nc Jun Yan

Q1. The thickness of photoresist applied to wafers in semiconductor manufacturing at a particular location on the wafer is uniformly distributed between 0.2050 and 0.2150 micrometers.

b a

(a) Find the proportion of wafers that exceeds 0.2125 micrometers.

(b) What thickness is exceeded by 10% of the wafers?

(c) Find the mean and standard deviation of photoresist thickness.

X = the thickness of photoresist applied to wafers

$$f(x) = \begin{cases} \frac{1}{0.01}, & 0.2050 < x < 0.2150 \\ 0, & \text{otherwise} \end{cases}$$

$$\frac{1}{b-a} = \frac{1}{0.2150 - 0.2050} = \frac{1}{0.01}$$

$X \sim U(0.2050, 0.2150)$

1a) $P(x > 0.2125) = \int_{0.2125}^{0.2150} \frac{1}{0.01}\,dx$ or $1 - \int_{0}^{0.2150}$

$$= \frac{1}{0.01}[x]_{0.2125}^{0.2150}$$

$$= \frac{1}{0.01}[0.2150 - 0.2125]$$

$$= 0.25$$ ※

1b) $P(x > y) = \int_{y}^{0.2150} \frac{1}{0.01}\,dx$

$$\frac{1}{10} = \frac{1}{0.01}[x]_{y}^{0.2150}$$

$$\frac{1}{1000} = 0.2150 - y$$

$$0.2140 = y$$

$y = 0.2140\,\mu m$ ※

1c) $E(x) = \mu = \frac{a+b}{2}$

$$= \frac{0.2050 + 0.2150}{2}$$

$= 0.21\,\mu m$ ※

$$Var(x) = \sigma^2 = \frac{(0.2150 - 0.2050)^2}{12}$$

$$\sigma^2 = \frac{1}{120000}$$

$$\sigma = \sqrt{\frac{1}{120000}}$$

$= 0.0029\,\mu m$ ※

Q2. The lifetime of a mechanical assembly in a vibration test is exponentially distributed with a mean of 400 hours.

ok

(a) What is the probability that an assembly on test fails in less than 100 hours?

(b) Find the probability that an assembly operates for more than 500 hours before failure.

(c) Find the standard deviation of the lifetimes of mechanical assemblies in vibration tests.

x: lifetime of a mechanical assembly in a vibration test

$X \sim Exp(400), x > 0$

2 a. $P(x < 100) = \int_0^{100} \frac{1}{400} e^{-\frac{x}{400}} dx$

$= \frac{1}{400} \left[-400 e^{-\frac{x}{500}}\right]_0^{100}$

$= -e^{-\frac{100}{400}} - (-e^0)$ 1

$= 0.2212$

$P(X > 500)$

b. $1 - P(x \le 500) = 1 - \int_0^{500} \frac{1}{400} e^{-\frac{x}{400}}$

$= 1 - \left[-e^{-\frac{500}{400}} - (-e^0)\right]$ 1

$= 0.2865$

No: ....

$\mu = \sigma$

2. c. $Var(x) = 400^2 = \mu^2$ | $\sigma = 400$ hrs

$= 160\,000$

3. a. $P(z < -0.6) = 0.2743$ b. $P(z > -1.28)$

Standard normal dist, $P(Z < a) = \alpha$ ← prob

std normal/Z ↙ (Z)

↓ normal/std Z score (a)

- a +ve or −ve
- $\alpha \geq 0$

$P(Z > a) = \underbrace{0.1711}_{< 0.5}$

$a = \underline{0.95}$

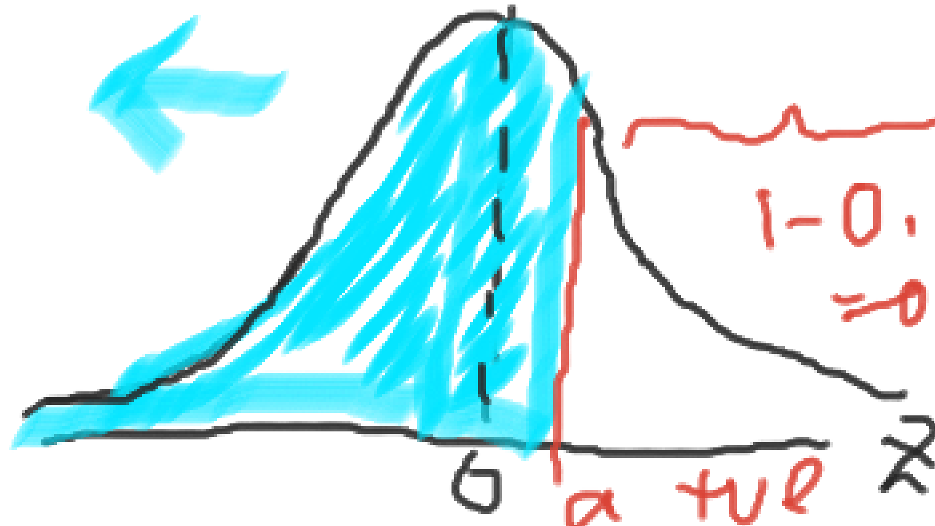
$P(Z < a) = \underbrace{0.1711}_{< 0.5}$

boundary = 0.95
⇓ mirror
$a = -0.95$

$P(Z > a) = \underbrace{0.5596}_{> 0.5}$

boundary = 0.15
⇓
$a = \underline{-0.15}$

$P(Z < a) = \underbrace{0.5596}_{> 0.5}$

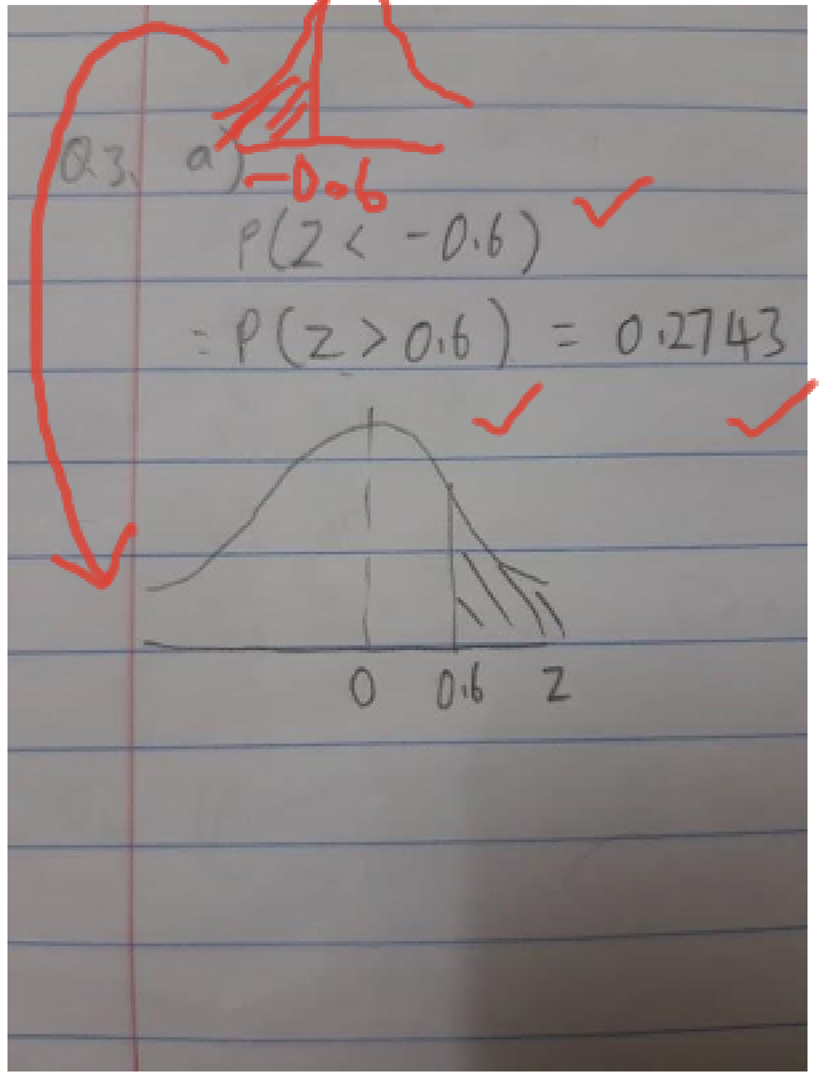


$a = \underline{0.15}$

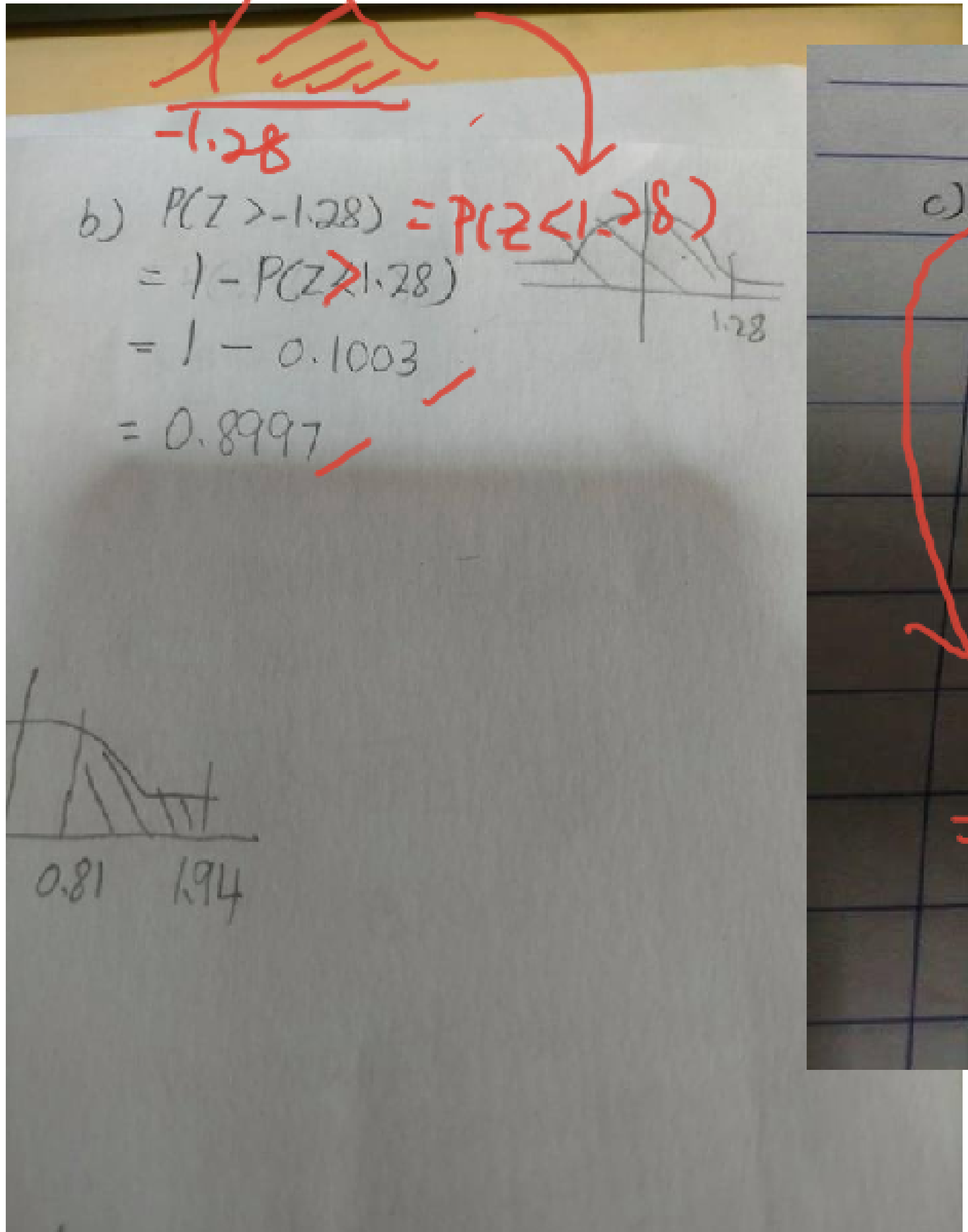
Q3. Let Z be the standardized normal variable, i.e. Z follows normal distribution with the mean $\mu = 0$, and variance $\sigma^2 = 1$. Find the value of the following probabilities. In each case, sketch a curve and shade the area representing the probability.

(a) $P(Z < -0.6)$ (b) $P(Z > -1.28)$ (c) $P(0.81 < Z < 1.94)$

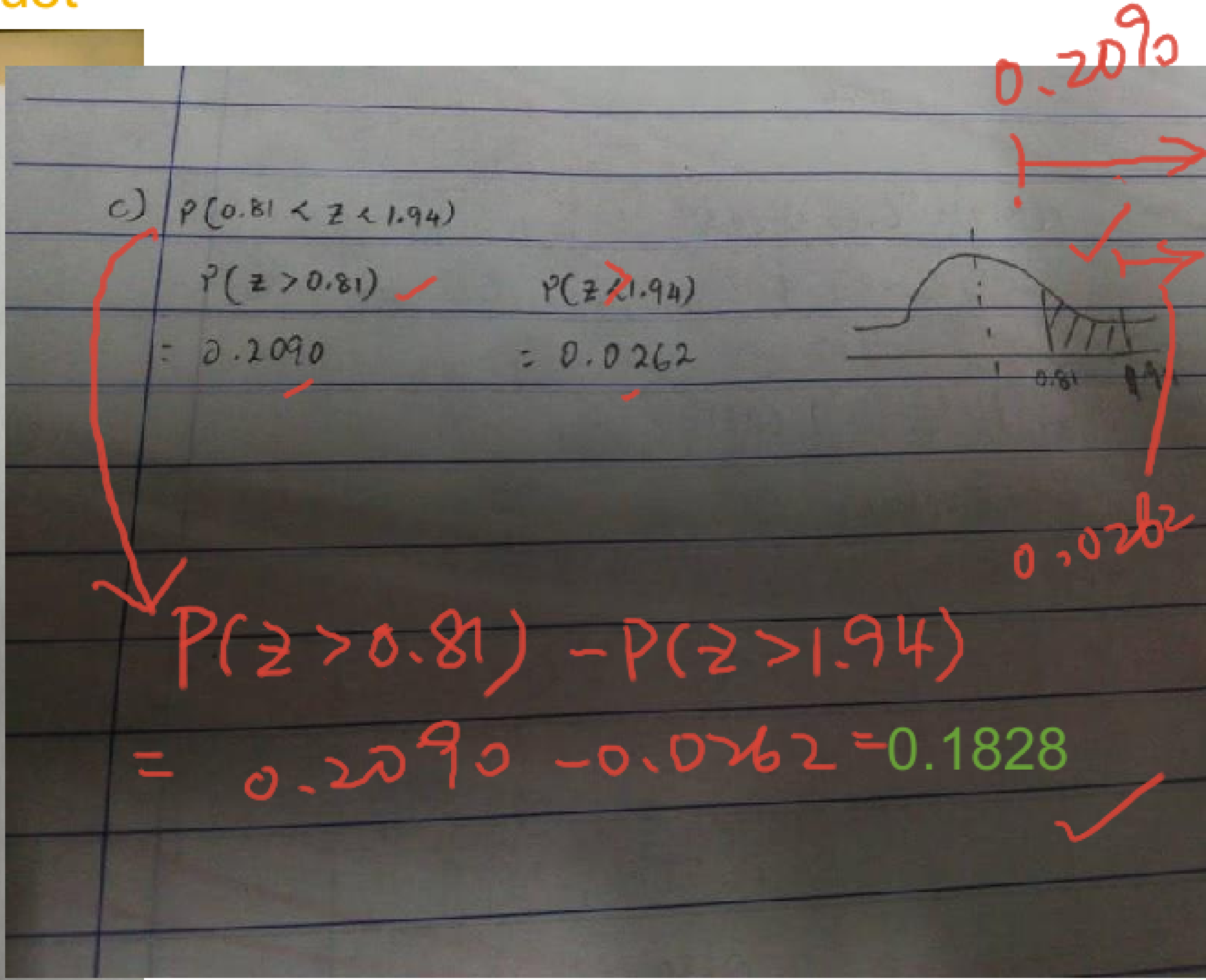
Khai Jun



Eason



Li Yuet



Q3. Let Z be the standardized normal variable, i.e. Z follows normal distribution with the mean $\mu = 0$, and variance $\sigma^2 = 1$. Find the value of the following probabilities. In each case, sketch a curve and shade the area representing the probability.

(d) $P(-0.68 < Z < 0)$ (e) $P(-0.46 < Z < 2.21)$ (f) $P(Z < -1.44 \text{ or } Z > 2.05)$

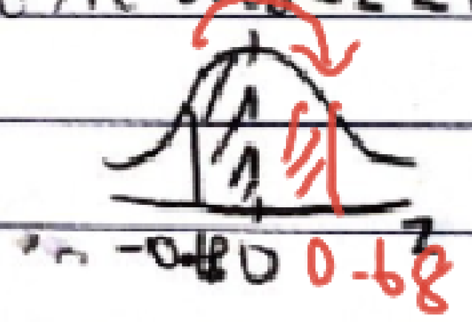
Cecilia

Ze Xuan

Pui Mun

$P(Z<-1.44)+P(Z>2.05)$
$= P(Z>1.44)+P(Z>2.05)$
$= \_\_ + \_\_$

d) $P(-0.68<Z<0) = 0.5-P(Z>0.68)$
$= 0.5-0.2483$
$= 0.2517$



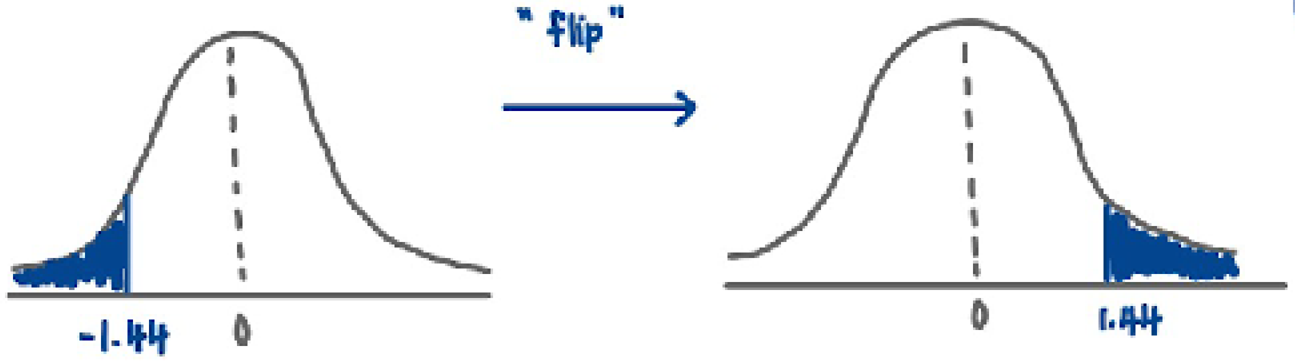
e) $P(-0.46<Z<2.21)$
$= 1-P(Z>0.46)-P(Z>2.21)$
$= 1-0.3228-0.01355$
$= 0.66365$

$P(Z>0.46)$

$P(Z>2.21)$

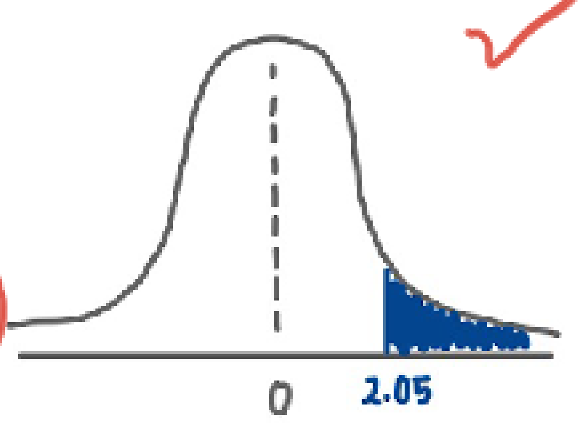
(f) $P(Z<-1.44 \text{ or } Z>2.05) = 0.09508$

$P(Z<-1.44)$



$P(Z>1.44) = 0.0749$

$P(Z>2.05) = 0.02018$

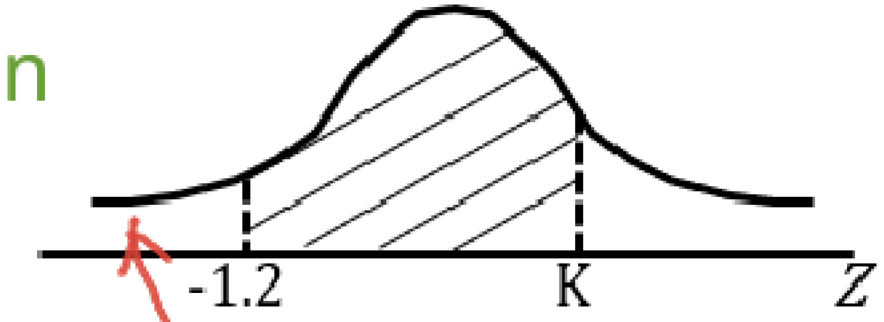


5✓

Q4. Find the value of K in each of the following cases. Given your answer correct to 2 decimal places.

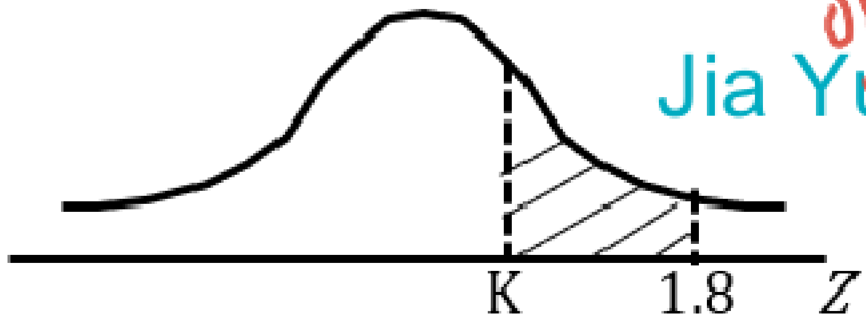
(a) Shaded area = 0.523

Aaron



(b) Shaded area = 0.355

Jia Yu ✓



	.07	.08
0.2	0.3936	0.3897

closest to 0.3909

$P(Z<-1.2) = P(Z>1.2) = 0.1151$ ✓

$1 - P(Z>1.2) - 0.523 = 0.3619$

$= P(Z>K)$

$k \approx 0.35$ ✓

(b)

Shaded = 0.355

$P(Z>1.8) = 0.0359$ ✓

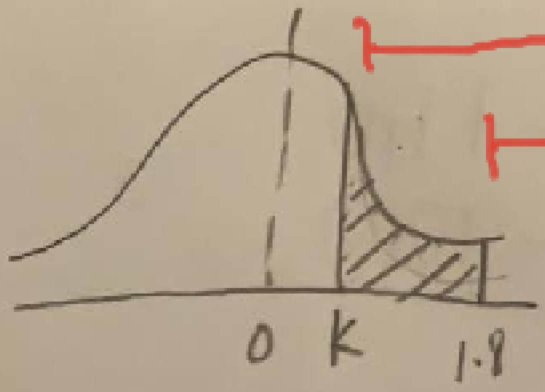
$0.355 = P(Z>K) - P(Z>1.8)$

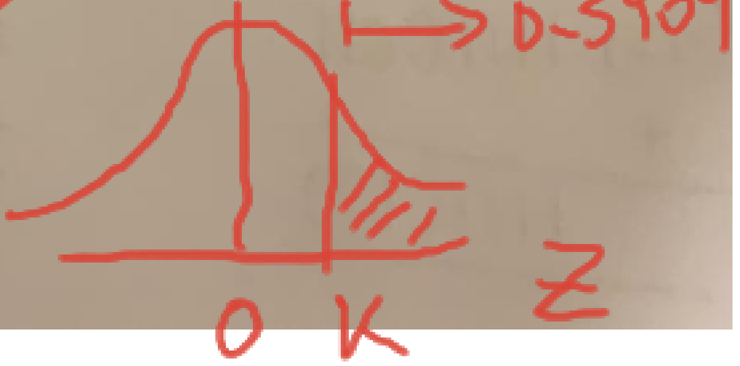
$= P(Z>K) - 0.0359$ ✓

$P(Z>K) = 0.3909$

$\therefore K \approx 0.28$ ✓

closest

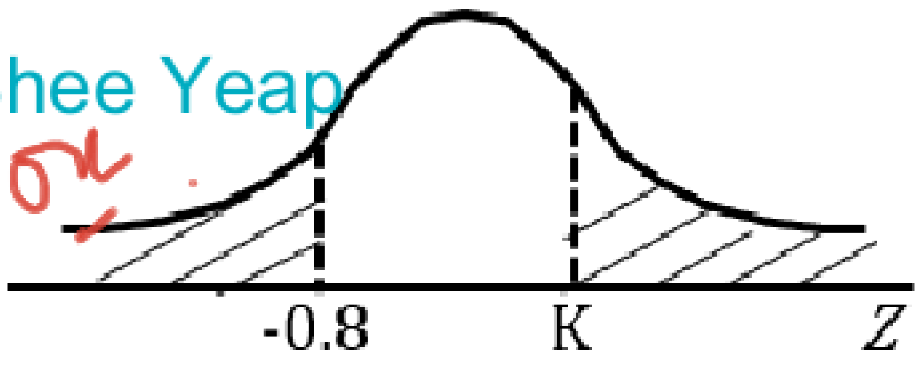




(c) Sum of shaded area = 0.616

Shee Yeap

ok

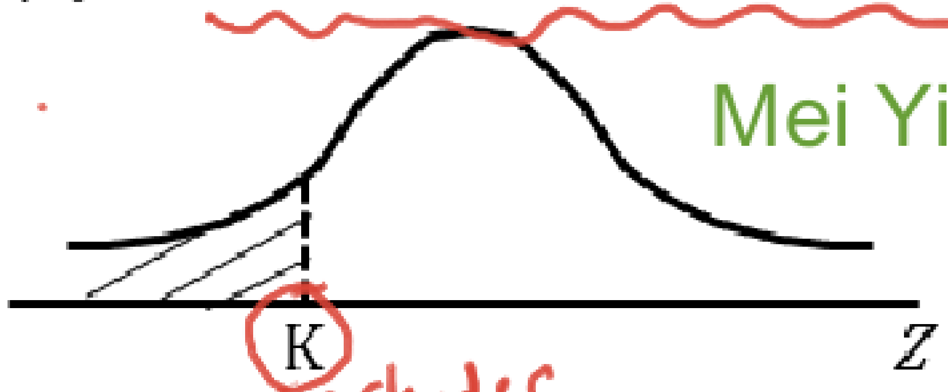


Q4

ok

(d) Unshaded area = 4 x shaded area

Mei Yi



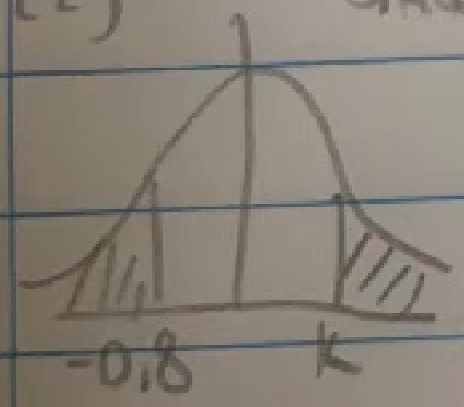
Let $P(Z < K) = x$

$P(Z > K) = 4 \times P(Z < K)$

$1 - P(Z < K) = 4 \times P(Z > K)$

$5 \times P(Z > K) = 1$

(c)



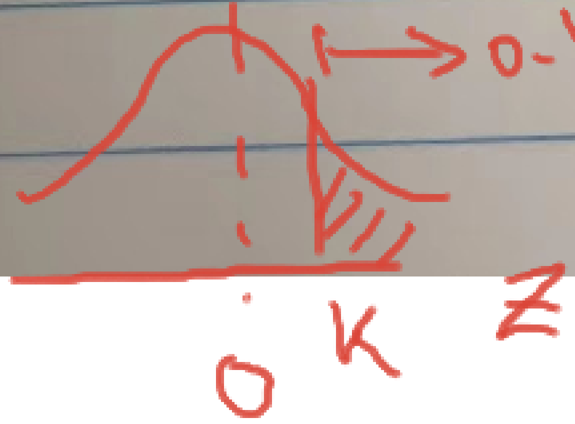
Shaded area = $0.616 = P(Z > k) + P(Z > 0.8)$

$P(Z < -0.8)$

$P(Z > k) = 0.616 - 0.249$

$= 0.4041$ ✓

$k \approx 0.24$ ✓

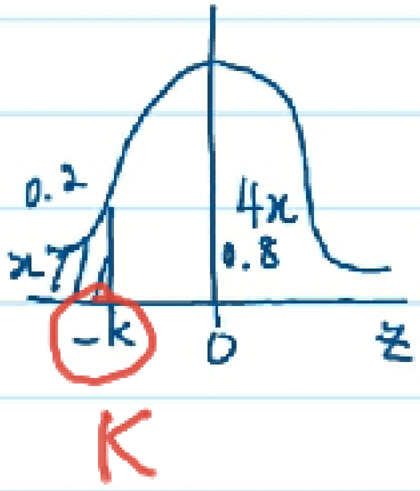


4d) . $P(Z < \cancel{K}k) = 0.2$

$P(Z > \cancel{K}-k) = 0.2$

$-k = 0.84$ ✓

$k = -0.84$ ✓



X : Continuous random variable, $X \sim N(\mu, \sigma^2)$

mean $= \mu$

std dev $= \sigma$

SOP :

$$X \xrightarrow{\text{① convert}} Z \xrightarrow{\text{② find}} \text{Prob}$$

X: raw/original

$\frac{X-\mu}{\sigma} = Z$

Z: std normal

② find: from std normal table

X : weight (kg), $X \sim N(10, 2^2)$ mean = 10kg, std dev = 2kg

$$P(X>12) \overset{①}{=} P\left(Z > \frac{12-10}{2}\right) = P(Z>1) \overset{②}{=} \underline{\underline{0.1587}}$$

or

$$P(X<12) = P(Z<1) = 1 - P(Z>1) = 1 - 0.1587 = \underline{\underline{0.8413}}$$

Ok

Q5. Steel rods are manufactured to a specification of 20cm length and are acceptable only if they are within the limits of 19.9cm and 20.1cm. The lengths are normally distributed with the mean 20.02cm and standard deviation 0.05cm. Find the percentage of rods which will be rejected as

Sean

(a) undersized. (b) oversized.

X: length of steel rod

$X \sim N(20.02, 0.05^2)$

Mean = 20.02

σ = 0.05

$P(19.9 < x < 20.1)$

$Z = \frac{X - \mu}{\sigma}$

(a) undersized

$P(x < 19.9) = P(Z < -2.4)$ ①

$= P(Z > 2.4)$

$z = \frac{19.9 - 20.02}{0.05}$

$= -2.4$

flip $= P(x > 19.9)$

2.4

② table

z = 0.0082

$0.0082 \times 100\%$

$= 0.82\%$

(b) Oversized

$P(x > 20.1) = P(Z > 1.6)$ ①

$z = \frac{20.1 - 20.02}{0.05}$

$= 1.6$

z = 0.0548

$0.0548 \times 100\%$

$= 5.48\%$ ②

8L

Q6. Your company requires a special type of inelastic rope, which is available from only two suppliers. Supplier A's ropes have a mean breaking strength of 1000kg, with a standard deviation of 100kg. Supplier B's ropes have a mean breaking strength of 900kg, with a standard deviation of 50kg. The distribution of the breaking strengths of each type of rope is normal. Your company requires that the breaking strength of a rope be at least 750kg. All other things being equal, which supplier should the company order the rope? Show your workings.

Cai Jie

Q6

A: $\mu = 1000, \sigma^2 = 100$

B: $\mu = 900, \sigma^2 = 50$

Supplier A:

$= P(Z_A \leq 2.5)$

$= 1 - P(Z_A > 2.5)$

$P(X_A \geq 750) = P(Z_A \geq \frac{750-1000}{100}) = P(Z_A \geq -2.5) = 1 - 0.00621$ ★

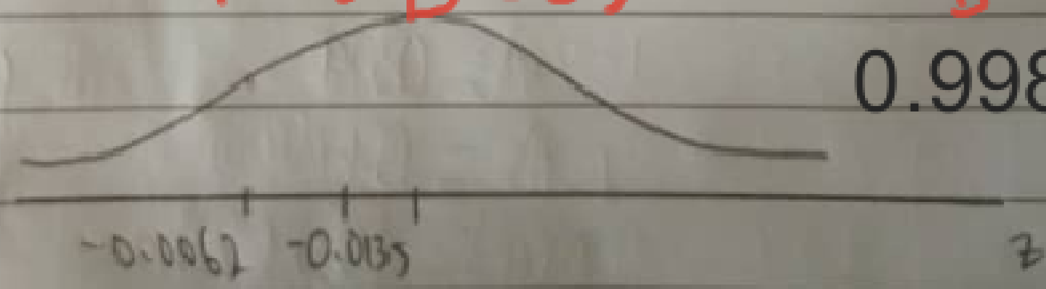
0.99379 ✓

Supplier B:

$P(X_B \geq 750) = P(Z_B \geq \frac{750-900}{50}) = P(Z_B \geq -3) = 1 - 0.00135$ △

$= P(Z_B \leq 3) = 1 - P(Z_B > 3)$

0.99865 ✓



Ans: Supplier B as its prob is higher.

Compare ★ and △, (higher prob)

X_A : breaking strength of supplier A's rope

$X_A \sim N(1000, 100^2)$

X_B : breaking strength of supplier B's rope

$X_B \sim N(900, 50^2)$

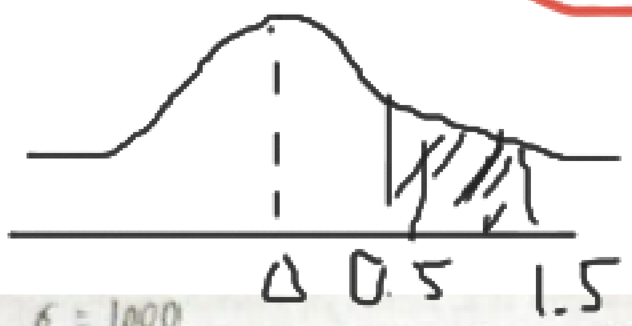
Q7. The life of a television tube measured in hours of use, is normally distributed with a mean of 5000 hours and a standard deviation of 1000 hours.

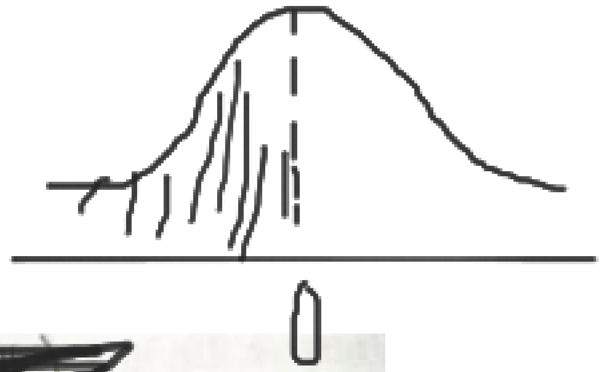
(a) Find the probability that a TV tube will last for

(i) between 5500 and 6500 hours, (ii) less than the expected life of a tube.

(b) Find the probability that for someone using a TV for 1500 hours per year, the tube will last for less than 5 years.

Yee Hao

(i) 

(ii) 

b) 

5×1500

$\mu = 5000$ $\sigma = 1000$

$X \equiv$ no. of hours that a TV tube will last for, [redacted]

$X \sim N(5000, 1000^2)$

a) (i) $P[5500 < X < 6500] = P(0.5 < Z < 1.5) = 0.2417$

$= \cancel{P[X > 5500] - P[X > 6500]}$

$= \cancel{P\left[Z > \frac{5500-5000}{1000}\right] - P\left[Z > \frac{6500-5000}{1000}\right]}$

$= P[Z > 0.5] - P[Z > 1.5]$

$= 0.3085 - 0.0668$

(ii) $P[X < 5000] = P\left[Z < \frac{5000-5000}{1000}\right]$

$= P[Z < 0]$

$= 0.5$

b) $P[X < 7500] = P\left[Z < \frac{7500-5000}{1000}\right]$

$= P[Z < 2.5]$

$= 1 - P[Z > 2.5]$

$= 1 - 0.00621$

$= 0.99379$

Chun Wai

$Z = \frac{X-\mu}{\sigma}$

Q8. The average weight of a packet of sugar packed by a certain machine is 500g and

or the standard deviation is 20g. Assume that the weights are normally distributed.

(a) In a batch of 2000 packets, how many packets weight

(i) more than 520g? (ii) less than 470g? (iii) between 520g and 530g?

(b) Find the minimum weight of the 5% heaviest packets.

of a packet of sugar

$X =$ ~~no. of packets that~~ weight, $X \sim N(500, 20^2)$ σ^2

(a) (i)

$P(\cancel{Z} > 520)$

$= P\left(Z > \frac{520-500}{20}\right)$

$= P(Z > 1)$

$= 0.1587$

no of packets $=$ $2000 \times 0.1587 = 317.4 \approx 317$

(a) (ii)

$P(\cancel{Z} < 470)$

$= P\left(Z < \frac{470-500}{20}\right)$

$= P(Z < -1.5)$

$= P(Z > 1.5)$

$= 0.0668$

$2000 \times 0.0668 = 133.6 \approx 134$

(a) (iii)

$P(520 < \cancel{Z} < 530)$

$= P\left(\frac{520-500}{20} < Z < \frac{(530-500)}{20}\right)$

$= P(1 < Z < 1.5)$

$= P(Z > 1) - P(Z > 1.5)$

$= 0.1587 - 0.0668$

$= 0.0919$

$2000 \times 0.0919 = 183.8 \approx 184$

(b)

$5\% = 0.05$

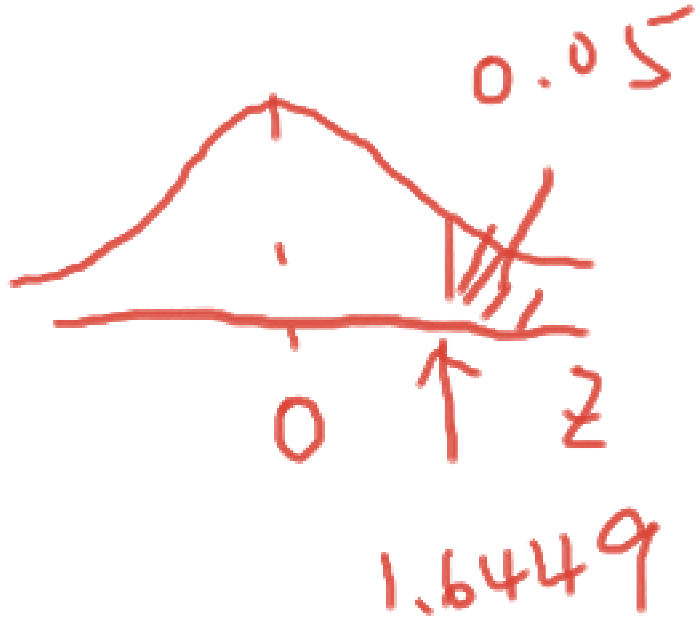
$P(\cancel{Z} > k) = 0.05$

$P\left(Z > \frac{k-500}{20}\right) = 0.05$

$\frac{k-500}{20} = 1.6449$

$k - 500 = 32.898$

$k = 532.898\text{g}$



Jing Xian

Q9. The amount of time required for a certain type c
at a service garage is normally distributed witl
deviation 8 minutes. The service manager pl
transmission of a customer's car 10 minutes, al
tells the customer that the car will be ready witl
(a) What is the probability that he will be wrong
(b) What is the probability that the working tim
52 minutes?
(c) What is the required working time allotme
that the transmission repair will be complet
(d) What is the working time allotment such tha
transmission repair can be completed withi

9) X : amount of time required for a certain type of automobile transmission repair at a service garage

$X \sim N(45, 8^2)$

a) $P(X > 50) = P\left(Z > \frac{50-45}{8}\right)$

$= P(Z > 0.625)$

$= P(Z > 0.63)$

$= 0.2643$

exclude 10 minutes before repair from 1 hour

b) $P(40 < X < 52) = P\left(\frac{40-45}{8} < Z < \frac{52-45}{8}\right)$

$= P(-0.625 < Z < 0.875)$

$= 1 - P(Z > 0.63) - P(Z > 0.88)$

$= 1 - 0.2643 - 0.1894$

$= 0.5463$

within

c) $P(X < k) = 0.9$

$P\left(Z < \frac{k-45}{8}\right) = 0.9$

$P\left(Z > \underbrace{\frac{k-45}{8}}_{+ve}\right) = 1 - 0.9$

$= 0.1$

$\frac{k-45}{8} = +1.2816 \quad k = 55.2528$ mins.

0 Z $\frac{k-45}{8}$

d) $P(X < k) = 0.3$

$P\left(Z < \frac{k-45}{8}\right) = 0.3$

$\frac{k-45}{8} = -0.5244$ -ve

$k = 40.8048$ mins.

0 Z

Janet

Q10. 10% of males suffer from a certain disease. Find the probability that more than 60 men in a randomly selected group of 500 males will suffer from the disease.

ok.

in a group of 500 males

Q10 X = number of males suffer from the dease, $X \sim B(500, 0.1)$

Since $n = 500 > 30$, $p = 0.1$, $np = 50 > 5$ and $nq = 450 > 5$

thus, normal approximation is be used, $X \sim N(\mu = np = 50, \sigma^2 = npq = 45)$

$P(X > 60) \approx P(X > 60.5)$

$= P\left(Z > \frac{60.5 - 50}{\sqrt{45}}\right)$

$= P(Z > 1.59)$ 1.57

$= 0.0582$

Jia Jie ok.

Q11. 10% of the chocolates produced in a factory are mis-shapes. In a sample of 1000 chocolates, find the probability that the number of mis-shapes is
(a) less than 80, (b) from 90 to 115, (c) 120 or more.

(11) X = no. of miss-shape chocolates out of 1000, $X \sim B(1000, 0.1)$

Since $n = 1000 > 30$, $np = 100 > 5$, $nq = 900 > 5$, thus normal approx is to be used, $X \sim N(100, (3\sqrt{10})^2)$ σ^2

a) $P[X < 80] \approx P[X < 79.5] = P\left[Z < \frac{79.5 - 100}{3\sqrt{10}}\right]$
$= P[Z < -2.16]$
$= P[Z > 2.16]$
$= 0.01539$

b) $P[90 \leq X \leq 115] \approx P[89.5 < X < 115.5] = P\left[\frac{89.5 - 100}{3\sqrt{10}} < Z < \frac{115.5 - 100}{3\sqrt{10}}\right]$
$= P[-1.11 < Z < 1.63]$
$= 1 - P[Z > 1.11] - P[Z > 1.63]$
$= 1 - 0.1335 - 0.0516$
$= 0.8149$

c) $P[X \geq 120] \approx P[X > 119.5] = P\left[Z > \frac{119.5 - 100}{3\sqrt{10}}\right]$
$= P[Z > 2.06]$
$= 0.01970$

$3(\sqrt{10})^2$ a

$(3\sqrt{10})^2$ 90 b

$\neq 3\sqrt{10}^2$ 30

Q12. The number of bacteria on a plate viewed under a microscope follows a Poisson distribution with parameter 60.

(a) Find the probability that there are between 55 and 75 bacteria on a plate.

(b) A plate is rejected if less than 38 bacteria are found. If 2000 such plates are viewed, how many will be rejected?

OK

60

$X \sim N(\mu, \sigma^2)$

12. X = number of bacteria on a plate, $X \sim P_o(60)$

Since $\lambda = 60 > 20$, normal approx is to be used, $X \sim N(60, 2\sqrt{15}^2)$

a) $P[55 < X < 75] \approx P[55.5 < X < 74.5] = P\left[\frac{55.5-60}{2\sqrt{15}} < Z < \frac{74.5-60}{2\sqrt{15}}\right]$

$= P[-0.58 < Z < 1.87]$

$= 1 - P[Z > 0.58] - P[Z > 1.87]$

$= 1 - 0.2810 - 0.0307$

$= 0.6883$

b) $P[X < 38] \approx P[X < 37.5] = P\left[Z < \frac{37.5-60}{2\sqrt{15}}\right]$

$= P[Z < -2.9]$

$= P[Z > 2.9]$

$= 0.00187$

0.00187×2000

$= 3.74$

$\therefore$ 4 plates

Shen Hoi

Q13. Customers arrive randomly at a department store at an average rate of 18.6 per minute. Assuming the customers arrivals form a Poisson distribution, calculate the probability that at most 25 customers arrive in any particular minute.

ok

λ

lambda

arrive

per minute

2)(3) X : no. of customer ~~arrivals~~ randomly at a department store $X \sim Po(18.6)$

Since $\lambda = 18.6 \approx 20$, Normal approximation is to be used.

$\Rightarrow X \sim N(18.6, 18.6)$

$P(X \le 25) \approx P(X < 25.5)$

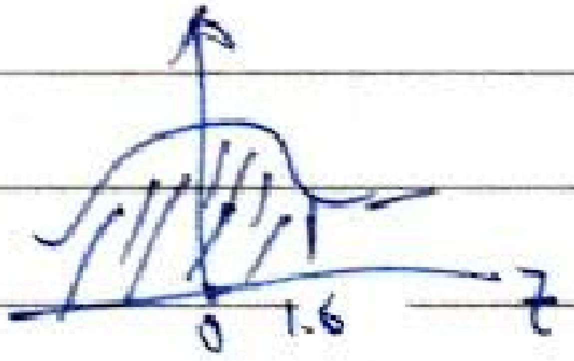
$= P\left(Z < \frac{25.5 - 18.6}{\sqrt{18.6}}\right)$

$= P(Z < 1.60)$

$= 1 - P(Z > 1.6)$

$= 1 - 0.0548$

$= 0.9452$



$\approx$

Probability Distributions (Additional questions)

the 1st one

geometric

binomial

Q1. Suppose in a city, 85% of all households have cable TV. Kang Hong

i) Find the probability that you would have to ask three households before finding one who has cable TV. (0.0191)

ii) Find the probability that among the four randomly selected households, at least one household have cable TV. (0.9995)

iii) Give the mean and standard deviation for the distribution in ii). (3.4, 0.7141)

Yu Hong

Q2. 0.5% of the households in City A spend more than RM2500 per month for grocery items. A group of 500 households are selected.

i) Calculate the probability that 2 to 4 households spend more than RM2500 per month for grocery. (0.6039)

ii) Calculate the probability that at least one household spent more than RM2500 per month for grocery items. (0.9179)

Q3. Suppose the weights of all packages of corn flour are normally distributed with a mean of 1000 grams and a standard deviation of 20 grams. A package is considered to meet the weight standard if the weight is between 960.6 grams and 1039 grams. Mavis

i) Find the percentage of the package that meet the weight standard. (0.95)

ii) 2.5% of the packages are more than k grams. Find the value of k. (1039.2)

iii) A random sample of 10 packages is selected. Find the probability that the sample contains more than 8 packages that meet the weight standard. (0.9138)

Q4. The distribution of the number of public buses stop at a particular bus stand has an average of 12 buses per hour. Find the probability that at least 2 buses stop in an interval of 10 minutes. (0.5940) Li Yuet

Q5. A traffic survey shows that 60% of the cars turn left at a T-junction. Find the probability that out of 100 cars, more than 70 cars will turn left at the T-junction. (0.01618) Eason

(i) x= No of households that would have to ask before finding one who has cable tv,, X ~ g(x; 0.85); x = 1, 2, 3, ...

Q1. (i) $P(X=3) = $ ~~${}^{4}C_{1}\ 0.85^{1}\ 0.15$~~

$= 0.85(0.15)^{3-1} = $ ~~0.1913~~ $= 0.0191$

(ii) x= No of households that have cable tv out of 4, X ~ B(4, 0.85), x = 0, 1, 2, 3, 4

(ii) $P(X \geq 1) = 1 - P(X=0)$

$= 1 - [\,{}^{4}C_{0}\ 0.85^{0}\ 0.15^{4}]$

$= 1 - 0.0005$

$= 0.9995$

(iii) $E(X) = \mu = np = 4(0.85)$

$= 3.4$ households

$\sigma^2\ \gamma^2 = npq = 4(0.85)(0.15)$

$= 0.51$

$\sigma\ \gamma = \sqrt{0.51}$

$= 0.7141$ households

OC

OC .

Q2) X = no of households in City A that spend more than RM2500 per month for grocery items out of 500 households. $X \sim B(500, 0.005)$

Since $n = 500$, $p = 0.005$, $np = 2.5 < 5$. ~~and $nq = 2.5 < 5$~~

Poisson approximation is used; $X \sim Po(2.5)$

i) $P(2 \leq X \leq 4) \approx e^{-2.5}\left(\frac{2.5^2}{2!} + \frac{2.5^3}{3!} + \frac{2.5^4}{4!}\right)$

$= 0.0821(3.125 + 2.603 + 1.628)$

$= 0.6039$

ii) $P(X \geq 1) = 1 - P(X=0)$

$= 1 - \frac{e^{-2.5}\, 2.5^0}{0!}$

$= 1 - 0.0821$

$= 0.9179$

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OK

3) X : Weights of the packaged of corn flour

$X \sim N(1000, 20^2)$

(i) $P(960.6 < x < 1039)$

$= P\left(\frac{960.6-1000}{20} < Z < \frac{1039-1000}{20}\right)$

$= P(-1.97 < z < 1.95)$

$= (1 - 0.0256 - 0.0244) \times 100$

$= 95\%$

(ii) $P(X > k) = 0.025$

$P\left(Z > \frac{k-1000}{20}\right) = 0.025$

$\frac{k-1000}{20} = 1.96$

$k = 1039.2$ kg

(iii) $X \sim B(10, 0.95)$ X : ~~Weights~~ No. of the packages of corn flour that meet the weight standard out of 10 packages

$P(x > 8) = {}^{10}C_9 (0.95)^9 (0.05)^1 + {}^{10}C_{10} (0.95)^{10} (0.05)^0$

$= 0.9139$

OK

Let x be the ~~probability~~ number of cars turn left at a T-junction out of 100. $X \sim B(100, 0.6)$

Since $n = 100 > 30$, $p = 0.6 \approx 0.5$, $np = 60$, $npq = 24$, > 5 normal distribution is used. $X \sim N(60, 24)$

$P(X > 70) \approx P(X > 70.5)$

$= P\left(Z > \frac{70.5-60}{\sqrt{24}}\right)$

$= P(Z > 2.14)$

$= 0.01618$

OK.

(Q4)

x : no of public buses stop at a particular bus stand in an interval of 10 mins

$X \sim P_o(2)$

interval	mean
60	12
10	$\frac{12}{6} = 2$

$\lambda = 2$

$P(X \geq 2) = 1 - P(x < 2)$

$= 1 - \left(\frac{e^{-2} 2^0}{0!} + \frac{e^{-2} 2^1}{1!}\right)$

$= 1 - 0.4060$

$= 0.5940$