Part 1:
1)

$$\text{World} \atop \text{Cube}[P] = {}^{World}_{Cam}[T] \cdot {}^{Cam}_{Cube}[P]$$

$$\left({}^{World}_{Cam}[T]\right)^{-1}{}^{world}_{cube}[P] = {}^{Cam}_{Cube}[P]$$

$$\left(\begin{bmatrix} 0 & -1 & 0 & 0.25 \\ -1 & 0 & 0 & -0.075 \\ 0 & 0 & -1 & 1.02 \\ 0 & 0 & 0 & 1 \end{bmatrix}\right)^{-1} \cdot \begin{bmatrix} 0.056 \\ -0.213 \\ 0.214 \\ 1 \end{bmatrix} = \begin{bmatrix} 0 & -1 & 0 & -0.075 \\ -1 & 0 & 0 & 0.25 \\ 0 & 0 & -1 & 1.02 \\ 0 & 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} 0.056 \\ -0.213 \\ 0.214 \\ 1 \end{bmatrix} = \begin{bmatrix} 0.138 \\ 0.194 \\ 0.806 \\ 1 \end{bmatrix}$$

2)

$$u_0 = v_0 = resolution / 2$$

$$p = 1 / pixels\ per\ m$$

$$x_c = p(u_c - u_0), \quad y_c = p(v_c - v_0)$$

$$x = 2 \cdot x_c / f \qquad y = 2 y_c / t$$

$$\begin{bmatrix} 0.138 \\ 0.193 \\ 0.805 \end{bmatrix}$$

4)
https://youtu.be/sd763AeN8E0

Part 2:
https://youtu.be/Hv3eGrI7yjc

Part 3:
1)
FCN:

Layer	Input Size	Output Size
1	784	128
2	128	64
3	64	10

CNN:

Layer	Input Channel Size	Output Channel Size	Input Array Size	Output Array Size

1 - Conv	1	128	28*28*1	24*24*32
2 - Maxpool	N/A	N/A	24*24*32	12*12*32
3 - Conv	128	128	12*12*32	10*10*32
4 - Maxpool	N/A	N/A	10*10*64	5*5*64
5 - Conv	128	64	5*5*32	4*4*64
6 - Maxpool	N/A	N/A	4*4*64	2*2*64
7 - fully connected	256	128	2*2*64	128
8 - fully connected	128	10	128	10

2)
Accuracy on the test set: 92.0%

3)
Accuracy on the test set: 98.34%

4)
a)
Accuracy on the test set: 97.78%

b)
The test accuracy is lower because there is missing data in the training set. This happens because the learning algorithm doesn't have as accurate information to make the decision. To be honest, I was surprised that the accuracy was that high.

Problem 4:
1)
I felt like all 3 were close in accuracy, but the order was CNN > CNNaug > FCN. This makes sense as it lines up the same as with what the results were from the accuracy on the test sets from Part 3 on the homework.

2)
FCN: https://youtu.be/NcpTDmKn5Ek
CNN: https://youtu.be/v46M1Wfh9XQ
CNNaug: https://youtu.be/iOgtlKK70Qc