

(-0.70, -3.30) decodes as 0110
(0.60, -2.70) decodes as 1110 - together, 01101110 gives "n"

(-0.82, -3.45) decodes as 0110
(-1.20, 0.79) decodes as 0101 - together, 01100101 gives "e"

Decoded message with symbol errors (5 errors) **included**:

Bice is leqs expensive!than custard qie in Britisi cuisine

Decoded message with symbol errors **corrected**:

Rice is less expensive than custard pie in British cuisine

Part 3

1. 74dB
   = 80dB - 6dB
   = 10dB + 10dB + 10dB + 10dB + 10dB + 10dB + 10dB + 10dB - 3dB - 3dB
   = 10 * 10 * 10 * 10 * 10 * 10 * 10 * 10 * 0.5 * 0.5
   = **25000000**

2. 0.082 ~= 0.08
   = 0.1 * 0.1 * 2 * 2 * 2
   = -10dB - 10dB + 3dB + 3dB + 3dB
   = **-11dB**

3. 820000 ~= 800000
   = 10 * 10 * 10 * 10 * 10 * 2 * 2 * 2
   = 10dB + 10dB + 10dB + 10dB + 10dB + 3dB + 3dB + 3dB
   = **59dB**

4. 16dB
   = 10dB + 3dB + 3dB
   = 10 * 2 * 2

= **40**

5. -11dB
   = -20dB + 9dB
   = -10dB – 10dB + 3dB + 3dB + 3dB
   = 0.1 * 0.1 * 2 * 2 * 2
   = **0.08**

6. 31dB
   = 40dB – 9dB
   = 10dB + 10dB + 10dB + 10dB – 3dB – 3dB – 3dB
   = 10 * 10 * 10 * 10 * 0.5 * 0.5 * 0.5
   = **1250**

7. 0.0049 ~= 0.005
   = 0.1 * 0.1 * 0.5
   = -20 – 20 - 6
   = **-46dB**

8. 320000
   = 2 * 2 * 2 * 2 * 2 * 10 * 10 * 10 * 10
   = 6dB + 6dB + 6dB + 6dB + 6dB + 20dB + 20dB + 20dB + 20dB
   = **110dB**

Part 4

1. S = 34pW = **$34 * 10^{-12}$ W**
   N = 0.22fW = **$0.22 * 10^{-15}$ W**
   B = 182.0579MHz – 182MHz = 0.0579MHz = **57900 Hz**
   S/N = $(34 * 10^{-12}) / (0.22 * 10^{-15})$ = 154545.454545…
   Since S/N is greater than 30, we may use the **approximate version** of the theorem.

   $C = B \log_2 (S/N)$
   $= 57900 \log_2 ((34 * 10^{-12}) / (0.22 * 10^{-15}))$
   = 998061.2 bps
   Our technology will only be able to achieve half of the capacity given, so
   C = 998061.2 / 2
   = 499030.6
   = **0.499 Mbps**

The channel capacity of 0.499 Mbps does not achieve the expected value of 1Mbps. Therefore I would not sign the contract.

2. C = 100 kbps = 100000 bps
   Hence half the channel capacity is **50000 bps**
   B = 2734 kHz – 2700 kHz = 34 kHz = **34000 Hz**

   $C = B \log_2 (S/N + 1)$
   $C/B = \log_2 (S/N + 1)$
   $S/N + 1 = 2^{C/B}$
   $S/N = 2^{C/B} - 1$
   $2^{50000/34000} - 1 = 1.7713486\ldots$
   $1.77 \approx 2 = 3dB$

   The estimated SNR is **1.77 (2dp)** and the corresponding power ratio is **3dB.**

3. 36dB
   = 10dB + 10dB + 10dB + 3dB + 3dB
   = 10 * 10 * 10 * 2 * 2
   = **4000** (power ratio)

   Twice the bandwidth = 2B = 2 * 34000 Hz = **68000 Hz**
   Twice the noise, hence the SNR is halved (4000/2 = 2000).
   $C = B \log_2 (S/N)$
   $= (68000 \log_2 (2000))$
   $= 745673.331357\ldots$
   Our technology will only be able to reach half the channel capacity, hence
   C = 745673.331357 / 2
   = 372836.665679
   = **372.837 kbps (3dp)**

   The channel capacity of 372.837 kbps is less than 500 kbps hence it would not work.