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University of Jordan
Faculty of Engineering & Technology
Department of Electrical Engineering
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EE321, First Exam

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Q1- Suppose three indistinguishable boxes has balls as follows,

Color	Box1	Box 2	Box3
Red	2	4	3
White	3	1	4
Blue	5	3	3

A box is selected at random and one ball is selected at random at its observed to be red, what is the probability that box three is selected?

1

~~P{red from box3} = ... $\sum$ P(Box3/Red) P(Red)~~

~~event A: {red & Box3}~~

Event A : Box 3

Event B : Red

$P(A) = \frac{1}{3}$

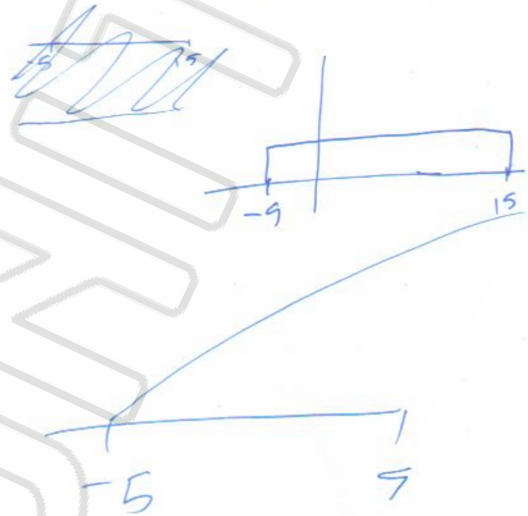
$P(B) = \frac{9}{28}$

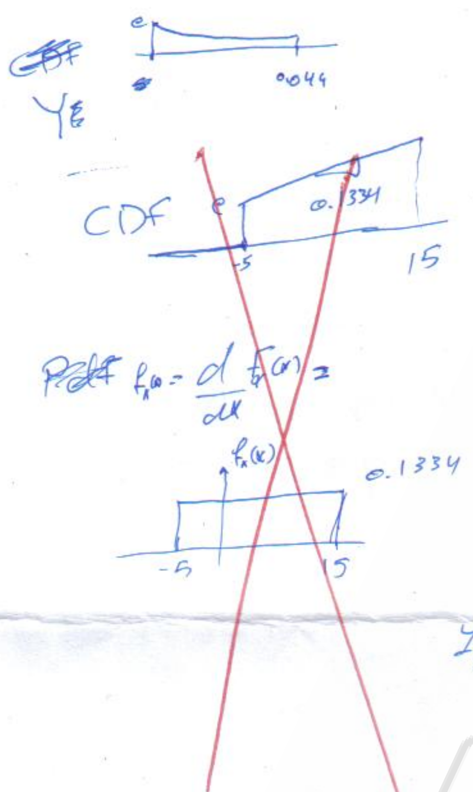
$P(A \cap B) = P(A) \cdot P(B) = \frac{3}{28}$

Q2- If X is uniform Random Variable on the interval (-5, 15). Define $Y = e^{\frac{-X}{5}}$.

Find:

1- The pdf of Y.
2- The expected value of Y.
3- The variance of Y.





0.1334x

$-5 \ln y = \frac{+x}{5}$

$f_Y(y) = f_X(x) \frac{dx}{dy}$

Q3- If X is a normal random variable with a mean $\bar{X} = 80$, and a standard deviation $\sigma_x = 10$. Compute the following probabilities

1- $P\{X \le 80\}$ 2- $P\{65 \le X \le 100\}$ 3- $P\{X > 70\}$

4- $P\{85 \le X \le 95\}$ 5- $P\{|X - 80| \le 80\}$

2

$F_x\left(\frac{X-80}{10}\right)$

(1) $P\{X \le 80\} = F_x(0) = 0.5$

(2) $P\{65 \le X \le 100\}$

$P\{X \le 100\} = F_x\left(\frac{100-80}{10}\right) = F_x(2) = 0.4773$

$P\{X \ge 65\} = F_x(1.5) = 0.9332$

$= F_x\left(\frac{95-80}{10}\right)$

$P\{65 \le X \le 100\} = 0.9773 - 0.9332 = 0.0441$

3) $P\{X > 70\}$

$F_x\left(\frac{90-80}{10}\right) = 0.8413$

(4) $P\{X \le 95\} = F_x\left(\frac{95-80}{10}\right) = F_x(1.5) = 0.9332$

$P\{X \ge 85\} = F_x\left\{\frac{75-80}{10}\right\} = F_x(-0.5) = 1 - F_x(0.5) = 1 - 0.6916 = 0.3085$

$P\{85 \le X \le 95\} = 0.9332 - 0.3085 = 0.6247$

5) $P\{|X \le 160$ & X

?

Q4- A Random Variable X has a pdf of the form

$$f_X(x)=\begin{cases} ax^2 & 0<x\le 2 \\ ax & 2<x\le 3 \end{cases}$$

Find:

1- The value of a.

2- $P\{2<X\le 3\}$

3- The CDF $F_X(x)$

1

① $f_X(x) \ge 0$

$f_X(x_2) \ge f_X(x_1)$

$x_2 > x_1$

$f_X(x) \ge 0$

$a \ge 0$

$$\boxed{\int_{-\infty}^{\infty} f_X(x) = 1} = \int_0^2 ax^2\,dx + \int_2^3 ax\,dx = 1$$

$$\frac{ax^3}{3}\Big|_0^2 + \frac{ax^2}{2}\Big|_2^3$$

$$= \frac{8}{3}a + \frac{a}{2}a = 1$$

$$a\left(\frac{8}{3}+\frac{1}{2}\right) = 1$$

$$\boxed{a = -2.167}$$

② $P\{2<x\le 3\} = \int_2^3 -2.167\,x\,dx =$

TABLE B-1
Values of $F(x)$ for $0 \le x \le 3.89$ in steps of 0.01

x	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
0.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
0.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
0.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
0.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
0.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
0.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
0.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
0.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
0.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9773	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990
3.1	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993
3.2	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995
3.3	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9996	.9997
3.4	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998	.9998
3.5	.9998	.9998	.9998	.9998	.9998	.9998	.9998	.9998	.9998	.9998
3.6	.9998	.9999	.9999	.9999	.9999	.9999	.9999	.9999	.9999	.9999
3.7	.9999	.9999	.9999	.9999	.9999	.9999	.9999	.9999	.9999	.9999
3.8	.9999	.9999	.9999	.9999	.9999	.9999	.9999	1.0000	1.0000	1.0000

Although a closed-form solution for $Q(x)$ is not known, an excellent approximation is

$$Q(x) \approx \left[\frac{1}{0.661x + 0.339\sqrt{x^2 + 5.51}}\right] \frac{e^{-x^2/2}}{\sqrt{2\pi}} \qquad x \ge 0 \qquad \text{(B-8)}$$

which is due to Börjesson and Sundberg, 1979. The maximum absolute relative error in the approximation for $Q(x)$ is given as 0.27 percent for any $x \ge 0$. By using the approximation (B-8) for $Q(x)$ in (B-7), an excellent approximation for $F(x)$ is realized.