EMT Homework - 1

Course: ME3103 - Expiremental Measures and Techniques
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Due Date: [09/11/2024]
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Problem 1

Ten measurements are made of a certain resistance giving the following values in kΩ: 1.21, 1.24, 1.25, 1.21, 1.23, 1.22, 1.22, 1.21, 1.23, 1.24.

In [21]:
```
# Calculate the mean, variance, and standard deviation
import sympy as sp
import numpy as np
```

In [4]:
```
x = [1.21, 1.24, 1.25, 1.21, 1.23, 1.22, 1.22, 1.21, 1.23, 1.24]
length = len(x)

print(length)
```

```
10
```

In [8]:
```
summation = sum(x)

mean = summation/length
print("The mean is [kohm]:", mean)
```

```
The mean is [kohm]: 1.226
```

In [22]:
```
vari_array=np.empty(10)

for i in range(0, 10):
    vari_array[i] = (1/(length - 1))* (x[i] - mean)**2
    print(vari)
variance = sum(vari_array)
print("The variance is [kohms^2]: ", variance)
```

```
-2.1777777777777816e-05
-2.1777777777777816e-05
-2.1777777777777816e-05
-2.1777777777777816e-05
-2.1777777777777816e-05
-2.1777777777777816e-05
-2.1777777777777816e-05
-2.1777777777777816e-05
-2.1777777777777816e-05
-2.1777777777777816e-05
The variance is [kohms^2]:  0.00020444444444444484
```

In [21]:
```
stand_dev = sp.sqrt(variance)
print("The Standard deviation is [kohms]: ", float(stand_dev))
```

```
The Standard deviation is [kohms]:  0.014298407059684826
```

Problem 2

A study was conducted on the production line of mechanical components, and you have collected data on the number of defects in a random sample. The mean number of defects per batch was found to be 30, with a standard deviation of 5 defects. Determine the upper and lower limits of defects for a two-tailed probability with a 90% confidence level. Draw the distribution for full credit.

In [23]:
```
mean_2 = 30 # per batch
sd = 5 #defects
CL = 0.90 #confidence level
```

In [24]:
```
# Upper limit
```

$$\frac{1}{2}\,\text{Prob}(X_{upper}) + \frac{1}{2}\,\text{Prob}(X_{lower}) = 0.90$$

In [25]:
```
#rearrange the equation for Tau to solve for x
```

$$
\begin{cases} X_{upper} = \tau\sigma + \mu \\ X_{lower} = -\tau\sigma + \mu \end{cases}
$$

Example 4-1

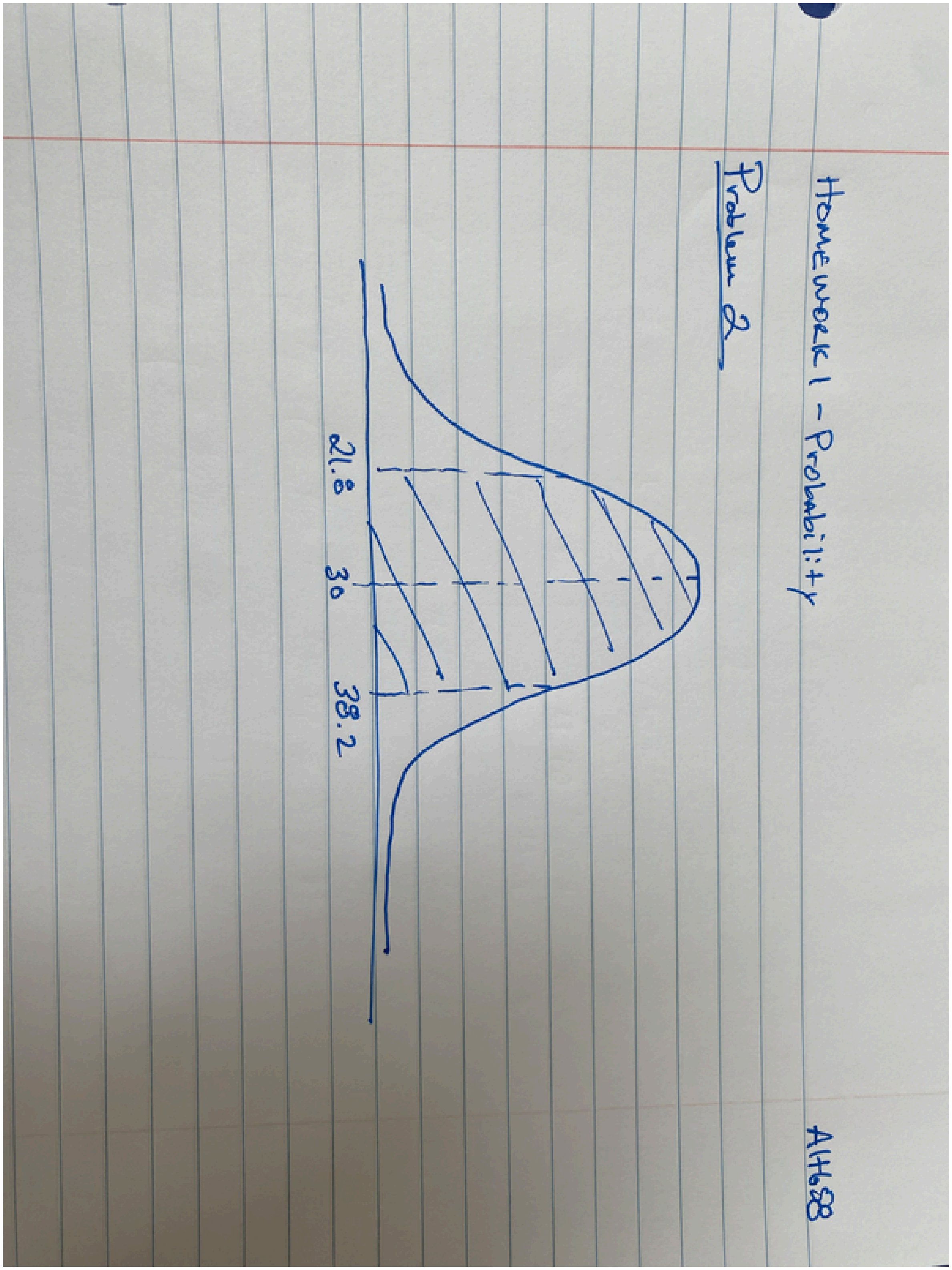
USEFUL STATISTICS

TABLE A.1 Tabulation of Two-Tailed Gaussian Probabilities

τ	Prob (τ)	τ	Prob (τ)	τ	Prob (τ)	τ	Prob (τ)
0.00	0.0000	1.00	0.6827	2.00	0.9545	3.00	0.9973002
0.02	0.0160	1.02	0.6923	2.02	0.9566	3.05	0.9977115
0.04	0.0319	1.04	0.7017	2.04	0.9586	3.10	0.9980647
0.06	0.0478	1.06	0.7109	2.06	0.9606	3.15	0.9983672
0.08	0.0638	1.08	0.7199	2.08	0.9625	3.20	0.9986257
0.10	0.0797	1.10	0.7287	2.10	0.9643	3.25	0.9988459
0.12	0.0955	1.12	0.7373	2.12	0.9660	3.30	0.9990331
0.14	0.1113	1.14	0.7457	2.14	0.9676	3.35	0.9991918
0.16	0.1271	1.16	0.7540	2.16	0.9692	3.40	0.9993261
0.18	0.1428	1.18	0.7620	2.18	0.9707	c. τ_{upper} 3.45	0.9994394
						3.46	0.9994584 ≈
0.20	0.1585	1.20	0.7699	2.20	0.9722	3.50	0.9995347
0.22	0.1741	1.22	0.7775	2.22	0.9736	3.55	0.9996147
0.24	0.1897	1.24	0.7850	2.24	0.9749	3.60	0.9996817
0.26	0.2051	1.26	0.7923	2.26	0.9762	3.65	0.9997377
0.28	0.2205	1.28	0.7995	2.28	0.9774	3.70	0.9997843
0.30	0.2358	1.30	0.8064	2.30	0.9786	3.75	0.9998231
0.32	0.2510	1.32	0.8132	2.32	0.9797	3.80	0.9998552
0.34	0.2661	1.34	0.8198	2.34	0.9807	3.85	0.9998818
0.36	0.2812	1.36	0.8262	2.36	0.9817	3.90	0.9999037
0.38	0.2961	1.38	0.8324	2.38	0.9827	3.95	0.9999218
0.40	0.3108	1.40	0.8385	2.40	0.9836	4.00	0.9999366
0.42	0.3255	1.42	0.8444	2.42	0.9845	4.05	0.9999487
0.44	0.3401	1.44	0.8501	2.44	0.9853	4.10	0.9999586
0.46	0.3545	1.46	0.8557	2.46	0.9861	4.15	0.9999667
0.48	0.3688	1.48	0.8611	2.48	0.9869	4.20	0.9999732
0.50	0.3829	1.50	0.8664	2.50	0.9876	4.25	0.9999786
c. τ_{lower} 0.52	0.3969	b. τ_{lower} 1.52	0.8715	2.52	0.9883	4.30	0.9999829
0.54	0.4108	1.54	0.8764	2.54	0.9889	4.35	0.9999863
0.56	0.4245	1.56	0.8812	2.56	0.9895	4.40	0.9999891
0.58	0.4381	1.58	0.8859	2.58	0.9901	4.45	0.9999911
0.60	0.4515	1.60	0.8904	2.60	0.9907	4.50	0.9999931
0.62	0.4647	1.62	0.8948	2.62	0.9912	4.55	0.9999946
0.64	0.4778	a. 1.64	0.8990	2.64	0.9917	4.60	0.9999957
0.66	0.4907	1.66	0.9031	2.66	0.9922	4.65	0.9999966
0.68	0.5035	1.68	0.9070	2.68	0.9926	4.70	0.9999973
0.70	0.5161	1.70	0.9109	2.70	0.9931	4.75	0.9999979
0.72	0.5285	1.72	0.9146	2.72	0.9935	4.80	0.9999984
0.74	0.5407	1.74	0.9181	2.74	0.9939	4.85	0.9999987
0.76	0.5527	1.76	0.9216	2.76	0.9942	4.90	0.9999990
0.78	0.5646	1.78	0.9249	2.78	0.9946	4.95	0.9999992

In [28]:
```
# refer to table at Prob(T) = 0.9 to find Tau = 1.64 approx.
Tau = 1.64

X_up = Tau*sd + mean_2
X_lo = -1*Tau*sd + mean_2


print("Upper X limit is [defects]: ", X_up)

print("Lower X limit is [defects]: ", X_lo)
```

```
Upper X limit is [defects]:  38.2
Lower X limit is [defects]:  21.8
```



Problem 3

**The production of a certain polymer fiber follows a normal distribution with a true mean diameter of
20 μm and a standard deviation of 30 μm.**

Draw the distribution and compute the probability of a measured value

a. greater than 80 μm.

b. between 50 μm and 80 μm.

c. less than 50 μm

d. less than 14 μm

e. between 8 μm and 14 μm

ALL PLOTS AT END OF DOCUMENT

Part A

In [3]:
```
true_mean = 20 #um dia.
sd = 30
# Compute the probability of each range


# First find Tau
t_a = (80 - true_mean) / sd
print(t_a)
#Prob of Tau is 0.9545 based on Table A1



Prob_a = 1 - ((1/2) + (1/2)*0.9545)
print("The probability that it is higher than 80 micrometers is [%]: ", Prob_a
```

```
2.0
The probability that it is higher than 80 micrometers is [%]:  2.275000000000
005
```

Part B

In [23]:

```
# First find Tau
t_b_lo = (50 - true_mean) / sd
t_b_hi = (80 - true_mean) / sd

print(t_b_lo, t_b_hi)
#Prob of Tau_b_hi is 0.9545
#Prob of Tau_b_lo is 0.6827 based on Table A1

#These numbers must be changed with table values
Prob_tb_lo = 0.6827
Prob_tb_hi = 0.9545

Prob_b = (1/2)*Prob_tb_hi - (1/2)*Prob_tb_lo

print("The probability it is in range of 50 and 80 micrometers is [%]: ", Prob
```

```
1.0 2.0
The probability it is in range of 50 and 80 micrometers is [%]:  13.590000000
000002
```

Part C

In [10]:

```
# First find Tau
t_c_lo = (50 - true_mean) / sd


print(t_c_lo)
#Prob of Tau_b_hi is 0.9545
#Prob of Tau_b_lo is 0.6827 based on Table A1

#These numbers must be changed with table values
Prob_tc_lo = 0.6827


Prob_c = (1/2) + (1/2)*Prob_tc_lo

print("The probability it is less than 50 micrometers is [%]: ", Prob_c*100)
```

```
1.0
The probability it is less than 50 micrometers is [%]:  84.135
```

Part D

In [24]:
```
# First find Tau
t_d_lo = (14 - true_mean) / sd


print(t_d_lo)
#Prob of Tau_b_hi is 0.9545
#Prob of Tau_b_lo is 0.6827 based on Table A1

#These numbers must be changed with table values
Prob_td_lo = 0.1585



Prob_d = 1/2 - (1/2)*Prob_td_lo

print("The probability it is less than 50 micrometers is [%]: ", Prob_d*100)
```

```
-0.2
The probability it is less than 50 micrometers is [%]:  42.075
```

Part E

In [17]:
```

# First find Tau
t_e_lo = (8 - true_mean) / sd
t_e_hi = (14 - true_mean) / sd

print(t_e_lo, t_e_hi)


#These numbers must be changed with table values
Prob_te_lo = 0.3108
Prob_te_hi = 0.1585

Prob_e = (1/2)*Prob_te_hi + (1/2)*Prob_te_lo

print("The probability it is in range of 8 and 14 micrometers is [%]: ", Prob_
```

```
-0.4 -0.2
The probability it is in range of 8 and 14 micrometers is [%]:  23.4650000000
00003
```

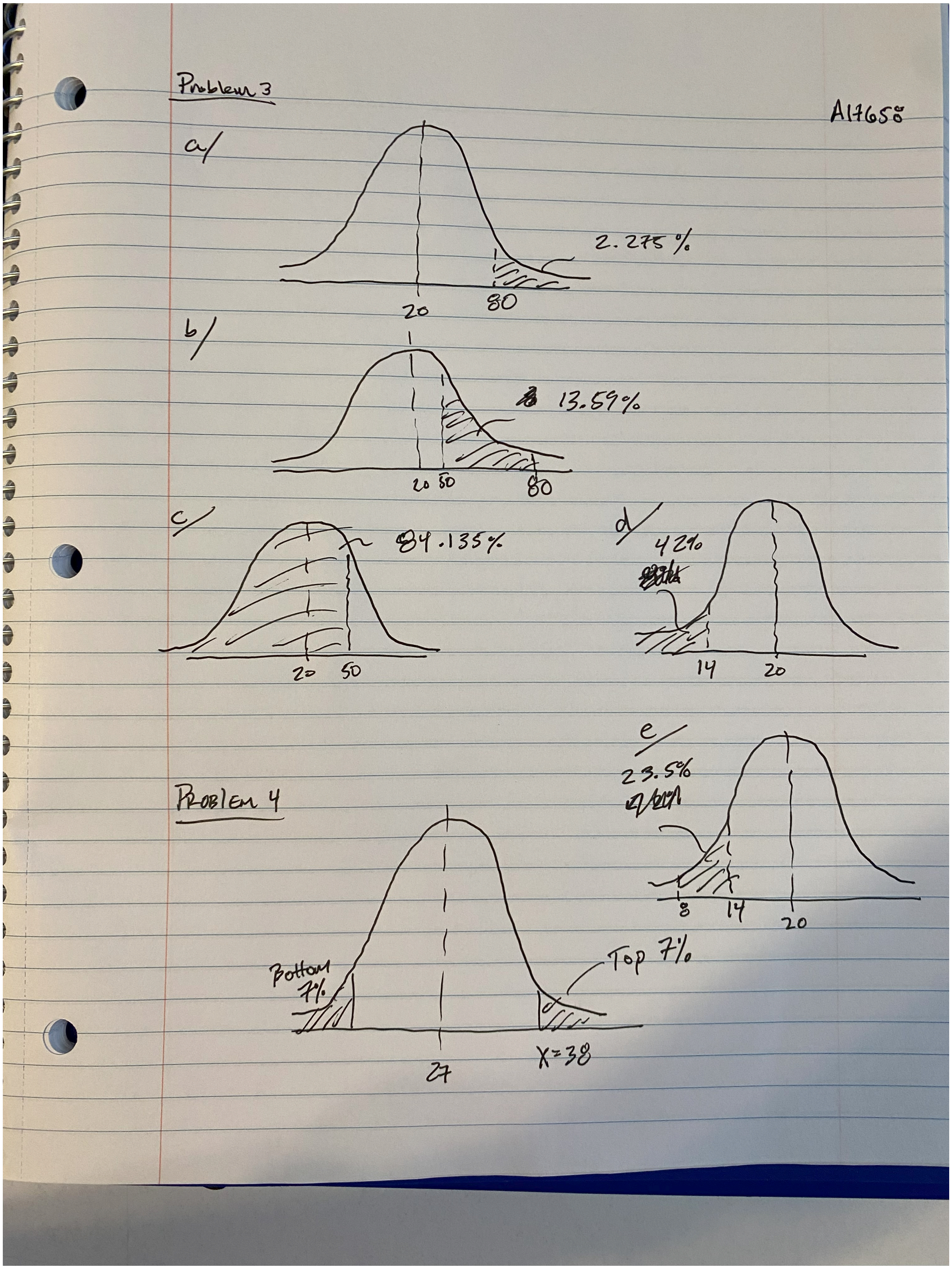
Problem 4

Allegedly you are very good at basketball and want to walk on the basketball team at MSU. To earn your spot on the team, you will need to shoot and score as many free throws as you can in 1 minute. Only the top 7% of people trying out will get a spot on the

team. The parent population mean free throws scored was 27 and the standard deviation was 7 baskets. What is the minimum number of free throws scored necessary to earn a

In [22]:
```
mean_freethrow = 27

sd_freethrow = 7

prob_tau_4 = 100 - 7*2

# Tau is 1.476 from Table A-1

x = 1.476*sd_freethrow + mean_freethrow
print("The minimum number of free throws is: ", np.ceil(x))
```

```
The minimum number of free throws is:  38.0
```


Problem 3
Al7658
a/
2.275 %
20
80
b/
13.59%
20 50
80
c/
84.135%
20 50
d/
42%
14 20
e/
23.5%
8 14 20
PROBLEM 4
Bottom 7%
Top 7%
27
X=38

In [ ]: