PROBABILITY & STATISTICS – LAB 3-2

B.Tech. Computer Science and Engineering (Cybersecurity)

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Batch: K2/A2	Date of performance: 13/01/2021

Aim: To work with probability distribution functions

1. The probability of entering students in chartered accountant will graduate is 0.5. Determine the probability that out of 10 students

i. None

ii. One

iii. At least one will graduate

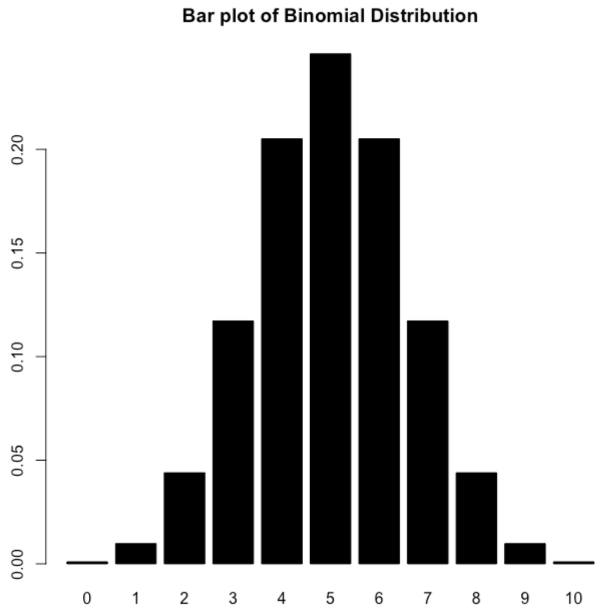
Write a R program for above problem.

Code:

```
print("Question 1")
x<-0:10
prob<-dbinom(x,10,.5)
prob
barplot(prob, col = "black", names.arg = x, main = "Bar plot of Binomial Distribution")
print("Probability of no graduates: ")
prob[1]
print("Probability of 1 graduate: ")
prob[2]
print("Probability of at lest 1 graduate: ")
y<-(cumsum(prob))
y[11]-prob[1]
```

Output:

```
> print("Question 1")
[1] "Question 1"
> x<-0:10
> prob<-dbinom(x,10,.5)
> prob
 [1] 0.0009765625 0.0097656250 0.0439453125 0.1171875000 0.2050781250 0.2460937500 0.2050781250 0.1171875000 0.0439453125 0.0097656250
[11] 0.0009765625
> barplot(prob, col = "black", names.arg = x, main = "Bar plot of Binomial Distribution")
> print("Probability of no graduates: ")
[1] "Probability of no graduates: "
> prob[1]
[1] 0.0009765625
> print("Probability of 1 graduate: ")
[1] "Probability of 1 graduate: "
> prob[2]
[1] 0.009765625
> print("Probability of at lest 1 graduate: ")
[1] "Probability of at lest 1 graduate: "
> y<-(cumsum(prob))
> y[11]-prob[1]
[1] 0.9990234
```



2. Find binomial distribution if the mean is 5 and variance is 10/3.

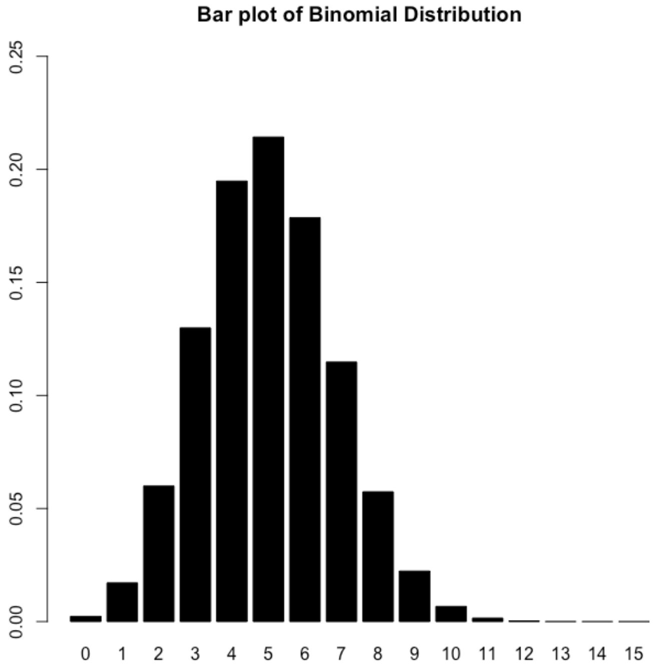
Write a R program for above problem. Also write a R program to plot probability distribution and cumulative probability distribution.

Code:

```
print("Question 2")
x<-0:15
mean<-5
variance<-10/3
q<-variance/mean
p<-1-q
n<-mean/p
prob<-dbinom(x,15,p)
prob
barplot(prob, col = "black", ylim = c(0,.25), names.arg = x, main = "Bar plot of Binomial Distribution")
print("Value of n: ")
n
print("Value of p: ")
p
print("Value of q: ")
q
```

Output:

```
> print("Question 2")
[1] "Question 2"
> x<-0:15
> mean<-5
> variance<-10/3
> q<-variance/mean
> p<-1-q
> n<-mean/p
> prob<-dbinom(x,15,p)
> prob
 [1] 2.283658e-03 1.712744e-02 5.994603e-02 1.298831e-01 1.948246e-01 2.143071e-01 1.785892e-01 1.148074e-01 5.740368e-02 2.232365e-02
[11] 6.697095e-03 1.522067e-03 2.536779e-04 2.927052e-05 2.090752e-06 6.969172e-08
> barplot(prob, col = "black", ylim = c(0,.25), names.arg = x, main = "Bar plot of Binomial Distribution")
> print("Value of n: ")
[1] "Value of n: "
> n
[1] 15
> print("Value of p: ")
[1] "Value of p: "
> p
[1] 0.3333333
> print("Value of q: ")
[1] "Value of q: "
> q
[1] 0.6666667
```



3. The number of traffic accidents that occur on a particular stretch of road during a month follows a Poisson distribution with a mean of 7.6. Find the probability that

i. less than three accidents will occur next month on this stretch of road.

ii. Exactly three accidents will occur next month on this stretch of road.

Write a R program for above problem.

Code:

```
print("Question 3")
print("Probability of less than 3 accidents occurring: ")
ppois(2,7.6)
print("Probability of exactly 3 accidents occurring: ")
dpois(3,7.6)
```

Output:

```
> print("Question 3")
[1] "Question 3"
> print("Probability of less than 3 accidents occurring: ")
[1] "Probability of less than 3 accidents occurring: "
> ppois(2,7.6)
[1] 0.01875692
> print("Probability of exactly 3 accidents occurring: ")
[1] "Probability of exactly 3 accidents occurring: "
> dpois(3,7.6)
[1] 0.03661436
>
```

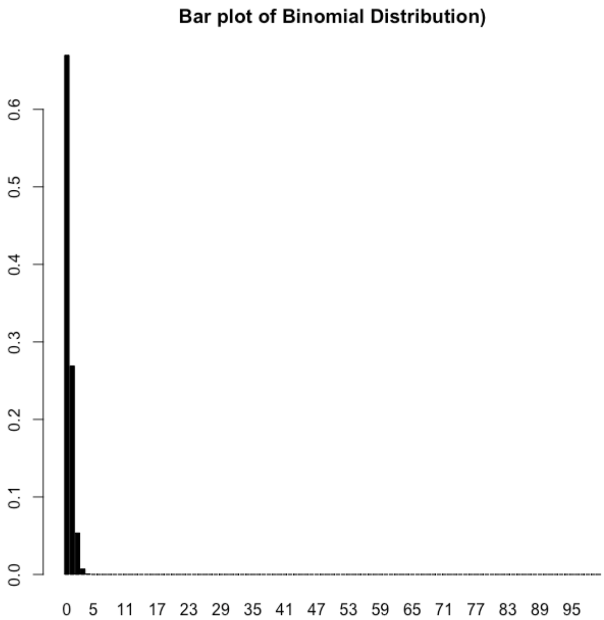
4. The items produced by a certain machine include only one defective in every 250 items. Ten bags of 10 items each are considered. Find the probability that in ten bags there is (i) no defective item, (ii) exactly one defective item, (iii) at least one defective item.

Code:

```
print("Question 4")
x<-0:100
prob<-dbinom(x,100,1/250)
prob
barplot(prob, col = "black", names.arg = x, main = "Bar plot of Binomial Distribution)")
print("Probability of no defective items: ")
prob[1]
print("Probability of exactly 1 defective items: ")
prob[2]
print("Probability of at least 1 defective items: ")
y<-(cumsum(prob))
y[101]-prob[1]
```

Output:

```
> print("Question 4")
[1] "Question 4"
> x<-0:100
> prob<-dbinom(x,100,1/250)
> prob
  [1]  6.697826e-01  2.689890e-01  5.347371e-02  7.015293e-03  6.832163e-04  5.268174e-05  3.349910e-06  1.806607e-07  8.434458e-09
 [10]  3.462607e-10  1.265451e-11  4.158107e-13  1.238526e-14  3.367015e-16  8.403050e-18  1.934839e-19  4.128045e-21  8.191726e-23
 [19]  1.516986e-24  2.629315e-26  4.276596e-28  6.542889e-30  9.435711e-32  1.285115e-33  1.655855e-35  2.021606e-37  2.341990e-39
 [28]  2.577826e-41  2.699101e-43  2.691251e-45  2.557950e-47  2.319685e-49  2.008763e-51  1.662357e-53  1.315591e-55  9.963168e-58
 [37]  7.224519e-60  5.018661e-62  3.341531e-64  2.133404e-66  1.306603e-68  7.679125e-71  4.332266e-73  2.346796e-75  1.220951e-77
 [46]  6.102030e-80  2.930082e-82  1.351999e-84  5.995310e-87  2.555169e-89  1.046696e-91  4.121173e-94  1.559604e-96  5.672576e-99
 [55] 1.982828e-101 6.660101e-104 2.149344e-106 6.663225e-109 1.983926e-111 5.671834e-114 1.556527e-116 4.099091e-119 1.035526e-121
 [64] 2.508446e-124 5.824079e-127 1.295439e-129 2.758937e-132 5.622721e-135 1.095853e-137 2.041051e-140 3.630096e-143 6.160013e-146
 [73] 9.964323e-149 1.534913e-151 2.249139e-154 3.131332e-157 4.136720e-160 5.178182e-163 6.132128e-166 6.858157e-169 7.229985e-172
 [82] 7.169403e-175 6.671499e-178 5.810567e-181 4.722683e-184 3.570183e-187 2.500829e-190 1.616194e-193 9.588589e-197 5.192143e-200
 [91] 2.548575e-203 1.124752e-206 4.418878e-210 1.526581e-213 4.565523e-217 1.158027e-220 2.422246e-224 4.011504e-228 4.931772e-232
[100] 4.001276e-236 1.606938e-240
> barplot(prob, col = "black", names.arg = x, main = "Bar plot of Binomial Distribution)")
> print("Probability of no defective items: ")
[1] "Probability of no defective items: "
> prob[1]
[1] 0.6697826
> print("Probability of exactly 1 defective items: ")
[1] "Probability of exactly 1 defective items: "
> prob[2]
[1] 0.268989
> print("Probability of at least 1 defective items: ")
[1] "Probability of at least 1 defective items: "
> y<-(cumsum(prob))
> y[101]-prob[1]
[1] 0.3302174
```



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PnS
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Q.1. Let x be a random variable denoting no. of graduating students

$n = 10$

$p = \frac{1}{2}$

$q = \frac{1}{2}$

i. $x = 0$

$P(x=0) = {}^{10}C_0 \left(\frac{1}{2}\right)^0 \left(\frac{1}{2}\right)^{10}$

$= 1 \times 1 \times \frac{1}{2^{10}} = \frac{1}{1024} = 0.000976$

ii. $x = 1$

$P(x=1) = {}^{10}C_1 \left(\frac{1}{2}\right)^1 \left(\frac{1}{2}\right)^9$

$= \frac{10}{1024} = 0.009765$

iii. $P(x \geq 1) = 1 - P(x=0)$

$= 1 - 0.000976$

$= 0.999024$

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Q.2 $np = 5$
$npq = \frac{10}{3}$

$\rightarrow$ $np = 5$ - (i)
$npq = \frac{10}{3}$ - (ii)

Substituting (i) in (ii)

$5q = \frac{10}{3}$

$q = \frac{2}{3}$

$\because p+q = 1$
$\therefore p = 1 - \frac{2}{3} = \frac{1}{3}$

Substituting p in (i)

$n\left(\frac{1}{3}\right) = 5$

$n = 15$

$\therefore$ BD

$P(x) = {}^{15}C_x \left(\frac{1}{3}\right)^x \left(\frac{2}{3}\right)^{15-x}$, for $x = 0, 1, \ldots 15$

x	$P(x)$	Cummulative PD
0	0.00228	0.00228
1	0.0171	0.01938
2	0.0599	0.07928
3	0.1298	0.20908
4	0.1948	0.40388
5	0.2143	0.61818
6	0.1785	0.79668
7	0.1148	0.91148
8	0.0574	0.96888
9	0.0223	0.99118
10	0.00669	0.99787
11	0.00152	0.99939
12	0.000253	0.999643
13	0.0000292	0.9996722
14	0.00000209	0.99967429
15	0.000000069	0.999674359

Q.3. $\lambda = 7.6$

$$P(x) = \frac{e^{-\lambda}\lambda^x}{x!}$$

i. $P(x<3) = P(x=0) + P(x=1) + P(x=2)$

$$= \frac{e^{-7.6}(7.6)^0}{0!} + \frac{e^{-7.6}(7.6)^1}{1!} + \frac{e^{-7.6}(7.6)^2}{2!}$$

$$= e^{-7.6}\left(1 + 7.6 + \frac{57.76}{2}\right)$$

$$= e^{-7.6}(8.6 + 28.88) = e^{-7.6} \times 37.48$$

$$= 0.0005004 \times 37.48$$

$$= \underline{0.01875}$$

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ii. $P(x=3) = \dfrac{e^{-7.6}(7.6)^3}{3!} = \dfrac{0.0005004 \times 438.976}{6}$

$= \underline{0.0366}$

Q.4. $n = 10 \times 10 = 100$, x: no. of defective items

$p = \dfrac{1}{250}$

$q = \dfrac{249}{250}$

$P(x) = {}^{100}C_x \left(\dfrac{1}{250}\right)^x \left(\dfrac{249}{250}\right)^{100-x}$

i. $x=0$

$P(x=0) = {}^{100}C_0 \left(\dfrac{1}{250}\right)^0 \left(\dfrac{249}{250}\right)^{100}$

$= 0.6697$

ii. $x=1$

$P(x=1) = {}^{100}C_1 \left(\dfrac{1}{250}\right)^1 \left(\dfrac{249}{250}\right)^{99}$

$= 0.2689$

iii $P(x \geq 1) = 1 - P(x=0)$

$= 1 - 0.6697$

$= 0.3303$