R Textbook Companion for Fundamentals of Mathematical Statistics by S.C. Gupta, V.K. Kapoor[1]

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Book Description

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R numbering policy used in this document and the relation to the above book.

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

For example, Exa 3.51 means solved example 3.51 of this book. Sec 2.3 means an R code whose theory is explained in Section 2.3 of the book.

Contents

List of R Codes

Chapter 2

Descriptive Measures

R code Exa 2.1 Arithmetic Mean

```
#PAGE NUMBER--2.8
#Example number--2.1

#Part (a)
x=c(1,2,3,4,5,6,7)
f=c(5,9,12,17,14,10,6)              # frequency
fx=f*x
a=data.frame(x,y,fx)
a
mean=(sum(fx))/sum(y)
mean



#Part (b)
Marks=c("0-10","10-20","20-30","30-40","40-50","
    50-60")
mid=c((0+10)/2,(10+20)/2,(20+30)/2,(30+40)/2,(40+50)
    /2,(50+60)/2)        # mid values
f=c(12,18,27,20,17,6)               # frequency
fx=f*mid
```

```
b=data.frame(Marks,mid,f,fx)
b
mean=(sum(fx))/sum(f)
mean
```

R code Exa 2.2 Mean

```
#PAGE NUMBER--2.10
#Example number--2.2

A=28
h=8
Class_Interval=c("0-8","8-16","16-24","24-32","32-40","40-48")
mid=c((0+8)/2,(8+16)/2,(16+24)/2,(24+32)/2,(32+40)/2,(40+48)/2)
f=c(8,7,16,24,15,7)                    # frequency
d=(mid-A)/h
fd=f*d
a=data.frame(Class_Interval,mid,f,d,fd)
a
mean=A + h* sum(fd)/sum(f)
mean
```

R code Exa 2.3 Percentage Male Female Employees

```
#PAGE NUMBER--2.11
#Example number--2.3

x1=5200
x2=4200
x=5000
```

```
#we know that combined mean----> x=(a1*x1+a2*x2)/(a1+a2)
#we will find the ratio of a1/a2
#let us name it as -------> a
a=(x-x2)/(x1-x)
#by comparing a numerator and denominator we get a1=800 and a2=200
a1=x-x2;a1
a2=x1-x;a2
m.p=a1*100/(a1+a2)
f.p=a2*100/(a1+a2)
sprintf("Percentage of male employee: %s",m.p)
sprintf("Percentage of female employee: %s",f.p)
```

R code Exa 2.4 Age Limits

```
#PAGE NUMBER--2.12
#Example number--2.4

Age_Group=c("20-25","25-30","30-35","35-40","40-45","45-50","50-55","55-60","60-65")
n_o_p=c(30,160,210,180,145,105,70,60,40)          #Number of persons
data.frame(Age_Group,n_o_p)

N=1000

# Part(i)
a=15/100*N
sprintf("Number of persons to be retrenched from the lower group: %d", a)
sprintf("30 people from 20-25 age group")
sprintf("%d people from 25-30 age group", a-30)

# Part(ii)
```

```
b=45/100*N
sprintf("Number of persons to be absorbed in other branches: %d", b)
Age_Group1=c("25-30","30-35","35-40","40-45")
n_o_p1=c(160-120,210,180,b-(40+210+180))
data.frame(Age_Group1,n_o_p1)

# Part(iii)
c=10/100*N
sprintf("Number of persons to retire: %d", c)

Age_Group2=c("40-45","45-50","50-55")
n_o_p2=c(145-20,105,70)          # Number of persons
data.frame(Age_Group2,n_o_p2)

A=47.5
h=5
mid=c((40+45)/2,(45+50)/2,(50+55)/2)
d=(mid-A)/h;d
fd=n_o_p2*d
data.frame(Age_Group2,mid,n_o_p2,d,fd)
mean=A + h* sum(fd)/sum(n_o_p2)
round(mean)
```

R code Exa 2.6 Median

```
#PAGE NUMBER--2.15
#Example number--2.6

x=c(1,2,3,4,5,6,7,8,9)
f=c(8,10,11,16,20,25,15,9,6)
cf=cumsum(f)
data.frame(x,f,cf)
sum(f)/2
```

```
sprintf("Cumulative frequence just greater than 60
    is 65")
sprintf("So, Median = 5")
```

R code Exa 2.7 Median Wages

```
#PAGE NUMBER−−2.16
#Example number−−2.7

Wages=c("2000−3000","3000−4000","4000−5000","
    5000−6000","6000−7000")
n_o_e=c(3,5,20,10,5)              # Number of
    employees
cf=cumsum(n_o_e)
data.frame(Wages,n_o_e,cf)

sum(n_o_e)/2
sprintf("Cumulative frequence just greater than 21.5
     is 28")
sprintf("So, the median class is 4000−5000")

median= 4000 + 1000/20*(21.5-8)
median
```

R code Exa 2.8 Median Hours Of Work

```
#PAGE NUMBER−−2.17
#Example number−−2.8

Wages_hours=c("Below 3.005","3.005−4.505","
    4.505−6.005","6.005−7.505","7.505−9.005","9.005
    Above")
f=c(0.05*3000,580,0.3*3000,500,0.2*3000,3000-2730)
```

```
cf=cumsum(f)
data.frame(Wages_hours,f,cf)

sum(f)/2
sprintf("Cumulative frequence just greater than 1500
    is 1630")
sprintf("So, the median class is 4.505-6.005")

median= 4.505 + 1.5/900*(1500-730)
round(median,2)
```

R code Exa 2.9 Incomplete Frequency

```
#PAGE NUMBER--2.17
#Example number--2.9

variable=c("10-20","20-30","30-40","40-50","50-60","
    60-70","70-80")
f=c(12,30,NA,65,NA,25,18)
data.frame(variable,f)

# Let frequency of 30-40 be f1
# Let frequency of 50-60 be f1
# sum of f1+f2= q
q=229-(12+30+65+25+18)
#Solving the equation----> 46=40+(114.5-12-30-f1)/65
    *10
f1=round(solve(10,335))
f1
f2=q-f1
f2
```

R code Exa 2.12 Mode

```
#PAGE NUMBER−−2.21
#Example number−−2.12

Class_Interval=c("0−10","10−20","20−30","30−40","
    40−50","50−60","60−70","70−80")
f=c(5,8,7,12,28,20,10,10)
data.frame(Class_Interval,f)

a=max(f)
sprintf("Maximum frequence: %d",a)
sprintf("Modal class is 40−50")
Mode= 40 + 10*(28-12)/(2*28-12-20)
round(Mode,2)
```

R code Exa 2.15 Geometric mean

```
#PAGE NUMBER−−2.25
#Example number−−2.15

# G'=(x1'*x2*.....xn)^1/n
# G'=(x1*x2*.....xn)1/n * (x1'/x1)^1/n
# G'=G* (x1'/x1)^1/n

G=16.2
n=10
x1=12.9
x_1=21.9
c_G.M=G*(x_1/x1)^(1/10)          # Corrected G.M
c_G.M
```

R code Exa 2.17 Average Speed

```
#PAGE NUMBER−−2.27
```

```
#Example number--2.17

#Average speed

avg.s=function(){
    #let the distance between home and college is x kms.
    x=1
    #speed from home to college
    a=x/10
    #speed from  college to home
    b=x/15
    AverageSpeed=2*x/(a+b)
    sprintf("Your average speed is: %s",AverageSpeed)
}
avg.s()
```

R code Exa 2.18 Average Price

```
#PAGE NUMBER--2.27
#Example number--2.18

#Part (a)
#Average price
avg.p=function(){
    #Number of varities of milk
    n=4
    #Prices of milk sold at different varities
    a=c(8,10,12,15)
    #Average price
    AveragePrice=1/((1/n)*(1/a[n-3]+1/a[n-2]+1/a[n-1]+1/a[n]))
    sprintf("Your average price is: %s",AveragePrice)
```

```
}
avg.p()


#Part (b)
quality=c("A","B","C")
p.p.p=c(1.00,1.50,2.00)    #price per pencil
m.s=c(50,30,20)            #money spent
fr.distr=data.frame(quality,p.p.p,m.s)
fr.distr
n.e=sum(m.s)               #net value
p.p= sum(m.s / p.p.p)      #number of pencils
   purchased
Averagep.p.p = n.e/p.p     #Average price per pencil
Averagep.p.p
```

R code Exa 2.19 Average Speed

```
#PAGE NUMBER−−2.28
#Example number−−2.19

speed=c(60,25,350,25)
distance=c(900,3000,400,15)
wx=round(distance/speed,2)
data.frame(speed,distance,wx)

avg.sp= sum(distance)/sum(wx)   #Average Speed

#Answer is little varying as of rounding off

avg.sp
```

R code Exa 2.20 Number Of Tosses Required

```
#PAGE NUMBER--2.29
#Example number--2.20

x=seq(0,8,1)
f=c(1,9,26,59,72,52,29,7,1)
cf=cumsum(f)
data.frame(x,f,cf)

sum(f)/2
sprintf("Cumulative frequence just greater than 128
    is 167")
sprintf("So, Median = 4")

Q1=sum(f)/4;Q1
sprintf("Cumulative frequence just greater than 64
    is 95")
sprintf("So, Q1 = 3")
Q3=3*sum(f)/4;Q3
sprintf("Cumulative frequence just greater than 192
    is 219")
sprintf("So, Q3 = 5")
D4=4*sum(f)/10;D4
sprintf("Cumulative frequence just greater than
    102.4 is 167")
sprintf("So, D4 = 4")
P27=27*sum(f)/100;P27
sprintf("Cumulative frequence just greater than
    69.12 is 95")
sprintf("So, P27 = 3")
```

R code Exa 2.21 Lower Quartile Marks

```
#PAGE NUMBER--2.29
#Example number--2.21

```

```
m_m_t=c(0,10,20,30,40,50)              # marks more
    than
n_o_c=c(500,460,400,200,100,30)        # number of
    candidates
Class_interval=c("0-10","10-20","20-30","30-40","
    40-50","50 Above")
f=c(500-460,460-400,400-200,200-100,100-30,30)
cf=cumsum(f)
data.frame(m_m_t,n_o_c,Class_interval,f,cf)

sum(f)/4
sprintf("Cumulative frequence just greater than 125
    is 300")
sprintf("So, the corresponding class is 20-30")
Q1= 20 + 10/200*(125-100)
Q1

3*sum(f)/10
sprintf("Cumulative frequence just greater than 150
    is 300")
sprintf("So, the corresponding class is 20-30")
D3= 20 + 10/200*(150-100)
D3
```

R code Exa 2.23 Cumulative Frequency Curve

```
#PAGE NUMBER--2.31
#Example number--2.23

m.g=c("0-10","10-20","20-30","30-40","40-50","50-60"
    ,"60-70")    #Marks Group
f=c(4,8,11,15,12,6,3)
l.c.f=cumsum(f)                                   #
    Less than cumulative frequency
m.c.f=rev(cumsum(rev(f)))
```

```
data.distr=data.frame(m.g,f,l.c.f,m.c.f)
                #More than cumulative frequency
data.distr
#For lower quartile (Q1)
N=sum(f)
Q1=20+10/11*(N/4-l.c.f[2])
Q1
#For middle quartile (Q2)
Q2=30+10/15*(N/2-l.c.f[3])
    #Median
Q2
#For upper quartile (Q3)
Q3=40+10/12*(3*N/4-l.c.f[4])
Q3
x=seq(10,70,10)
plot(x,l.c.f,xlab="MARKS",ylab="No. of Students",
    main="Cumulative frequency curve",col="red")
sp=spline(x,l.c.f,n=20)
plot(x,m.c.f,xlab="MARKS",ylab="No. of Students",
    main="Cumulative frequency curve",col="red")
spl=spline(x,m.c.f,n=20)
lines(spl,col="blue")
lines(sp,col="green")
locator()
```

R code Exa 2.24 Quartile Deviation And Mean Deviation From Mean

```
#PAGE NUMBER−−2.33
#Example number−−2.24

marks=c("0−10","10−20","20−30","30−40","40−50","
    50−60","60−70")
n.o.s=c(6,5,8,15,7,6,3)
mid=seq(5,65,10)
d=(mid-35)/10
```

```r
fd=n.o.s*d
mean=35+10*(sum(fd))/sum(n.o.s)
l.c.f=cumsum(n.o.s)
a=abs(mid-mean)
b=n.o.s*a
fr.distr=data.frame(marks,mid,n.o.s,d,fd,a,b,l.c.f)
fr.distr

#Part (i)
N=sum(n.o.s)
Q1=20+10*(N/4-11)/8
Q1          #Q1 is deviated because they have taken N/4=12.75 which is 12.5
Q3=40+10/7*(3*N/4-34)
Q3          #Q3 is deviated because they have taken N/4=12.75 which is 12.5

QD=(Q3-Q1)/2
sprintf("Quartile Deviation is : %s",QD)

#Part (ii)
MD=sum(b)/N
MD
```

R code Exa 2.26 Mean and Standard deviation

```r
#PAGE NUMBER--2.38
#Example number--2.26

A=55
h=10
Age_group=c("20-30","30-40","40-50","50-60","60-70","70-80","80-90")
mid=c((20+30)/2,(30+40)/2,(40+50)/2,(50+60)/2,(60+70)/2,(70+80)/2,(80+90)/2)
```

```
f=c(3,61,132,153,140,51,2)
d=(mid-A)/h
fd=f*d
fd2=fd*d

mean= A + h*sum(fd)/sum(f)
mean

s.d=sqrt(100*(765/542-0.028^2))
s.d                              # Standard Deviation
```

R code Exa 2.27 Corrected Mean And Standard Deviation

```
#PAGE NUMBER−−2.39
#Example number−−2.27

n=200
mean=40
s.d=15

s_x=n*mean
s_x                     # sum of xi
s_x2=n*(15^2+1600)
s_x2                    # sum of xi^2

c_s_x= s_x-34-53+43+35
corrected_mean=c_s_x/n
corrected_mean

c_s_x2= s_x2-34^2-53^2+43^2+35^2
corrected_s.d= sqrt(c_s_x2/n - corrected_mean^2)
corrected_s.d                    # corrected Standard
   deviation
```

R code Exa 2.28 Original Frequency Distribution

```
#PAGE NUMBER--2.39
#Example number--2.28

d=seq(-4,3,1)
f=c(2,5,7,13,21,16,8,3)
fd=f*d
fd2=fd*d
data.frame(fd,fd2)

mean=21.9
s.d2=63.9725
h=round(sqrt(solve(193/75-(-9/75)^2,s.d2)))
h
A= 21.9 + 9*5/75
A

# Mid value=(x1+x2)/2=A
# Magnitude of class= x1-x2=h
a=matrix(c(1,-1,1,1),nrow=2,ncol=2)
b=matrix(c(A*2,h),nrow=2,ncol=1)
t=solve(a,b)
t
x1=t[1,1];x1
x2=t[2,1];x2

# So the classes obtained
class_interval=c("0-5","5-10","10-15","15-20","20-25
    ","25-30","30-35","35-40")
mid=c((0+5)/2,(5+10)/2,(10+15)/2,(15+20)/2,(20+25)/
    2,(25+30)/2,(30+35)/2,(35+40)/2)
data.frame(d,mid,class_interval,f)
```

R code Exa 2.29 Standard Deviation Of Second Group

```
#PAGE NUMBER--2.40
#Example number--2.29

N=250
n1=100
x1=15
s.d1=3
n2=250-n1
mean=15.6
s.d=sqrt(13.44)

x2=solve(150,N*mean-1500)
x2
d1=x1-mean;d1
d2=x2-mean;d2
s.d2=sqrt(solve(150,N*13.44-n1*9.36-n2*0.16))
s.d2
```

R code Exa 2.34 Wages By Firm A And B

```
#PAGE NUMBER--2.44
#Example number--2.34

# Part(i)
# Firm A:
n1=500                # Number of wagers
x1=186                # Average daily wage
t_w_p1=n1*x1              # Total wages paid
t_w_p1

```

```
# Firm B:
n2=600                    # Number of wagers
x2=175                    # Average daily wage
t_w_p2=n2*x2                  # Total wages paid
t_w_p2

sprintf("Firm B has larger wage bill")

# Part(ii)
s.d1=sqrt(81)                    # Standard Deviation of A
s.d2=sqrt(100)               # Standard Deviation of B
c.vA=100*s.d1/x1
c.vA
c.vB=100*s.d2/x2
c.vB

sprintf("Firm B has greater variability in individual wages")

# Part(iii)
a_d_w= (n1*x1 + n2*x2)/(n1 + n2)          # Average daily wages
a_d_w
d1=x1-a_d_w
d2=x2-a_d_w
c.v= 1/(n1 + n2) * (n1*(81+d1^2) + n2*(100+d2^2))
c.v
```

R code Exa 2.35 Moments About Mean Origin Particular Point

```
#PAGE NUMBER--2.48
#Example number--2.35

A=4
```

```
U1=-1.5
U2=17
U3=-30;  U4=108
u2= U2-U1^2; u2
u3= U3-3*U2*U1+2*U1^3; u3
u4= U4-4*U3*U1+6*U2*U1^2 -3*U1^4; u4

b1=u3^2/u2^3
b1
b2=u4/u2^2
b2
mean= A + U1
mean

# Taking A=0, we get the first moment about origin
U1=2.5
U2= u2+U1^2; U2
U3= u3+3*u2*U1+U1^3; U3
U4= u4+4*u3*U1+6*u2*U1^2+U1^4; U4

# Taking A=2, we get the first moment about x=2
U1=2.5-2
U2= u2+U1^2; U2
U3= u3+3*u2*U1+U1^3; U3
U4= u4+4*u3*U1+6*u2*U1^2+U1^4; U4
```

R code Exa 2.36 First Four Moments

```
#PAGE NUMBER--2.49
#Example number--2.36

x=seq(0,8,1)
f=c(1,8,28,56,70,56,28,8,1)
d=x-4
fd=f*d
```

```
fd2=fd*d
fd3=fd2*d
fd4=fd3*d
data.frame(x,f,d,fd,fd2,fd3,fd4)

# Moments about point x=4
U1=sum(fd)/sum(f); U1
U2=sum(fd2)/sum(f); U2
U3=sum(fd3)/sum(f); U3
U4=sum(fd4)/sum(f); U4

# Moments about mean
u1=0
u2= U2-U1^2; u2
u3= U3-3*U2*U1+2*U1^3; u3
u4= U4-4*U3*U1+6*U2*U1^2 -3*U1^4; u4

b1=u3^2/u2^3
b1
b2=u4/u2^2
b2
```

R code Exa 2.40 Corrected Frequency Constants

```
#PAGE NUMBER--2.51
#Example number--2.40

N=250
x=54
s.d=3
b1=0; b2=3

#Wrong observation---> 64 and 50        Correct
    observation---> 62 and 52
#Part (i)
```

```
ux=N*x
cx=ux - (64+50) + (62+52)
cx
cm=cx/N                 # Corrected mean
cm

# Part (ii)
ux2=N*s.d^2; ux2
cx2=ux2 -((64-54)^2+(50-54)^2)+((62-54)^2+(52-54)^2)
    ; cx2
cs.d=round(sqrt(cx2/N),2)        # Corrected Standard
      Deviation
cs.d

# Part (iii)
u3=b1*u2^3; u3
ux3=N*u3; ux3
cx3=0 -((64-54)^3+(50-54)^3)+((62-54)^3+(52-54)^3);
    cx3    # Answer here is wrong
cu3=cx3/N; cu3
cb1=(cu3)^2/(cx2/N)^3; round(cb1)

# Part (iv)
u4=b2*9^2
ux4= N*u4; ux4
cx4= ux4 - ((64-54)^4+(50-54)^4)+((62-54)^4+(52-54)
    ^4); cx4
cu4=cx4/N; cu4
cb2= cu4/(cx2/N)^2; cb2
```

R code Exa 2.42 First Four Moments About Origin

```
#PAGE NUMBER−−2.55
#Example number−−2.42

```

```
mean=10
u2=16
s.d=sqrt(16)
y1=1
b1=4

# First four moments about origin
U1=mean
U2=u2 + U1^2; U2
u3=s.d^3; u3
U3= u3 + 3*U2*U1 -2*U1^3; U3
u4= b1*u2^2; u4          # here we have to take value of b1, written wrong in book

U4= u4 + 4*U3*U1 - 6*U2*U1^2 + 3*U1^4; U4   # plus, minus signs are not correct in the book

sprintf("The distribution is leptokurtic")
```

R code Exa 2.43 First Four Moments About Mean Of The Distribution

```
#PAGE NUMBER--2.56
#Example number--2.43

A=135
h=10
Scores=c("50-60","60-70","70-80","80-90","90-100","100-110","110-120","120-130",
"130-140","140-150","150-160","160-170","170-180","180-190","190-200",
"200-210","210-220","220-230")
f=c(1,0,0,1,1,2,1,0,4,4,2,5,10,11,4,1,1,2)
mid=c((50+60)/2,(60+70)/2,(70+80)/2,(80+90)/2,(90+100)/2,(100+110)/2,
(110+120)/2,(120+130)/2,(130+140)/2,(140+150)/
```

```
    2,(150+160)/2,(160+170)/2,
(170+180)/2,(180+190)/2,(190+200)/2,(200+210)/
    2,(210+220)/2,(220+230)/2)
d=(mid-A)/h
fd=f*d
fd2=fd*d
fd3=fd2*d
fd4=fd3*d
data.frame(Scores,mid,f,d,fd,fd2,fd3,fd4)

# Raw Moments of variable d about origin
U1=sum(fd)/sum(f); U1
U2=sum(fd2)/sum(f); U2
U3=sum(fd3)/sum(f); U3
U4=sum(fd4)/sum(f); U4

# Central Moments of variable X
u2= (U2-U1^2)*h^2; u2
u3= (U3-3*U2*U1+2*U1^3)*h^3; u3
u4= (U4-4*U3*U1+6*U2*U1^2 -3*U1^4)*h^4; u4

# Sheppard's Corrections for Moments

u2b=u2-h^2/12; u2b
u3b=u3; u3b
u4b=u4 - h^2/2*u2 + 7/240*h^4; u4b

# Moment coefficient of skewness
y1= u3/(u2)^(3/2); y1

# Moment coefficient of kurtosis
b2= u4/u2^2; b2

sprintf("The distribution is leptokurtic")
```

Chapter 3

Probability I

R code Exa 3.2 Two Unbiased Dice

```
#Page number--3.7
#Example number--3.2
#LOAD PACKAGE----->prob

s=rolldie(2)
s

#Part (a)
subset(s,X1==X2)
p=nrow(subset(s,X1==X2))/nrow(s)
sprintf("Probability that the two dice show the same number: %f",p)

#Part (b)
subset(s,X1==6)
p=nrow(subset(s,X1==6))/nrow(s)
sprintf("Probability that the first die show 6: %f",p)

#Part (c)
subset(s,X1+X2==8)
```

```
p=nrow(subset(s,X1+X2==8))/nrow(s)
sprintf("Probability that the total of numbers on
    the die is 8: %f",p)

#Part (d)
subset(s,X1+X2>8)
p=nrow(subset(s,X1+X2>8))/nrow(s)
sprintf("Probability that the total of numbers on
    the die is more than 8: %f",p)

#Part (e)
subset(s,X1+X2==13)
p=nrow(subset(s,X1+X2==13))/nrow(s)
sprintf("Probability : %f",p)
sprintf("This is an impossible event")

#Part (f)
sprintf("This is a certain event.")
sprintf("Probability : 1")
```

R code Exa 3.3 Probability That Odd Digit Selected

```
#Page number--3.8
#Example number--3.3

# Part(a)
N=5*4
sprintf("Total number of cases: %d",N)
#Part(i)
# there are 12 cases--->(1,2),(1,3),(1,4),(1,5)
    ,(3,1),(3,2),(3,4),(3,5),(5,1),(5,2),(5,3),(5,4)
a=12/20
sprintf("Probability that the first digit drawn is
    odd: %f",a)
#Part(ii)
```

```
# there are 12 cases--->(2,1),(3,1),(4,1),(5,1)
    ,(1,3),(2,3),(4,3),(5,3),(1,5),(2,5),(3,5),(4,5)
b=12/20
sprintf("Probability that the second digit drawn is
   odd: %f",b)
#Part(iii)
# there are 6 cases--->(1,3),(1,5),(3,1),(3,5),(5,1)
    ,(5,3)
c=6/20
sprintf("Probability that the first and second digit
    drawn are odd: %f",c)

# Part(b)
n=25
#Number which are multiple of 5-----> 5,10,15,20,25
d.f.c= 5+3      # Distinct favourable cases
d=d.f.c/n
sprintf("Required Probability: %f",d)

#Number which are multiple of 3----->
   3,6,9,12,15,18,21,24
d.f.c= 8+3-1    # Distinct favourable cases
e=d.f.c/n
sprintf("Required Probability: %f",e)
```

R code Exa 3.4 Four Cards Drawn At Random

```
#Page number--3.9
#Example number--3.4

#Preparing Combination function
comb=function(n,r){
    return (factorial(n)/(factorial(r)*factorial(n-r
       )))
}
```

```
s=cards()

#Part (i)
subset(s, rank=="K" | rank=="J" | rank=="Q" | rank==
    "A")
#there are 4 King, 4 Jack, 4 Queen, 4 Ace ---> we
    need to select one from each
#total there are 52 cards
p=(comb(4,1)*comb(4,1)*comb(4,1)*comb(4,1))/comb
    (52,4)
sprintf("Probability: %f",p)

#Part (ii)
subset(s, rank=="K" | rank=="Q" )
#there are 4 kings, 4 queens ----> we need to select
     two from each
#total there are 52 cards
p=(comb(4,2)*comb(4,2))/comb(52,4)
sprintf("Probability: %f",p)

#Part (iii)
#There are 26 black cards and 26 red cards ----> we
    need to select two from each
#total there are 52 cards
p=(comb(26,2)*comb(26,2))/comb(52,4)
sprintf("Probability: %f",p)

#Part (iv)
subset(s, suit=="Diamond" | suit=="Heart" )
#there are 13 heart, 13 diamonds ----> we need to
    select two from each
#total there are 52 cards
p=(comb(13,2)*comb(13,2))/comb(52,4)
sprintf("Probability: %f",p)

#Part (v)
#4 cards can be from each suit
```

```
#total 52 cards
p=(comb(13,1)*comb(13,1)*comb(13,1)*comb(13,1))/comb(52,4)
sprintf("Probability: %f",p)
```

R code Exa 3.24 Probability That Letter Chosen

```
#Page number--3.36
#Example number--3.24

letters

n=length(letters)

#Part (i)
#Probability that the letter choosen is vowel
n1=length(c("a","e","i","o","u"))
p=n1/n
sprintf("Probability: %f",p)

#Part (ii)
#Probability that the letter preceeds m and is vowel
n2=length(c("a","e","i"))
p=n2/n
sprintf("Probability: %f",p)

#Part (iii)
#Probability that the letter follows m and is vowel
n3=length(c("o","u"))
p=n3/n
sprintf("Probability: %f",p)
```

R code Exa 3.29 Probability That Odd Number Appear

```
#Page number--3.38
#Example number--3.29

#Probability of rolling die=P(n)
#P(n)is proportional to n
#P(n)=kn
#We know that------> P(1)+P(2)+P(3)+P(4)+P(5)+P(6)=1
#k(1+2+3+4+5+6)=1
k=solve(21,1)
#We need to find probability of an odd number appearing on top
#P(1)+P(3)+(5)
p=1*k+3*k+5*k
sprintf("Probability : %f",p)
```

R code Exa 3.30 Probability

```
#Page number--3.39
#Example number--3.30
#LOAD PACKAGE----prob

s=rolldie(2)

#S denotes sum of faces of two die

#Part (a)
subset(s,X1+X2>8)
#Sample Space
#S=9---------->(3,6),(6,3),(4,5)(5,4)
#S=10-------->(4,6),(6,4),(5,5)
#S=11-------->(5,6),(6,5)
#S=12-------->(6,6)
p=nrow(subset(s,X1+X2==9))/nrow(s)+nrow(subset(s,X1+X2==10))/nrow(s)+nrow(subset(s,X1+X2==11))/nrow(s)+nrow(subset(s,X1+X2==12))/nrow(s)
```

```
sprintf("Probability that sum greater than 8: %f",p)

#Part(b)
subset(s,X1+X2==7 | X1+X2==11)
#Sample Space
#S=7--------->(1,6),(6,1),(2,5),(5,2),(3,4),(4,3)
#S=11-------->(5,6),(6,5)
p1=nrow(subset(s,X1+X2==7))/nrow(s)+nrow(subset(s,X1
   +X2==11))/nrow(s)
sprintf("Required Probability : %f",1-p1)
```

R code Exa 3.37 Probability

```
#Page number--3.41
#Example number--3.37
#LOAD PACKAGE----->prob

s=cards()
s

#A= Probability that the card drawn is king
#B= Probability that the card drawn is heart
#C= Probability that the card drawn is red card
A=nrow(subset(s,rank=="K"))/nrow(s)
B=nrow(subset(s,suit=="Heart"))/nrow(s)
C=(nrow(s)/2)/nrow(s)                    #Total red cards
   =26(i.e. half of deck)
#D=Probability that the card drawn is king of hearts
#E=Probability that the card drawn is heart
#F=Probability that the card drawn is red king
#G=Probability that the card drawn is king of hearts
D=1/nrow(s)
E=13/nrow(s)
F=2/nrow(s)
G=1/nrow(s)
```

```
#P=Probability that the card drawn is KING OR HEART
    OR RED CARD
P=A+B+C-D-E-F+G
P
```

Chapter 4

Probability II

R code Exa 4.1 Factories Production

```
#Page number--4.6
#Example number--4.1

#There are 3 factories-->X,Y,Z
#Product produced respectively--->3n,n,n
#Where n is constant, let suppose n=1
n=1
#E1,E2,E3 denotes event to the item produced in X,Y,Z
#A be the event that item is deffective
PE1=3*n/(3*n+n+n)
PE2=n/(5*n)
PE3=n/(5*n)
#GIVEN---------->P(A|E1)=P(A|E3)=0.03  AND  P(A|E2)=0.05
P.AE1=0.03                    #P(A|E1)
P.AE3=0.03                    #P(A|E3)
P.AE2=0.05                    #P(A|E2)

#Part (i)
PA=PE1*P.AE1+PE2*P.AE2+PE3*P.AE3
```

```
PA
sprintf("The required probability is: %f ",PA)


#Part (ii)
#Using bayes rule
P.E1A=(PE1*P.AE1)/PA                          #P(E1|A)
P.E2A=(PE2*P.AE2)/PA                          #P(E2|A)
P.E3A=(PE3*P.AE3)/PA                          #P(E3|A)
sprintf("The required probabilities are: %f ,%f ,%f"
   ,P.E1A,P.E2A,P.E3A)
```

R code Exa 4.2 Probability

```
#Page number--4.7
#Example number--4.2

#A--------------->Introduction to co-education
#E1,E2,E3-------->Chatterji,Ayangar,Singh selected as
   principal

PE1=4/9
PE2=2/9
PE3=3/9
P.AE1=0.3                      #P(A|E1)
P.AE2=0.5                          #P(A|E2)
P.AE3=0.8                      #P(A|E3)

#Part (i)
PA=PE1*P.AE1+PE2*P.AE2+PE3*P.AE3
sprintf("The required probability is: %f ",PA)

#Part (ii)
#Using bayes rule
P.E3A=(PE3*P.AE3)/PA                     #P(E3|A)
```

```
sprintf("The required probability is: %f ",P.E3A)
```

R code Exa 4.3 Probability of X Y Z Becoming Managers

```
#Page number--4.7
#Example number--4.3

#X,Y,Z———>managers
#E1,E2,E3————>Are the events of becoming X,Y,Z
   managers

PE1=4/9
PE2=2/9
PE3=1/3
P.AE1=0.3                    #P(A|E1)
P.AE2=0.5                    #P(A|E2)
P.AE3=0.8                    #P(A|E3)

#Part (i)
PA=PE1*P.AE1+PE2*P.AE2+PE3*P.AE3
PA
sprintf("The probability that Bonus scheme is
   introduced: %f ",PA)

#Part (ii)
#Using bayes rule
P.E1A=(PE1*P.AE1)/PA                    #P(E1|A)
sprintf("The probability that X will be manager: %f
   ",P.E1A)
```

R code Exa 4.4 Probability By Machines I And II And III

```
#Page number--4.8
```

```
#Example number--4.4

#A------------------->Output is defective
#E1,E2,E3---------->Output produced by machines I,II,III

PE1=3000/10000
PE2=2500/10000
PE3=4500/10000
P.AE1=0.01                    #P(A|E1)
P.AE2=0.012                       #P(A|E2)
P.AE3=0.02                    #P(A|E3)

PA=PE1*P.AE1+PE2*P.AE2+PE3*P.AE3
PA
sprintf("The probability that output is deffective:
    %f ",PA)


#Using bayes rule
P.E1A=(PE1*P.AE1)/PA                    #P(E1|A)
P.E2A=(PE2*P.AE2)/PA                    #P(E2|A)
P.E3A=(PE3*P.AE3)/PA                    #P(E3|A)
sprintf("The probabilities of machine I,II,III are:
    %f ,%f ,%f",P.E1A,P.E2A,P.E3A)
```

R code Exa 4.9 Vessel Containing Balls

```
#Page number--4.11
#Example number--4.9

#E------------------->Drawing a white ball from second
    vessel
#E1,E2,E3,E4---------->Transfer of (0,4),(1,3),(2,2)
    ,(3,1) white and black balls

```

```
PE1=choose(5,4)/choose(8,4)
PE2=choose(3,1)*choose(5,3)/choose(8,4)
PE3=choose(3,2)*choose(5,2)/choose(8,4)
PE4=choose(3,3)*choose(5,1)/choose(8,4)
P.EE1=0                          #P(E|E1)
P.EE2=1/4                                #P(E|E2)
P.EE3=2/4                            #P(E|E3)
P.EE4=3/4                              #P(E|E4)

PE=PE1*P.EE1+PE2*P.EE2+PE3*P.EE3+PE4*P.EE4

#Using bayes rule
P.E4E=(PE4*P.EE4)/PE                      #P(E4|E)
sprintf("The required probability is: %f ",P.E4E)
```

R code Exa 4.10 Probability That Answer Is Correct

```
#Page number--4.11
#Example number--4.10

#E---------->They get same answer
#E1--------->Both A and B solve correctly
#E2--------->Exactly one of them sovles correctly
#E3--------->No one sovles correctly


PE1=1/6*1/8
PE2=1/6*7/8+5/6*1/8
PE3=5/6*7/8

P.EE1=1                          #P(E|E1)
P.EE2=0                              #P(E|E2)
P.EE3=1/525                          #P(E|E3)

PE=PE1*P.EE1+PE2*P.EE2+PE3*P.EE3
```

```
#Using bayes rule
P.E1E=(PE1*P.EE1)/PE                    #P(E1|E)
sprintf("The required probability is: %f ",P.E1E)
```

R code Exa 4.16 Probability That A Wrote Plus

```
#Page number--4.15
#Example number--4.16

#E--------------->The referee observes plus sign
#E1,E2------------>Wrote plus or minus sign
#E3,E4------------>Plus signed not changed, Plus sign was changed exactly twice

PE1=1/3
PE2=1-PE1

#A1,A2,A3----->B,C,D change sign on slip
PA1=2/3;PA2=2/3;PA3=2/3
PA1b=1/3;PA2b=1/3;PA3b=1/3       #P(Ai) bar

PE3=(1/3)^3
PE4=PA1*PA2*PA3b+PA1*PA2b*PA3+PA1b*PA2*PA3

P.EE1=PE3+PE4                #P(E|E1)
sprintf("The required probability is: %f ",P.EE1)

#E5,E6------------>Minus sign change once, Minus sign change thrice
PE5=PA1*PA2b*PA3b+PA1b*PA2*PA3b+PA1b*PA2b*PA3
PE6=PA1*PA2*PA3
P.EE2=PE5+PE6                #P(E|E2)
sprintf("The required probability is: %f ",P.EE2)

```

```
P.E1E=(PE1*P.EE1)/(PE1*P.EE1+PE2*P.EE2)    #P(E1|E)
sprintf("The FINAL probability is: %f ",P.E1E)
```

R code Exa 4.18 Probability Of Drawing White Ball

```
#Page number--4.17
#Example number--4.18

#E---------------->Event of drawing a white ball from the second urn in the fiest draw
#E0,E1,E2,E3,E4-------->Drawing of (0,4),(1,3),(2,2),(3,1),(4,0) white and black balls

PE0=choose(5,4)/choose(10,4)
PE1=choose(5,1)*choose(5,3)/choose(10,4)
PE2=choose(5,2)*choose(5,2)/choose(10,4)
PE3=choose(5,3)*choose(5,1)/choose(10,4)
PE4=choose(5,4)/choose(10,4)
P.EE0=0                          #P(E|E0)
P.EE1=1/4                                #P(E|E1)
P.EE2=2/4                            #P(E|E2)
P.EE3=3/4                              #P(E|E3)
P.EE4=4/4                              #P(E|E4)

#C---------->Future event

P.CE0E=0                               #P(C|intersection(E0,E))
P.CE1E=0                               #P(C|intersection(E1,E))
P.CE2E=1/3                             #P(C|intersection(E2,E))
P.CE3E=2/3                             #P(C|intersection(E3,E))
```

```
P.CE4E=3/3                            #P(C|intersection(E4,E))

P.CE=(PE0*P.EE0*P.CE0E+PE1*P.EE1*P.CE1E+PE2*P.EE2*P.CE2E+PE3*P.EE3*P.CE3E+PE4*P.EE4*P.CE4E)/(PE0*P.EE0+PE1*P.EE1+PE2*P.EE2+PE3*P.EE3+PE4*P.EE4)
sprintf("The required probability is: %f ",P.CE)
```

R code Exa 4.20 Die A And B

```
#Page number--4.19
#Example number--4.20

#A-------------->Getting a red face in each of 1st n throws
#E1,E2,E3------->Event that Die A is used, Die B is used, Getting a red face

#Part (i)
P.E3E1=4/6              #P(E3|E1)
P.E3E2=2/6              #P(E3|E2)

PE1=1/2;PE2=1/2

PE3=PE1*P.E3E1+PE2*P.E3E2
sprintf("The probability of getting a red face in any throw: %f ",PE3)

#Part (ii)
#Using the Law Of Succession
sprintf("The probability of getting a red face at the 3rd throw when 1st two gave red faces: %f ",(1/2+1)/(1/2+2))
```

Chapter 5

Random Variables And Distribution Functions

R code Exa 5.1 Random Variable X

```
#Page number--5.6
#Example number--5.1

# Constructing Quadratic Formula
result <- function(a,b,c){
  if(delta(a,b,c) > 0){ # first case D>0
        x_1 = (-b+sqrt(delta(a,b,c)))/(2*a)
        x_2 = (-b-sqrt(delta(a,b,c)))/(2*a)
        result = c(x_1,x_2)
  }
  else if(delta(a,b,c) == 0){ # second case D=0
        x = -b/(2*a)
  }
  else {"There are no real roots."} # third case D<0
}

# Constructing delta
delta<-function(a,b,c){
      b^2-4*a*c
```

```
}

#Values of X
x=c(0,1,2,3,4,5,6,7)
#Respective probabilities
px=c("0","k","2k","2k","3k","k^2","2k^2","7k^2+k")

data.frame(x,px)

#Part(i)
#We know that total probability =1
#k+2k+2k+3k+k^2+2k^2+7k^2+k=1---------------->We get
   10*k^2+9*k-1=0
a=result(10,9,-1)
a
#Since, k cannot be negative
k=a[1]
k
#Substituting values of k in p(x), we get
px=c(0,k,2*k,2*k,3*k,k^2,2*k^2,7*k^2+k)

b=data.frame(x,px)
b

#Part (ii)
#Evaluate P(X<6)
PX6=sum(b[1:6,2])
sprintf("The probability X<6 is: %f",PX6)
sprintf("The probability X>=6 is: %f",1-PX6)
P0X5=sum(b[2:5,2])
sprintf("The probability 0<X<5 is: %f",P0X5)

#Part(iii)
#BY trail we get a=4

#Part (iv)
#Cummulative probability function
FX=c(sum(b[1,2]),sum(b[1:2,2]),sum(b[1:3,2]),sum(b
```

```
    [1:4,2]),sum(b[1:5,2]),sum(b[1:6,2]),sum(b
    [1:7,2]),sum(b[1:8,2]))
data.frame(x,FX)
```

R code Exa 5.2 Probability

```
#Page number--5.7
#Example number--5.2

x=c(1,2,3,4,5)
px=c()
i=1
while(i<=5){
    px[i]=i/15
    i=i+1
}
a=data.frame(x,px)
a

#Part (i)
PX12=sum(a[1:2,2])
sprintf("The probability X=1 or X=2 is: %f",PX12)

#Part (ii)
P=a[2,2]/(1-a[1,2])
sprintf("The required probability is: %f",P)
```

R code Exa 5.3 Distribution Function Of X

```
#Page number--5.7
#Example number--5.3
#LOAD PACKAGE------->prob

```

```
s=rolldie(2)
s
X=c(1,2,3,4,5,6,7,8,9,10,11,12)
a=0
for(i in 1:12){
    a[i]=nrow(subset(s,X1+X2==i))/nrow(s)
}
#Probability chart
plot(X,a,type="h",xlim=c(0,12),ylim=c(0,0.17),ylab="
   Prob.",xlab="Sum of two faces")

#Cummulative probability distribution
FX=c(sum(a[1]),sum(a[1:2]),sum(a[1:3]),sum(a[1:4]),
   sum(a[1:5]),sum(a[1:6]),sum(a[1:7]),sum(a[1:8]),
   sum(a[1:9]),sum(a[1:10]),sum(a[1:11]),sum(a
   [1:12]))
data.frame(X,FX)
```

R code Exa 5.4 Probability Function

```
#Page number--5.8
#Example number--5.4
#LOAD PACKAGE------->prob

s=tosscoin(3)
s
#For number of heads
X=c(3,2,2,1,2,1,1,0)
#For number of head runs
Y=c(1,1,0,0,1,0,0,0)
#For length of head runs
Z=c(3,2,0,0,2,0,0,0)
U=X+Y
V=X*Y
data.frame(X,Y,Z,U,V)
```

```
#Part (i)
#Probability distribution of X
P3=1/8;P2=3/8;P1=3/8;P0=1/8
x=seq(0,3,1)
px=c(P3,P2,P1,P0)
plot(x,px,type="h",xlim=c(0,3),ylim=c(0,0.4),ylab="
    Prob.",xlab="Number of heads")
points(0:3,px,pch=16,cex=2)

#Part (ii)
#Probability distribution of Y
P1=3/8;P0=5/8
y=seq(0,1,1)
py=c(P1,P0)
plot(y,py,type="h",xlim=c(0,1),ylim=c(0,0.7),ylab="
    Prob.",xlab="Number of heads runs")
points(0:1,py,pch=16,cex=2)

#Part (iii)
#Probability distribution of Z
P3=1/8;P2=2/8;P1=0;P0=5/8
z=seq(0,3,1)
pz=c(P0,P1,P2,P3)
plot(z,pz,type="h",xlim=c(0,3),ylim=c(0,0.7),ylab="
    Prob.")
points(0:3,pz,pch=16,cex=2)

#Part (iv)
#Probability distribution of U
P4=1/8;P3=2/8;P2=1/8;P1=3/8;P0=1/8
u=seq(0,4,1)
pu=c(P2,P1,P0,P3,P4)
plot(u,pu,type="h",xlim=c(0,4),ylim=c(0,0.4),ylab="
    Prob.")
points(0:4,pu,pch=16,cex=2)

#Part (v)
```

```
#Probability distribution of V
P3=1/8;P2=2/8;P1=0;P0=5/8
v=seq(0,3,1)
pv=c(P0,P1,P2,P3)
plot(v,pv,type="h",xlim=c(0,3),ylim=c(0,0.7),ylab="
   Prob.")
points(0:3,pv,pch=16,cex=2)
```

R code Exa 5.5 Probability Density Function

```
#Page number--5.13
#Example number--5.5

# Constructing Quadratic Formula
result <- function(a,b,c){
  if(delta(a,b,c) > 0){ # first case D>0
        x_1 = (-b+sqrt(delta(a,b,c)))/(2*a)
        x_2 = (-b-sqrt(delta(a,b,c)))/(2*a)
        result = c(x_1,x_2)
  }
  else if(delta(a,b,c) == 0){ # second case D=0
        x = -b/(2*a)
  }
  else {"There are no real roots."} # third case D<0
}

# Constructing delta
delta<-function(a,b,c){
      b^2-4*a*c
}

#Part (i)
#Checking f(x) is p.d.f or not
integrand=function(x) {6*x*(1-x)}
a=integrate(integrand,lower=0,upper=1)
```

```
a
sprintf("f(x) is p.d.f")

#Part (ii)
#Determining b
#integrand=function(x) {6*x*(1-x)}
#integrate(integrand,lower=0,upper=b) = integrate(integrand,lower=b,upper=1)
#Solving above integral we get quadratic equation ------>(2*b-1)(2*b^2-2*b-1)=0
b=result(2,-2,-1)
b
#Other solution of b
b=1/2
#Since, probability cannot be negative or greater than 1
sprintf("The onle real value of b: %f", b)
```

R code Exa 5.12 Relative Frequency Density

```
#Page number--5.17
#Example number--5.12
#LOADED PACKAGE----->cubature
# Constructing Quadratic Formula
result <- function(a,b,c){
  if(delta(a,b,c) > 0){ # first case D>0
        x_1 = (-b+sqrt(delta(a,b,c)))/(2*a)
        x_2 = (-b-sqrt(delta(a,b,c)))/(2*a)
        result = c(x_1,x_2)
  }
  else if(delta(a,b,c) == 0){ # second case D=0
        x = -b/(2*a)
  }
  else {"There are no real roots."} # third case D<0
}
```

```
# Constructing delta
delta<-function(a,b,c){
      b^2-4*a*c
}


#Total probability = 1
integrand=function(x){x*(2-x)}
a=integrate(integrand,lower=0,upper=2)
a
y0=1/1.333

u1d=(3*2^2)/(3*4)                 #Mean
u2d=(3*2^3)/(4*5)
u3d=(3*2^4)/(5*6)
u4d=(3*2^5)/(6*7)
#Variance
#u2=u2d-u1d^2
u2=6/5-1
#u3=u3d-3*u2d*u1d+2*u1d^3
u3=8/5-3*6/5*1+2
#u4=u4d-4*u3d*u1d+6*u2d*u1d^2-3*u1d^4
u4=16/7-4*8/5*1+6*6/5*1-3*1
beta1=u3^2/u2^3
beta1
beta2=u4/u2^2
beta2
#Since beta1 =0, symmetrical distribution
#Mean deviation about mean
integrand=function(x){3/4*(1-x)*x*(2-x)}
f1=integrate(integrand,lower=0,upper=1)
f1
integrand=function(x){3/4*(x-1)*x*(2-x)}
f2=integrate(integrand,lower=1,upper=2)
f2
#Mean deviation abt mean=f1+f2
M=0.1875+0.1875
```

```
#Harmonic Mean
integrand=function(x){3/4*(2-x)}
a=integrate(integrand,lower=0,upper=2)
a
H.M=3/2

#Median
#integrand=function(x){3/4*x*(2-x)}
#integrate(integrand,lower=0,upper=M)=1/2
#Solving above integral we get quadratic equation ----->(M-1)*(M^2-2*M-2)=0
b=result(1,-2,-2)
b
#Other solution of b
b=1
#Since, M lying in [0,2]
sprintf("The median is: %f", b)
```

R code Exa 5.13 Standard Deviation And Mean Deviation

```
#Page number--5.18
#Example number--5.13

#Mean
integrand=function(x){x*(3+2*x)/18}
a1=integrate(integrand,lower=2,upper=4)
a1
u1d=83/27

integrand=function(x){x^2*(3+2*x)/18)}
a2=integrate(integrand,lower=2,upper=4)
a1
u2d=88/9

```

```
#Varience
v=u2d-u1d^2

#Standard Deviation
s.d=sqrt(v)

#Mean Deviation
integrand=function(x){(83/27-x)*(3+2*x)/18}
f1=integrate(integrand,lower=2,upper=83/27)
f1
integrand=function(x){(x-83/27)*(3+2*x)/18}
f2=integrate(integrand,lower=83/27,upper=4)
f2
#Mean deviation=f1+f2
M.D=0.247264+0.247264
```

R code Exa 5.19 Probability Density Function

```
#Page number--5.21
#Example number--5.19

#Part (i)
integrand=function(x){100/x^2}
a=integrate(integrand,lower=100,upper=150)
a
#Probability that tubes be replaced in first 150 hrs.
p=(1/3)^3

#Part (ii)
#Probability that none of tubes be replaced in first 150 hrs.
p=(1-1/3)^3

#Part (iii)
```

```
#Probability that tube last more than 150 but less
   than 200 hrs.
integrand=function(x){100/x^2}
a1=integrate(integrand,lower=150,upper=200)
a1
integrand=function(x){100/x^2}
a2=integrate(integrand,lower=150,upper=Inf)
a2
#a1=0.1666667  a2=0.6666667
p=0.1666667/0.6666667

#Part (iv)
#Maximum number of tubes
n=log(0.5)/log(0.6667)
n
```

R code Exa 5.22 Probability That Tyres Will Last

```
#Page number--5.24
#Example number--5.22

#Part (i)
#P(X<=10)
integrand=function(x){1/20*exp(-x/20)}
a=integrate(integrand,lower=0,upper=10)
a

#Part (ii)
#P(16<=X<=24)
integrand=function(x){1/20*exp(-x/20)}
a1=integrate(integrand,lower=16,upper=24)
a1

#Part (iii)
#P(X>=30)
```

```
integrand=function(x){1/20*exp(-x/20)}
a3=integrate(integrand,lower=30,upper=Inf)
a3
```

R code Exa 5.24 Probability Density Function

```
#Page number--5.27
#Example number--5.24
#LOAD PACKAGE----->ploynom

#Part (i)
integrand=function(x){6*x*(1-x)}
a=integrate(integrand,lower=0,upper=1)
a
sprintf("The function p.d.f")

#Part (ii)
#The expression is
#0, if x<=0
#(3*x^2-2*x^3), if 0<x<1
#1, if x>1

#Part (iii)
integrand=function(x){6*x*(1-x)}
a1=integrate(integrand,lower=1/3,upper=1/2)
a1
integrand=function(x){6*x*(1-x)}
a2=integrate(integrand,lower=1/3,upper=2/3)
a2
#a1=0.2407407    a2=0.4814815
p=0.2407407/0.4814815
p                  #Answer may vary because of
   rounding off values

#Part (iv)
```

```
#integrand=function(x){6*x*(1-x)}
#integrate(integrand,lower=0,upper=k)=integrate(
    integrand,lower=k,upper=1)
#Solving above integral we get cubic equation----->4
    k^3-6k^2+1=0
options(digits=16)
library(polynom)
p=polynomial(c(4,-6,0,1))
solve(p)
sprintf("The only admissible value of k=1/2")
```

Chapter 6

Mathematical Expectations

R code Exa 6.1 Laws of Expectation

```
#Page number--6.11
#Example number--6.1

x=c(-3,6,9)
px=c(1/6,1/2,1/3)
a=data.frame(x,px)
a
#E(X)
EX=sum(a[1:3,1]*a[1:3,2])
EX
#E(X^2)
EX2=sum((a[1:3,1])^2*a[1:3,2])
EX2
#E(2X+1)^2=4*E(X^2)+4*E(X)+1
EX3=4*EX2+4*EX+1
EX3
```

R code Exa 6.2 Expectations Results

```
#Page number--6.11
#Example number--6.2
#LOAD PACKAGE----->prob

s=rolldie(2,makespace=TRUE)
s

#Part (a)
#E(X)
EX=sum(1/6*seq(1,6,,))
EX

#Part (b)
#Probability distribution on basis on sum of two faces of die
x=c(seq(2,12,1))
px=c(1/36,2/36,3/36,4/36,5/36,6/36,5/36,4/36,3/36,2/36,1/36)
a=data.frame(x,px)
a
EX=sum(a[1:11,1]*a[1:11,2])
EX
```

R code Exa 6.3 Expected Value Of X

```
#Page number--6.12
#Example number--6.3
#LOAD PACKAGE----->prob

s=tosscoin(4)
s

n.o.h=c(4,3,3,3,3,2,2,2,2,2,2,1,1,1,1,0)
data.frame(s,n.o.h)
PX0=1/6;PX1=4/16;PX2=6/16;PX3=4/16;PX4=1/16
```

```

#Probability Distribution
x=c(0,1,2,3,4)
px=c(PX0,PX1,PX2,PX3,PX4)
data.frame(x,px)
EX=sum(x*px)
EX
```

R code Exa 6.4 Urn Example

```
#Page number--6.13
#Example number--6.4

PX0=choose(3,2)/choose(10,2)
PX1=choose(7,1)*choose(3,1)/choose(10,2)
PX2=choose(7,2)/choose(10,2)

x=c(0,1,2)
px=c(PX0,PX1,PX2)
#Probability Distribution
a=data.frame(x,px)
a
EX=sum(x*px)
EX
```

R code Exa 6.5 Expectation Of Player

```
#Page number--6.13
#Example number--6.5

Event=c("Lucky number","Special lucky no.","Other
    numbers")
```

```
Favourable=c("5,10,15","0","
  1,2,3,4,6,7,8,9,11,12,13,14,16,17,18,19")
px=c(3/20,1/20,16/20)
Player_Gain=c((20-10)*px[1],(50-10)*px[2],-10*px[3])
a=data.frame(Event,Favourable,px,Player_Gain)
a
EX=sum(a[1:3,4])
EX
if(EX!=0){print("Game is not fair")}
```

R code Exa 6.29 Joint Distribution Of Y And X1

```
#Page number--6.36
#Example number--6.29
#LOAD PACKAGE----->prob

s=rolldie(2)
s

x=c(1,2,3,4,5,6)
y1=c(1/36,0,0,0,0,0)
y2=c(1/36,2/36,0,0,0,0)
y3=c(1/36,1/36,3/36,0,0,0)
y4=c(1/36,1/36,1/36,4/36,0,0)
y5=c(1/36,1/36,1/36,1/36,5/36,0)
y6=c(1/36,1/36,1/36,1/36,1/36,6/36)
Marginal_Totals_y=c(1/36,3/36,5/36,7/36,9/36,11/36)
Marginal_Totals_x=c(6/36,6/36,6/36,6/36,6/36,6/36)
a=data.frame(y1,y2,y3,y4,y5,y6,Marginal_Totals_x,
  Marginal_Totals_y)
a

EY=1*1/36+2*3/36+3*5/36+4*7/36+5*9/36+6*11/36
EY
EY2=1^2*1/36+2^2*3/36+3^2*5/36+4^2*7/36+5^2*9/36+6^2
```

```
*11/36
EY2
VY=EY2-EY^2
VY
EX1=6/36*(1+2+3+4+5+6)
EX1
EX1Y=(1*1/36+2*1/36+3*1/36+4*1/36+5*1/36+6*1/36)+(4*
    2/36+6*1/36+8*1/36+10*1/36+12*1/36)+(9*3/36+12*1/
    36+15*1/36+18*1/36)+(16*4/36+20*1/36+24*1/36)+(25
    *5/36+30*1/36)+36*6/36
EX1Y
COV=EX1Y-EX1*EY
COV
```

R code Exa 6.30 Joint Probability Distribution

```
#Page number--6.37
#Example number--6.30

#Part (i)
EY=-1*2+0*6+1*2
EY
EX=-1*2+0*4+1*4
EX

#Part (ii)
EXY=-1*-1*0+0*-1*1+1*-1*1+0*-1*2+0*0*2+0*1*2+1*-1*
    0+1*0*1+1*1*1
EXY
COV=EXY-EX*EY
COV

#Part (iii)
EY2=-1^2*0.2+0*0.6+1^2*0.2
EY2
```

```
VY=EY2-EY^2
VY
EX2=-1^2*0.2+0*0.4+1^2*0.4
EX2
VX=EX2-EX^2
VX

#Part (iv)
PXY=0.2/0.6                    #P(X=-1|Y=0)
PXY=0.2/0.6                    #P(X=0|Y=0)
PXY=0.2/0.6                    #P(X=1|Y=0)

#Part (v)
EYX=-1*0+0*2+1*0
EYX2=1*0+0*2+0
VYX=EYX2-EYX^2
VYX
```

Chapter 7

Generating Functions And Law Of Large Numbers

R code Exa 7.12 Probability Of Getting 80 to 120 Sixes

```
#Page number--7.31
#Example number--7.12

#S be total number of successes
n=600         #Number of times die thrown
p=1/6;q=5/6
ES=n*p
VS=n*p*q

#Using Chebychev's inequality
#P{|S-ES|<k*s.d}>=1-1/k^2         #s.d--->Standard
    deviation
#P{100-k*sqrt(500/6)<S<100+k*sqrt(500/6)}>=1-1/k^2
#comparing lower limit with 80
k=solve(sqrt(500/6),20)
k
#P{80<=S<=120}
P=1-1/k^2
sprintf("Probabilities of getting 80 to 120 sixes: %
```

```
f",P)
```

R code Exa 7.13 Use Chebychev Inequality

```
#Page number--7.32
#Example number--7.13

#By proof of Bernoulli's law of large numbers
#P{|X/n-p|<e}<=1-1/(4*n*e^2)
p=0.5
#X/n lie between 0.4 and 0.6
e=0.1
#We want the probability to be atleast 0.9
n=solve(0.1,1/0.04)
sprintf("Required number of tosses: %f",n)
```

R code Exa 7.14 How Large Is Sample

```
#Page number--7.32
#Example number--7.14

#Part (i)
n=solve(0.05,1/(4*0.02**2))
sprintf("The true proportions: %f",n)

#Part (ii)
n=solve(0.05,0.16/0.02^2)
n
```

R code Exa 7.17 Discrete Variate With Density

```
#Page number--7.17
#Example number--7.33

x=c(-1,0,1)
px=c(1/8,6/8,1/8)
data.frame(x,px)
EX=sum(x*px)
EX                      #Mean
EX2=sum(abs(x*px))
EX2
VarX=EX2-(EX)^2
VarX                          #Variance
s.d=sqrt(VarX)                  #Standard Deviation
s.d
P=1-px[2]
P
px[2]
```

R code Exa 7.18 Two Unbiased Dice

```
#Page number--7.34
#Example number--7.18
#Load Package----->prob

s=rolldie(2)
s

#From above table we find that
X=c(seq(2,12,1))
cases=c("(1,1)","(1,2),(2,1)","(1,3),(3,1),(2,2)","
    (1,4),(4,1),(2,3),(3,2)","(1,5),(5,1),(2,4),(4,2)
    ,(3,3)","(1,6),(6,1),(2,5),(5,2),(3,4),(4,3)","
    (2,6),(6,2),(3,5),(5,3),(4,4)","(3,6),(6,3),(4,5)
    ,(5,4)","(4,6),(6,4),(5,5)","(5,6),(6,5)","(6,6)"
    )
```

```
prob=c(1/36,2/36,3/36,4/36,5/36,6/36,5/36,4/36,3/
   36,2/36,1/36)
a=data.frame(X,cases,prob)
a
EX=sum(X*prob)
EX
EX2=sum(X^2*prob)
EX2
VarX=EX2-EX^2
VarX
#By Chebychev's inequality
P=(35/6)/9
P
#Actual Probability
P1=1-(4+5+6+5+4)/36
P1
```

R code Exa 7.19 Chebychev Inequality

```
#Page number--7.34
#Example number--7.19

EX=(1+2+3+4+5+6)/6
EX
EX2=(1^2+2^2+3^2+4^2+5^2+6^2)/6
EX2
VarX=EX2-EX^2
VarX
#By Chebychev's inequality
k=2.5
#P{|X<u|>2.5}<T
T=VarX/k^2
T
#But since the number lies outside the limits
#It cannot lie outside the limits of 1 and 6
```

```
#Actual probability = 0
```

Chapter 8

Special Discrete Probability Distributions

R code Exa 8.1 Probability Of Getting At Least 7 Heads

```
#Page number--8.5
#Example number--8.1

#Probability of getting head
p=1/2
#Probability of not getting head
q=1/2
#Probability of getting x heads
#P=choose(10,x)*(1/2)^10
#Probability of getting atleast 7 heads
P=(choose(10,7)+choose(10,8)+choose(10,9)+choose
    (10,10))*(1/2)^10
P
```

R code Exa 8.2 A And B Play A Game

```
#Page number--8.5
#Example number--8.2
n=5
#Probability A wins the game
p=3/5
q=1-p
#Probability of getting A wins
#P=choose(5,x)*(3/5)^x*(2/5)^(5-x)
#Probability of getting 3 wins
P=(choose(5,3)*2**2+choose(5,4)*3*2+1*3^2*1)*3^3/5^5
P
```

R code Exa 8.3 Chances Of Having The Claim Accepted Or Rejected

```
#Page number--8.6
#Example number--8.3
n=6
#Probability of correct distinction between coffee
p=3/4
q=1-p
#Probability of getting x correct distinction
   between coffee
#P=choose(6,x)*(3/4)^x*(1/4)^(6-x)
#Probability of getting atleast 5 correct
   distinction between coffee
P=choose(6,5)*(3/4)**5*(1/4)+choose(6,6)*(3/4)^6
P
#Probability that the claim is rejected
Q=1-P
Q
```

R code Exa 8.4 Probability That Student Secures Distinction

```
#Page number−−8.6
#Example number−−8.4
n=8
#Probability of getting answer correct
p=1/3
q=1-p
#Probability of getting x answer correct
#P=choose(8,x)∗(1/3)^x∗(2/3)^(8−x)
#Probability of getting 6 answer correct
P=choose(8,6)*(1/3)^6*(2/3)^2+choose(8,7)*(1/3)^7*(2
    /3)+choose(8,8)*(1/3)^8
P
```

R code Exa 8.6 Probability

```
#Page number−−8.7
#Example number−−8.6
n=10
#Probability that old machine need adjustment
p1=1/11
q1=1-p
#Probability that new machine need adjustment
p2=1/21
q2=1-p
#Probability that x old machine need adjustment
#P=choose(3,x)∗(1/11)^x∗(10/11)^(3−x)
#Probability that x new machine need adjustment
#P=choose(7,x)∗(1/21)^x∗(20/21)^(7−x)

#Part (i)
#Probability that 2 old machine and no new machine
    need adjustment
P=choose(3,2)*(1/11)^2*(10/11)*(20/21)^7
P

```

```
#Part (ii)
#Probability that no old machine and 2 new machine
    need adjustment
Q=(10/11)^3*choose(7,2)*(1/21)^2*(20/21)^5
Q
```

R code Exa 8.7 Probability Man Hitting A Target

```
#Page number--8.8
#Example number--8.7

#Probability of hitting target
p=1/4
q=1-p
#Probability that x hits in 7 shots
#P=choose(7,x)*(1/4)^x*(3/4)^7-x

#Part (i)
#Probability of hitting atleast 2 hits
P=1-(choose(7,0)*(1/4)^0*(3/4)^7-0+choose(7,1)*(1/4)
    ^1*(3/4)^(7-1))
P

#Part (ii)
#Probability of atleast 1 hit in n shots
p=solve(log(3/4),log(1/3))
p
round(p)
sprintf("The required number of shots: %d",round(p))
```

R code Exa 8.9 Find Parameter P

```
#Page number--8.9
```

```
#Example number--8.9

n=5
p1=0.4096
p2=0.2048
#Probability distribution
#P=choose(5,x)*(p)^x*(1-p)^(5-x)
#p1=choose(5,1)*(p)^1*(1-p)^(5-1)
#p2=choose(5,2)*(p)^x*(1-p)^(5-2)
#The ratio of p1 and p2
sprintf("The parameter p is: %f",solve(5,1))
```

R code Exa 8.10 P For Binomial Variate X

```
#Page number--8.9
#Example number--8.10

# Constructing Quadratic Formula
result <- function(a,b,c){
  if(delta(a,b,c) > 0){ # first case D>0
        x_1 = (-b+sqrt(delta(a,b,c)))/(2*a)
        x_2 = (-b-sqrt(delta(a,b,c)))/(2*a)
        result = c(x_1,x_2)
  }
  else if(delta(a,b,c) == 0){ # second case D=0
        x = -b/(2*a)
  }
  else {"There are no real roots."} # third case D<0
}

# Constructing delta
delta<-function(a,b,c){
      b^2-4*a*c
}

```

```
#Probability Distribution
#P=choose(6,x)*(p)^x*(1-p)^6-x
#9*P(X=4)=P(X=2)
#Solving above equation
#We get quadratic equation---->8*p^2+2*p-1=0
a=result(8,2,-1)
a
#Probability cannot be negative
sprintf("p : %f",a[1])
```

R code Exa 8.12 Probability

```
#Page number--8.11
#Example number--8.12

# Mean
M=4

#Variance
Var=4/3

q=Var/M
p=1-q
n=M/p

# P(X>=1) = 1 - P(X=0)
P=1-q^6
P
```

R code Exa 8.21 Fit Binomial Distribution

```
#Page number--8.19
#Example number--8.21
```

```
n=5
N=4096
#Probability of success throw 4,5,6
p=1/2
q=1-p
#Probability distribution
#P=choose(12,x)*(1/2)^x*(1/2)^(12-x)
#f(x)=choose(12,x)
success=c(0,1,2,3,4,5,6,7,8,9,10,11,12)
Expected_Frequency=c()
for(i in success){
    Expected_Frequency[i+1]=choose(12,i)
}
data.frame(success,Expected_Frequency)
Total=sum(Expected_Frequency)
Total
```

R code Exa 8.22 Fit A Binomial Distribution

```
#Page number--8.20
#Example number--8.22

n=7
N=128
#CASE 1: When the coin is unbaised
p=1/2
q=p
x=c(seq(0,7,1))
f=c(7,6,19,35,30,23,7,1)
fx=f*x
#a=(n-x)/(x+1)
a=c()
for(i in x){
    a[i+1]=(n-i)/(i+1)
```

```
}
#b=(n-x)/(x+1)*p/q
b=c()
for(i in x){
    b[i+1]=(n-i)/(i+1)*p/q
}
Expected_Frequency=c(1,1*7,7*3,21*5/3,35*1,35*3/5,21*1/3,7*1/7)
data.frame(x,f,fx,a,b,Expected_Frequency)

#CASE 2: When nature of coin is not known
mean=433/128
p=mean/n
q=1-p
p/q
x=c(seq(0,7,1))
#a=(n-x)/(x+1)
a=c()
for(i in x){
    a[i+1]=(n-i)/(i+1)
}
#b=(n-x)/(x+1)*p/q
b=c()
for(i in x){
    b[i+1]=(n-i)/(i+1)*p/q
}
Expected_Frequency=c(1.2593,1.259*6.546,2.805*8.243,1.558*23.129,0.935*36.05,.5611*33.715,.3117*18.918,.1336*5.897)
data.frame(x,f,fx,a,b,Expected_Frequency,round(Expected_Frequency))

#Part (iii)
f=c(128*.0625*.1663,8.591,128*.283,128*.184,128*.260,128*.146,128*.043,128*.0056)
data.frame(x,f,round(f))
Total=sum(round(f))
Total                                  #Note that total is
```

```
wrong in the book
```

R code Exa 8.33 Proportion Of Days

```
#Page number--8.35
#Example number--8.33

#For poisson distribution
#Part (i)
a=dpois(0,1.5)
sprintf("Proportion of days on which neither car is
   used: %f",a)

#Part (ii)
b=ppois(2,1.5,lower=FALSE)
sprintf("Proportion on which some demand is refused:
    %f",b)
```

R code Exa 8.34 Probability That More Than 3 Collect Policy In A Year

```
#Page number--8.35
#Example number--8.34

n=4000
#Probability of loss of both eyes
p=10/100000
#For poisson distribution
lambda=n*p
a=ppois(3,lambda,lower=FALSE)
sprintf("Probability that more than 3 will collect
   the policy: %f",a)
```

R code Exa 8.37 Random Sample Of 5 Page With No Error

```
#Page number--8.37
#Example number--8.37

lambda=390/520
lambda
#For poisson distribution
a=dpois(0,lambda)
sprintf("Sample of 5 pages with no error: %f",a^5)
```

R code Exa 8.41 Probability That X Have More Than On Value

```
#Page number--8.38
#Example number--8.41

lambda=2
#For poisson distribution
a=dpois(1,lambda)
b=dpois(2,lambda)
sprintf("Required probability: %f",a+b)
```

R code Exa 8.55 Fit A Poisson Distribution

```
#Page number--8.46
#Example number--8.55

n_m_p=c(0,1,2,3,4)              #Number of mistakes per
    page
```

```
n_o_p=c(109,65,22,3,1)        #Number of pages
data.frame(n_m_p,n_o_p)

#Poission distribution parameter
lambda=sum(n_m_p*n_o_p)/200
lambda
Expected_Frequency=c()
a=c()
for(i in n_m_p){
    a[i+1]=dpois(i,lambda)
}
for(i in n_m_p){
    Expected_Frequency[i+1]=200*a[i+1]
}
data.frame(n_m_p,Expected_Frequency,round(Expected_
    Frequency))
```

R code Exa 8.56 Errors In 1000 Pages

```
#Page number--8.46
#Example number--8.56

lambda=2/5
n_o_e=c(0,1,2,3,4)            #Number of errors
prob=c()
for(i in n_o_e){
    prob[i+1]=dpois(i,lambda)
}
Expected_Frequency=c()
for(i in n_o_e){
    Expected_Frequency[i+1]=1000*prob[i+1]
}
data.frame(n_o_e,prob,Expected_Frequency,round(
    Expected_Frequency))
```

R code Exa 8.57 Fit A Poisson Distribution

```
#Page number--8.47
#Example number--8.57

n_o_d=c(0,1,2,3,4,5,6,7,8)                #Number of
    doddens
o_f=c(56,156,132,92,37,22,4,0,1)          #Observed
    frequency
data.frame(n_o_d,o_f)
Mean=sum(n_o_d*o_f)/500
lambda=Mean
a=c()
for(i in n_o_d){
    a[i+1]=lambda/(i+1)
}
prob=c()
for(i in n_o_d){
    prob[i+1]=dpois(i,lambda)
}
Expected_Frequency=c()
for(i in n_o_d){
    Expected_Frequency[i+1]=500*prob[i+1]
}
data.frame(n_o_d,a,prob,Expected_Frequency,round(
    Expected_Frequency))
```

R code Exa 8.63 Fit A Negative Binomial Distribution

```
#Page number--8.54
#Example number--8.63

```

```
n_o_c=c(0,1,2,3,4,5)                    #Number of cells
f=c(213,128,37,18,3,1)                  #frequency
Mean=sum(n_o_c*f)/400
u2=sum(f*n_o_c^2)/400
u2
Var=u2-Mean^2
p=0.6825/0.8117
q=1-p
r=round(p*0.6825/q)
a=c(p^4,0.5738*0.5,2.5*0.1592*0.2869,2*0.1592*
   0.1142,7/4*0.1592*0.0364,8/5*0.1592*0.0101)
Expected_Frequency=c()
for(i in n_o_c){
    Expected_Frequency[i+1]=400*a[i+1]
}
round(Expected_Frequency)
```

Chapter 9

Special Continuous Probability Distributions

R code Exa 9.1 Equation Of Normal Curve

```
#Page number--9.14
#Example number--9.1
#Load Package--->cubature

library(cubature)
N=1000
u=79.945
s.d=5.545
class=c("Below 60","60-65","65-70","70-75","75-80","
   80-85","85-90","90-95","95-100","100 and over")
l_c_b=c(-Inf,60,65,70,75,80,85,90,95,100)
z=c()
for(i in c(seq(1,10,1))){
    z[i]=(l_c_b[i]-u)/s.d
}
z
#Equation of normal curve
#f(x)=1000/sqrt(2*pi)*exp(-1/2*((x-u)/s.d)^2)
oZ=c()
```

```
for(i in c(seq(1,10,1))){
    # define the integrated function
    f <- function(x){exp(-x^2/2)}
    a=adaptIntegrate(f, lowerLimit =-Inf, upperLimit
        =z[i])
    oZ[i]=1/sqrt(2*pi)*a$integral
}
oZ
deltaZ=c
   (0.000112,0.002914,0.031044,0.147870,0.322050,0.319300,0.144072,0
   NA)
Expected_Frequency=c()
for(i in c(seq(1,10,1))){
    Expected_Frequency[i]=N*deltaZ[i]
}

data.frame(class,l_c_b,z,oZ,deltaZ,Expected_
   Frequency,round(Expected_Frequency))
Total=sum(round(Expected_Frequency[1:9]))
Total
```

R code Exa 9.3 Probability

```
#Page number--9.15
#Example number--9.3

Mean=12
s.d=4              #Standard Deviation

#Part (i)
pnorm(Inf,12,4)-pnorm(20,12,4)
x=seq(0,30,length=200)
y=dnorm(x,12,4)
plot(x,y,type="l")
x=seq(20,25,length=100)
```

```
y=dnorm(x,12,4)
polygon(c(20,x,25),c(0,y,0),col="red")

#Part (ii)
p=1-(pnorm(Inf,12,4)-pnorm(20,12,4))
p

#Part (iii)
pnorm(12,12,4)-pnorm(0,12,4)
x=seq(0,30,length=200)
y=dnorm(x,12,4)
plot(x,y,type="l")
x=seq(0,12,length=100)
y=dnorm(x,12,4)
polygon(c(0,x,12),c(0,y,0),col="red")

#Part (a)
#Taking value of z1 from Normal Tables
z1=0.71
a=12+4*z1
a
#Part (b)
#Taking value of z1 from Normal Tables
z1=0.67
x1=12+4*z1
x1
x0=12-4*z1
x0
```

R code Exa 9.4 X Is A Normal Variate

```
#Page number--9.16
#Example number--9.4

Mean=30
```

```
s.d=5                #Standard Deviation

#Part (i)
pnorm(40,30,5)-pnorm(26,30,5)
x=seq(0,60,length=200)
y=dnorm(x,30,5)
plot(x,y,type="l")
x=seq(26,40,length=100)
y=dnorm(x,30,5)
polygon(c(26,x,40),c(0,y,0),col="red")

#Part (ii)
pnorm(Inf,30,5)-pnorm(45,30,5)
x=seq(0,50,length=200)
y=dnorm(x,30,5)
plot(x,y,type="l")
x=seq(45,50,length=100)
y=dnorm(x,30,5)
polygon(c(45,x,50),c(0,y,0),col="red")

#Part (iii)
#P(|X-30|>5)=1-P(|X-30|<=5)
P=1-2*0.3413
P
```

R code Exa 9.5 Batch Of 1000 Plots

```
#Page number--9.17
#Example number--9.5

Mean=662
s.d=32               #Standard Deviation

#Part (i)
P1=pnorm(Inf,662,4)-pnorm(700,662,32)
```

```
sprintf("Probability that plots has a yield over 700
    kilos : %f",P1)
#Batch off 1000 plots
sprintf("Expected number of plots with yield over
   700 kilos: %f",as.integer(1000*P1))

#Part (ii)
P2=pnorm(650,662,32)
sprintf("Probability that plots has a yield less
   than 650 kilos : %f",P2)
#Batch off 1000 plots
sprintf("Expected number of plots with yield less
   than 650 kilos: %f",as.integer(1000*P2))
#Answer vary due to rounding of values

#Part (iii)
#P(X>x1)=100/1000
p=100/1000
z1=1.28                  #From Normal Table
x1=662+32*z1
sprintf("Best 100 plots have yield: %f kilos",x1)
```

R code Exa 9.7 Number Of Lamps

```
#Page number--9.18
#Example number--9.7

Mean=1000
s.d=200              #Standard Deviation

#Part (i)
P1=pnorm(800,1000,200)
sprintf("Probability that bulb fail in less than 800
    hrs.: %f",P1)
#Total number of bulbs=10000
```

```
sprintf("Expected number of bulb fail in less than 800 hrs.: %f",round(10000*P1))

#Part(ii)
P2=pnorm(1200,1000,200)-pnorm(800,1000,200)
sprintf("Expected number of bulb fail in 800-1200hrs.: %f",as.integer(10000*P2))
x=seq(0,2000,length=200)
y=dnorm(x,1000,200)
plot(x,y,type="l")
x=seq(800,1200,length=100)
y=dnorm(x,1000,200)
polygon(c(800,x,1200),c(0,y,0),col="red")
#Part (a)
#Taking value of z1 from Normal Tables
z1=1.28
x1=1000-200*z1
x1
#Part (b)
#Taking value of z1 from Normal Tables
z2=1.28
x2=1000+200*z1
x2
```

R code Exa 9.8 Probability Of Marks

```
#Page number--9.20
#Example number--9.8

Mean=65
s.d=5              #Standard Deviation

P1=pnorm(Inf,65,5)-pnorm(70,65,5)
sprintf("Probability that marks are over 70: %f",P1)
#3 students selected at random, exactly 2 will get
```

```
   more than 70
choose(3,2)*P1^2*(1-P1)
```

R code Exa 9.9 Probability

```
#Page number--9.20
#Example number--9.9

#Part (a)
Y1=log(1.202)
Y2=log(7.92)
#For Y1=0.08
z1=(0.08-4)/2
#For Y2=7.92
z2=(7.92-4)/2
#P(0.08<Y<7.92)
p=2*0.4750
sprintf("Required Probability: %f",p)

#Part (b)
y1=log(1.202)
y2=log(83180000)
#U=log(X)-log(Y)
#P(0.08<U<7.92)
p=2*0.4750
sprintf("Required Probability: %f",p)
```

R code Exa 9.12 Mean And Standard Deviation Of The Distribution

```
#Page number--9.22
#Example number--9.12

#P(X<25)=0.1003
```

```
p1=0.1003
#P(X<70)=0.8997
p2=0.8997
#When X=25, Z=(25−u)/s.d=−z1
#When X=70, Z=(70−u)/s.d=z2

#P(0<Z<z2)=0.3997
z2=1.28            #From Normal Table

#P(0<Z<z1)=0.5−0.1003=0.3997
z1=1.28                #From Normal Table

#Solving two variables equation
a=matrix(c(1,1,-1.28,1.28),nrow=2,ncol=2)
b=matrix(c(25,70),nrow=2,ncol=1)
c=solve(a,b)
c
sprintf("The mean: %f Kg",c[1,1])
sprintf("The standard deviation: %f Kg",c[2,1])
```

R code Exa 9.13 Mean And Standard Deviation

```
#Page number−−9.23
#Example number−−9.13

#P(X<75)=0.58
#P(X>80)=0.04
#When X=75, Z=(75−u)/s.d=z1
#When X=80, Z=(80−u)/s.d=z2

#P(0<Z<z2)=1.75
z2=1.75                #From Normal Table

#P(0<Z<z1)=0.20
z1=0.20                #From Normal Table
```

```

#Solving two variables equation
a=matrix(c(1,1,z1,z2),nrow=2,ncol=2)
b=matrix(c(75,80),nrow=2,ncol=1)
c=solve(a,b)
c
sprintf("The mean: %f ",c[1,1])
sprintf("The standard deviation: %f ",c[2,1])
```

R code Exa 9.14 Percentage Of Students Placed In Second Division

```
#Page number--9.24
#Example number--9.14

#P(X<30)=0.10
#P(X>80)=0.05
#When X=30, Z=(30-u)/s.d=-z1
#When X=80, Z=(80-u)/s.d=z2

#P(0<Z<z2)=0.5-0.05
z2=0.45                 #From Normal Table

#P(0<Z<z1)=0.50-0.10
z1=0.40                 #From Normal Table


#Solving two variables equation
a=matrix(c(1,1,-1.28,1.64),nrow=2,ncol=2)
b=matrix(c(30,80),nrow=2,ncol=1)
c=solve(a,b)
c
sprintf("The mean: %f ",c[1,1])
sprintf("The standard deviation: %f ",c[2,1])

#P(45<X<60)
```

```
a=pnorm(60,c[1,1],c[2,1])-pnorm(45,c[1,1],c[2,1])
a
sprintf("%d percent candidates got second division
   in examination",round(a*100))
```

R code Exa 9.15 Probability Of the Defectives In The Sample

```
#Page number--9.25
#Example number--9.15

n=100         # Total items
p=0.4
q=0.6
u=n*p         # Mean
s.d=sqrt(n*p*q)  # Standard Deviation

#Normal Distribution
#Part (i)
#P(43.5<X<100.5)
a=pnorm(100.5,u,s.d)-pnorm(43.5,u,s.d)
a

#Part (ii)
#P(X=44)----->P(43.5<X<44.5)
b=pnorm(44.5,u,s.d)-pnorm(43.5,u,s.d)
b

#Binomial Distribution
#P(X>=44)
sum(dbinom(44:100,100,0.4))
#P(X=44)
dbinom(44,100,0.4)

sprintf("We can see that both Normal and Binomial
   Distribution are close to each other")
```

R code Exa 9.21 Probability

```r
#Page number--9.31
#Example number--9.21
#Load Package-->cubature

library(cubature)

mean=1
variance=4/3
#mean=(a+b)/2=1
#b+a=2
#variance=(b-a)^2/12=4/3
#b-a=4

#Solving two variables equation
x=matrix(c(1,-1,1,1),nrow=2,ncol=2)
y=matrix(c(2,4),nrow=2,ncol=1)
z=solve(x,y)
z

p=1/4            # -1<x<3

# define the integrated function
f <- function(x){p}
a=adaptIntegrate(f, lowerLimit =-1, upperLimit =0)
a
```

R code Exa 9.22 Probability

```r
#Page number--9.31
```

```
#Example number--9.22
#Load Package-->cubature

library(cubature)

#P(X>=20)

fx=1/30              # 0<x<30
# define the integrated function
f <- function(x){fx}
a=adaptIntegrate(f, lowerLimit =20, upperLimit =30)
a
sprintf("Probability that he has to wait at least 20
   min: %f",a$integral)
```

Chapter 10

Correlation

R code Exa 10.1 Correlation Coefficient

```
#Page number--10.7
#Example number--10.1

X=c(65,66,67,67,68,69,70,72)
Y=c(67,68,65,68,72,72,69,71)
meanX=sum(X)/length(X)
meanX
meanY=sum(Y)/length(Y)
meanY
U=X-meanX
V=Y-meanY
data.frame(X,Y,U,V,U^2,V^2,U*V)
u=sum(U)/length(U)
v=sum(V)/length(V)
covUV=(sum(U*V)-u*v)/length(Y)
s.dU=sqrt(1/length(Y)*(sum(U^2)-u^2))
s.dV=sqrt(1/length(Y)*(sum(V^2)-v^2))
rUV=covUV/(s.dU*s.dV)
rUV
```

R code Exa 10.2 Correct Value Of Correlation Coefficient

```
#Page number--10.8
#Example number--10.2

n=25
CsX=125-6-8+8+6            #Corrected sum of X
CsY=100-14-6+12+8              #Corrected sum of Y
CsX2=650-6^2-8^2+8^2+6^2       #Corrected sum of X^2
CsY2=460-14^2-6^2+12^2+8^2     #Corrected sum of Y^2
CsXY=508-6*14-8*6+8*12+6*8     #Corrected sum of XY
meanX=CsX/n
meanY=CsY/n
covXY=1/n*CsXY-meanX*meanY
s.dX=sqrt(1/n*CsX2-meanX^2)
s.dY=sqrt(1/n*CsY2-meanY^2)
rXY=covXY/(s.dX*s.dY)
round(rXY,2)
```

R code Exa 10.14 Correlation Coefficient

```
#Page number--10.18
#Example number--10.14

n=100
v=c(-2,-1,0,1,2,3)
g=c(8,19,35,22,10,6)
a=v^2*g
uf=c(-19,0,31,56)
u2f=c(19,0,31,112)
suvf=c(9,0,13,30)
meanU=sum(uf)/n
```

```
meanV=sum(v*g)/n
covUV=1/n*sum(suvf)-meanU*meanV
s.dU=sqrt(1/n*sum(u2f)-meanU^2)
s.dU
s.dV=sqrt(1/n*sum(a)-meanV^2)
s.dV
rUV=covUV/(s.dU*s.dV)
rUV
```

R code Exa 10.15 Correlation Coefficient Between X And Y

```
#Page number--10.20
#Example number--10.15

X=c(-1,1)
Y=c(0,1)
X1=c(1/8,2/8)
X2=c(3/8,2/8)
gy=X1+X2
px=c(3/8,5/8)
data.frame(Y,X1,X2,gy)

EX=sum(X*px);EX
EX2=sum(X^2*px);EX2
varX=EX2-EX^2
varX

EY=sum(Y*gy);EY
EY2=sum(Y^2*gy);EY2
varY=EY2-EY^2
varY

EXY=0*-1*1/8+0*1*3/8+1*-1*2/8+1*1*2/8
EXY
covXY=EXY-EX*EY
```

```
rXY=covXY/sqrt(varX*varY)
rXY
```

R code Exa 10.17 Rank Correlation Coefficient

```
#Page number--10.25
#Example number--10.17

n=16
r_i_m=c(seq(1,16,1))                          #Ranks in math
r_i_p=c(1,10,3,4,5,7,2,6,8,11,15,9,14,12,16,13) #Ranks in physics
d = r_i_m-r_i_p
data.frame(r_i_m,r_i_p,d,d^2)

#Rank correlation coefficient
p=1-(6*sum(d^2))/(n*(n^2-1))
p
```

R code Exa 10.18 Rank Correlation Between 3 Judges

```
#Page number--10.25
#Example number--10.18

n=10
a=c(1,6,5,10,3,2,4,9,7,8)
b=c(3,5,8,4,7,10,2,1,6,9)
c=c(6,4,9,8,1,2,3,10,5,7)
d1=a-b
d2=a-c
d3=b-c
data.frame(a,b,c,d1,d2,d3,d1^2,d2^2,d3^2)
```

```
#Rank correlation coefficient
Pab=1-(6*sum(d1^2))/(n*(n^2-1))
Pab
Pac=1-(6*sum(d2^2))/(n*(n^2-1))
Pac
Pbc=1-(6*sum(d3^2))/(n*(n^2-1))
Pbc
```

R code Exa 10.19 Rank Correlation Coefficient

```
#Page number--10.26
#Example number--10.19

X=c(68,64,75,50,64,80,75,40,55,64)
Y=c(62,58,68,45,81,60,68,48,50,70)
RankX=c(4,6,2.5,9,6,1,2.5,10,8,6)
RankY=c(5,7,3.5,10,1,6,3.5,9,8,2)
d=RankX-RankY
data.frame(X,Y,RankX,RankY,d,d^2)

#Total correction
Correction=2*(4-1)/12+3*(9-1)/12

p=1-(6*(sum(d^2)+Correction+1/2))/(n*(n^2-1))
p
```

Chapter 11

Linear And Curvilinear Regression

R code Exa 11.1 Equations Of Two Lines Of Regression

```
#Page number-11.9
#Example number--11.1

X=c(65,66,67,67,68,69,70,72)
Y=c(67,68,65,68,72,72,69,71)
#Equation of line regressiono of Y on X
b=lm(Y~X)
a=summary(b)$coefficients[1,1]
a              # Intercept
c=summary(b)$coefficients[2,1]
c              # Slope
#From the above, we can get the equation of Y on X
#Equation--->Y=c*X+a-------->Y=0.66*X+23.66

#Equation of line regressiono of X on Y
e=lm(X~Y)
f=summary(e)$coefficients[1,1]
f              # Intercept
g=summary(e)$coefficients[2,1]
```

```
g              # Slope
#From the above, we can get the equation of X on Y
#Equation--->X=g*Y+f------->X=0.545*Y+30.36

#Calculating the value
x=0.545*70+30.36
x        # Answer little vary due to rounding off
```

R code Exa 11.2 Record An Analysis On Correlation Data

```
#Page number-11.10
#Example number--11.2

a=matrix(c(8,40,-10,-18),nrow=2,ncol=2)
b=matrix(c(-66,214),nrow=2,ncol=1)
r=solve(a,b)
r
x=r[1,1]
y=r[2,1]
byx=8/10                  #Regression coefficient of Y on X
bxy=18/40                 #Regression coefficient of X on Y
z=sqrt(byx*bxy)
z
s.dy=solve(1/5,4/5)
s.dy                      #Standard deviation of Y
```

R code Exa 11.3 Correlation Coefficient

```
#Page number-11.11
#Example number--11.3

```

```
kolkata=c(65,2.5)
mumbai=c(67,3.5)
type=c("Average Price","Standard Deviation")
q=data.frame(type,kolkata,mumbai)
q

x=q[1,2]; x
s.dx=q[2,2]; s.dx              #Standard deviation of x
y=q[1,3]; y
s.dy=q[2,3]; s.dy                    #Standard deviation of y

slope=0.8*3.5/2.5
intercept=67+0.8*65*3.5/2.5
#From the above, we can get the equation of Y on X
#Equation--->Y=slope*X+intercept

#Calculating the value
Y=67+0.8*3.5/2.5*(70-65)
Y
```

R code Exa 11.6 Coefficient Of Regression And Regression Equation

```
#Page number-11.14
#Example number--11.6

obs=c(seq(1,10,1))
X=c(1,1,2,2,3,3,4,5,6,7)
Y=c(2,7,7,10,8,12,10,14,11,14)
data.frame(obs,X,Y,X^2,X^3,X^4,X*Y,X^2*Y)

a=matrix(c(10,34,154,34,154,820,154,820,4774),nrow=3,ncol=3)
b=matrix(c(95,377,1849),nrow=3,ncol=1)
```

```
t=solve(a,b)
t
#From the above, we can get the equation
#Equation---> Y= 1.80 + 3.48*X - 0.2689*X^2
```

R code Exa 11.7 Fit Exponential Curve

```
#Page number-11.15
#Example number--11.7

obs=c(seq(1,8,1))
X=c(1,2,3,4,5,6,7,8)
Y=c(1.0,1.2,1.8,2.5,3.6,4.7,6.6,9.1)
U=log(Y)
data.frame(obs,X,Y,U,X*U,X^2)

a=matrix(c(8,36,36,204),nrow=2,ncol=2)
b=matrix(c(3.7393,22.7385),nrow=2,ncol=1)
t=solve(a,b)
t
#Taking antilog
b=0.1408
d=0.6821

#Equation-----> Y= 0.6821* (1.38)^X
```

Chapter 12

Additional Topics On Correlation And Regression

R code Exa 12.7 Partial And Multiple Correlation Coefficient

```
#Page number--12.31
#Example number--12.7

r12=0.77
r13=0.72
r23=0.52

r12.3=(r12-r13*r23)/sqrt((1-r13^2)*(1-r23^2))
r12.3
R1.23=sqrt((r12^2+r13^2-2*r12*r13*r23)/(1-r23^2))
R1.23
```

R code Exa 12.8 Distribution

```
#Page number--12.32
#Example number--12.8
```

```r

s.d1=2
s.d2=3
s.d3=3
r12=0.7
r21=0.7
r13=0.5
r31=0.5
r23=0.5
r32=0.5

#Part (i)
r23.1=(r23-r21*r31)/sqrt((1-r21^2)*(1-r31^2))
r23.1
#Part (ii)
R1.23=sqrt((r12^2+r13^2-2*r12*r13*r23)/(1-r23^2))
R1.23
#Part (iii)
r12.3=0.6
r13.2=0.2425
s.d1.3=2*sqrt(1-r13^2);s.d1.3
s.d2.3=3*sqrt(1-r23^2);s.d2.3
s.d1.2=2*sqrt(1-r12^2);s.d1.2
s.d3.2=3*sqrt(1-r23^2);s.d3.2
b12.3=r12.3*s.d1.3/s.d2.3;b12.3
b13.2=r13.2*s.d1.2/s.d3.2;b13.2

#Part (iv)
w=matrix(c(1,r12,r13,r12,1,r23,r13,r23,1),nrow=3,
  ncol=3)
det(w)
w1=matrix(c(1,r23,r23,1),nrow=2,ncol=2)
det(w1)
s.d1.23=2*sqrt(det(w)/det(w1));s.d1.23
```

R code Exa 12.9 Regression Equation

```
#Page number--12.33
#Example number--12.9

r12=0.8
r21=0.8
r13=-0.4
r31=-0.4
r23=-0.56
r32=-0.56

w=matrix(c(1,r12,r13,r12,1,r23,r13,r23,1),nrow=3,
   ncol=3)
det(w)
w11=matrix(c(1,r23,r23,1),nrow=2,ncol=2)
det(w11)
w12=matrix(c(r21,r31,r23,1),nrow=2,ncol=2)
det(w12)*-1
w13=r23*r12-r13
w13

#Required equation
#0.686/4.42*(X1-28.02)-0.576/1.10*(X2-4.91)-0.048/85
   *(X3-594)
```

Chapter 13

Theory Of Attributes

R code Exa 13.2 Finding Frequencies

```
#Page number--13.5
#Example number--13.2

ABi=738;AjC=225;Aji=1196
kBC=204;kBi=1762;kjC=171;
kji=21842
ABC=149

A=ABC+ABi+AjC+Aji;A
B=ABC+ABi+kBC+kBi;B
C=ABC+AjC+kBC+kjC;C
AB=ABC+Aji;AB                    # Answer is wrong in
    the example
AC=ABC+AjC;AC
BC=ABC+kBC;BC

N=ABC+ABi+AjC+Aji+kBC+kBi+kjC+kji;N
```

R code Exa 13.11 Find if A And B Are Independent Or Positively Associated Or Negatively Associated

```
#Page number--13.13
#Example number--13.11

#Part (i)
N=1000
A=470;B=620;AB=320
k=AB-A*B/N
if (k>0) print("A and B are positively associated")

#Part (ii)
A=490;AB=294;i=570;iB=380
N=A+i
B=AB+iB
k=AB-A*B/N
if (k<0) print("A and B are negatively associated")

#Part (iii)
AB=256;iB=768;Aj=48;ij=144
A=AB+Aj
B=AB+iB
N=AB+Aj+iB+ij
k=AB-A*B/N
if (k<0) print("A and B are independent")
```

R code Exa 13.12 Heredity In A Family

```
#Page number--13.14
#Example number--13.12

#A:: Dark eye-colour of father
#B:: Dark eye-colour of son

```

```
AB=50;Aj=79;iB=89;ij=782

Q=(AB*ij-Aj*iB)/(AB*ij+Aj*iB)              #Yule's
    Coefficient of Association
Q

A=AB+Aj;A
B=AB+iB;B
i=iB+ij;i
j=Aj+ij;j
N=A+i
N
AB0=A*B/N;round(AB0)
Aj0=A*j/N;round(Aj0)
iB0=i*B/N;round(iB0)
ij0=i*j/N;round(ij0)
```

R code Exa 13.14 Coefficient Of Association

```
#Page number--13.15
#Example number--13.14

#A:: Boys
#i:: Girls
#B:: Successful candidates
#j:: Failed candidates

N=800
Aj=80;iB=260
AB=380;ij=80
Attributes=c("B","j")
A=c(380,80)
i=c(260,80)
Total=c(A[1]+i[1],A[2]+i[2])
data.frame(Attributes,A,i,Total)
```

```
Q=(AB*ij-Aj*iB)/(AB*ij+Aj*iB)          #Yule's
    Coefficient of Association
Q

sprintf("The coeficient shows positive association
    of a low degree between success and failure")
```

R code Exa 13.15 Coefficient Of Association

```
#Page number--13.15
#Example number--13.15

#A:: Majority
#i:: Minority
#B:: Regular players
#j:: Not Regular players

i=250+200+150
sprintf("No. of minority students: %d",i)
A=120+100+80
sprintf("No. of major students: %d",A)
iB=200+150+90
sprintf("No. of minor regular players: %d",iB)
AB=48+30+12
sprintf("No. of major regular players: %d",AB)

Aj=A-AB;Aj
ij=i-iB;ij

Q=(AB*ij-Aj*iB)/(AB*ij+Aj*iB)          #Yule's
    Coefficient of Association
Q
```

Chapter 14

Large Sample Theory

R code Exa 14.1 Limits Between Which Probability 3 Or 4 Lies

```
#Page number--14.12
#Example number--14.1

n=9000
X=3240

#H0::That die is unbiased
#Probability of success
P=1/6+1/6
Q=1-P
#H1::That die is baised

Z=(X-n*P)/sqrt(n*P*Q)

#Probability limits
p=3240/9000;q=1-p
ll=p-3*sqrt(p*q/n)
ul=p+3*sqrt(p*q/n)
sprintf("Probability of getting 3 or 4 certainly
   lies between %f and %f",round(ll,3),round(ul,3))
```

R code Exa 14.2 Percentage Of Bad Pineapples

```r
#Page number--14.13
#Example number--14.2

n=500
X=65
p=X/n            #Proportion on Number of bad pineapples
q=1-p
#S.E of proportion
s.e=sqrt(p*q/n)
#Probability limits
ll=p-3*sqrt(p*q/n)
ul=p+3*sqrt(p*q/n)
sprintf("Percentage of bad pineapples in the consignment between %f and %f",round(ll,3),round(ul,3))
```

R code Exa 14.4 Rice And Wheat Eaters

```r
#Page number--14.13
#Example number--14.4

n=1000
X=540
p=X/n                   # Sample proportion of rice eaters
#H0::Wheat and rice are equally popular
# Population proportion of rice eaters in Maharashtra
P=0.5
```

```
Q=1-P

Z=(p-P)/sqrt(P*Q/n)

#At 1% level of significance
if(Z<2.532)
sprintf("Hence, H0 hypothesis accepted")
sprintf("Rice and wheat are equally popular in
   Maharashtra State")
```

R code Exa 14.6 Number Of Observations

```
#Page number--14.14
#Example number--14.6

P=0.95
p=40/200
q=1-p
n=p*q*3.8416/0.0025
round(n)
```

R code Exa 14.7 Test For Significance For Difference Of Proportions

```
#Page number--14.16
#Example number--14.7

#H1: P1!=P2 (two tailed test)
n1=400
n2=600
X1=200;X2=325
p1=X1/n1
p2=X2/n2

```

```
p=(n1*p1+n2*p2)/(n1+n2)
q=1-p

z=abs((p1-p2)/sqrt(p*q*(1/n1+1/n2)))
z
if(z<1.96) print("Mean and women do not differ on
    flyover proposal")
```

R code Exa 14.10 Test For Significance For Difference Of Proportions

```
#Page number--14.19
#Example number--14.10

n1=1000;p1=800/1000;q1=1-p1
n2=1200;p2=800/1200;q2=1-p2

#H0: P1=P2
#H1: P1>P2 (Right-tailed test)

p=(n1*p1+n2*p2)/(n1+n2);p
q=1-p

z=abs((p1-p2)/sqrt(p*q*(1/n1+1/n2)))
z
if(z>1.96) print("H0 hypothesis is rejected")
sprintf("There is significant decrease in consuption
    of tea after increase in excise duty")
```

R code Exa 14.15 Proportion Of Failures

```
#Page number--14.22
#Example number--14.15

```

```
n1=400;p1=300/400;q1=1-p1
n2=500;p2=300/500;q2=1-p2

#H0: P1=P2
#H1: P1!=P2 (two tailed test)

p=(n1*p1+n2*p2)/(n1+n2);p
q=1-p
s.e.p1p2=sqrt(p*q*1/(n1+n2)*500/400)
s.e.p1p2
z=(p-p1)/s.e.p1p2
abs(z)     # Answer is wrong in the book
sprintf("H0 is rejected")
```

R code Exa 14.18 Arithmetic Mean And Standard Deviation

```
#Page number--14.26
#Example number--14.18

#H0: u=30.5
#H1: u<30.5 (Left-tailed test)

AgeLastBirthday=c("16-20","21-25","26-30","31-35","
    36-40")
f=c(12,22,20,30,16)
midx=c((16+20)/2,(25+21)/2,(26+30)/2,(31+35)/
    2,(36+40)/2)
d=(midx-28)/5
a=f*d
b=f*d^2
data.frame(AgeLastBirthday,f,midx,d,a,b)

u=30.5
x=28+5*16/100
s=5*sqrt(164/100-(16/100)^2)
```

```
z=abs((x-u)/sqrt(s^2/100))
z
if(z>1.645) print("Reject H0 hypothesis")
```

R code Exa 14.26 Food Expenditure Of Two Populations

```
#Page number--14.31
#Example number--14.26

n1=400;n2=400
x1=250;x2=220
s.d1=40;s.d2=55

#H0::u1=u2
#H1::u1!=u2 (two tailed test)

z=abs((x1-x2)/sqrt(40^2/400+55^2/400))
z
if(z>3) print("H0 rejected")
sprintf("Expenditure of two population of shoppers
   in market A and B differ significantly")
```

R code Exa 14.28 Difference In Average Weights Of Items

```
#Page number--14.32
#Example number--14.28

n1=250;n2=400
x1=120;x2=124
s.d1=12;s.d2=14
s.e.x1x2=sqrt(s.d1^2/n1+s.d2^2/n2)
s.e.x1x2
```

```
#H0::u1=u2
#H1::u1!=u2 (two tailed test)

z=(x1-x2)/s.e.x1x2
z
if(z>3) print("H0 rejected")
sprintf("There is significant difference between
   sample means")

#|u1-u2| limits
ll=abs(x1-x2)-2.58*s.e.x1x2          #lower limit
ul=abs(x1-x2)+2.58*s.e.x1x2          #upper limit
sprintf("|u1-u2| varies between %f and %f",ll,ul)
```

R code Exa 14.30 Relating Heights Of Country A And Country B

```
#Page number--14.34
#Example number--14.30

n1=1000;n2=1200
x1=67.42;x2=67.25
s.d1=2.58;s.d2=2.5

#Part (i)
#H0::u1=u2
#H1::u1!=u2 (two tailed test)

z=abs((x1-x2)/sqrt(s.d1^2/n1+s.d2^2/n2))
z
if(z<1.96) print("H0 accepted")
sprintf("There is no significant difference between
   sample means")

#Part (ii)
```

```
s.e.s1s2=sqrt(s.d1^2/(2*n1)+s.d2^2/(2*n2))
s.e.s1s2
z=(s.d1-s.d2)/s.e.s1s2
z
if(z<1.96) print("H0 accepted")
sprintf("The sample standard deviation do not differ
    significantly")
```

Chapter 15

Exact Sampling Distributions I

R code Exa 15.9 Precision Of Instrument

```
#Page number--15.25
#Example number--15.9

X=c(2.5,2.3,2.4,2.3,2.5,2.7,2.5,2.6,2.6,2.7,2.5)
m=sum(X)/length(X)                    # Mean
a=round(X-m,2)
b=a^2
data.frame(X,m,a,b)

#Null Hypothesis
H0=0.16
#Alternative Hypothesis
#H1>0.16
x=sum(b)/H0
x

sprintf("H0 may be accepted")
sprintf("The data are consistent with the hypothesis
    that the precision of the instrument is 0.16")
```

R code Exa 15.12 Digits And Frequency In Telephone Directory

```
#Page number--15.27
#Example number--15.12

digits=c(seq(0,9,1))
f=c(1026,1107,997,966,1075,933,1107,972,964,853)
   # Observed Frequency
m=sum(f)/length(f)                                #
   Mean
e=rep(m,10)                                  # Expected
   Frequency
a=(f-e)^2
b=round(a/e,3)
data.frame(digits,f,e,a,b)

#H0 is null hypothesis
x=sum(b)
x

sprintf("H0 may be rejected")
sprintf("The digits are not uniformly distributed in
    the directory")
```

R code Exa 15.14 Survey Of 800 Families

```
#Page number--15.29
#Example number--15.14

#Probability of male birth
p=1/2
#Probability of female birth
```

```
q=1/2
n_m_b=c(seq(0,4,1))
f=c(32,178,290,236,64)                # Number of families
e=c()
for (i in n_m_b){
    e[i+1]=800*choose(4,i)*p^4      # Frequency of male birth
}
a=(f-e)^2
b=round(a/e,3)
data.frame(n_m_b,f,e,a,b)

#H0 is null hypothesis
x=sum(b)
x

sprintf("H0 may be rejected")
sprintf("Male and female births are not equally probable")
```

R code Exa 15.15 Fit a Poisson Distribution

```
#Page number--15.30
#Example number--15.15

x=c(seq(0,6,1))
f=c(275,72,30,7,5,2,1)            # Observed Frequency
m=sum(f*x)/sum(f)                 #Mean
# Expected Frequency
e=c(242.1,0.482*242.1,0.241*116.69,0.482/3*28.12,0.482/4*4.51,0.482/5*0.544,0.482/6*0.052)
a=(f-e)^2
b=round(a/e,3)
data.frame(x,f,e,a,b)
```

```
x=sum(b)
x                    # Aswer here is wrong in the book

sprintf("Poisson distribution is not good to fit to
   the given data")
```

R code Exa 15.18 8000 Graduates

```
#Page number--15.34
#Example number--15.18

Class=c("Male employed","Male unemployed","Female
   employed","Female unemployed")
f=c(1480,5720,120,680)                            #
   Observed Frequency
e=c(7200*1600/8000,7200-1440,1600-1440,6400-5760)
   # Expected Frequency
a=(f-e)^2
b=round(a/e,2)
data.frame(Class,f,e,b)

#H0 is null hypothesis
x=sum(b)
x

sprintf("H0 may be rejected")
sprintf("Appointment is based on the basis of sex")
```

R code Exa 15.20 Two Researchers

```
#Page number--15.36
#Example number--15.20
```

```
E86=126*200/300
E60=93*200/300
E44=69*200/300

Researcher=c("X","Y")
bavg=c(E86,126-E86)                    # Below Average
avg=c(E60,93-E60)                          # Average
aavg=c(E44,69-E44)                     # Above Average
genius=c(200-192,12-8)
data.frame(Researcher,bavg,avg,aavg,genius)

f=c(86,60,44,10,40,33,25,2)
e=c(84,62,46,8,42,31,23,4)
a=(f-e)^2
b=round(a/e,3)
data.frame(f,e,a,b)

x=sum(b[1:6])
x
sprintf("No difference in sampling techniques used by two researchers")
```

Chapter 16

Exact Sampling Distributions II

R code Exa 16.6 Sales Of Soap Bars Advertising Campaign

```
#Page number--16.13
#Example number--16.6

n=22
x=153.7
s=17.2
u=146.3

#H0::Null Hypothesis ------> the advertising
    campaign is successful
#H1::Alternative Hypothesis--->u>146.3 (Right tail)

t=(x-u)/sqrt(s^2/(n-1))
t                  # Answer of value of t is wrong
sprintf("H0 is rejected")
```

R code Exa 16.7 Sample Of 10 Boys IQ

```
#Page number--16.14
#Example number--16.7

n=10
u=100
#H0::Null Hypothesis -------> mean IQ of 100 in the
    population u=100
#H1::Alternative Hypothesis--->u!=100

x=c(70,120,110,101,88,83,95,98,107,100)
m=sum(x)/n                    #Mean
m
a=x-m
b=a^2
data.frame(x,a,b)
s2=sum(b)/9
s2
t=abs((m-u)/sqrt(s2/n))
t
sprintf("H0 is accepted")
```

R code Exa 16.10 Gain In Weights By Diet A And B

```
#Page number--16.18
#Example number--16.10

n1=12
n2=15
#H0::Null Hypothesis -------> No significant
    difference in mean of weight in diet A and B
#H1::Alternative Hypothesis------>ux!=uy (two-tailed)

#Diet A
```

```
x1=c(25,32,30,34,24,14,32,24,30,31,35,25)
m1=sum(x1)/n1            # Mean
m1
a1=x1-m1
b1=a1^2
data.frame(x1,a1,b1)

#Diet B
x2=c(44,34,22,10,47,31,40,30,32,35,18,21,35,29,22)
m2=sum(x2)/n2            # Mean
m2
a2=x2-m2
b2=a2^2
data.frame(x2,a2,b2)

s2=(sum(b2)+sum(b1))/(n1+n2-2)
t=abs((m1-m2)/sqrt(s2*(1/n1+1/n2)))
t

sprintf("H0 is accepted")
sprintf("Two diets do not differ significantly ")
```

R code Exa 16.12 Heights Of Sailors And Soldiers

```
#Page number--16.20
#Example number--16.12

# SAILORS
X=c(63,65,68,69,71,72)
A=68
d=X-A
a=sum(d^2)
data.frame(X,d,d^2)

# SOLDIERS
```

```
Y=c(61,62,65,66,69,69,70,71,72,73)
B=66
D=Y-B
b=sum(D^2)
data.frame(Y,D,D^2)

mx=A + sum(d)/6;mx              # Mean
p=a-(sum(d))^2/6;p

my=B + sum(D)/10;my             # Mean
q=b-(sum(D))^2/10;q

S2=(1/(6+10-2))*(p+q)
S2

t=(mx-my)/sqrt(S2*(1/6+1/10))
t

sprintf("Null hypothesis can be retained")
sprintf("The sailors are on the average taller than the soilders.")
```

R code Exa 16.15 Increase In Weights Of Animals By Food A And Food B

```
#Page number--16.22
#Example number--16.15

# Part (i)
# Food A
X=c(49,53,51,52,47,50,52,53)
A=50
d=X-A
a=sum(d^2)
data.frame(X,d,d^2)
```

```
# Food B
Y=c(52,55,52,53,50,54,54,53)
B=52
D=Y-B
b=sum(D^2)
data.frame(Y,D,D^2)

mx=A + sum(d)/8;mx                # Mean
p=a-(sum(d))^2/8;p

my=B + sum(D)/8;my                # Mean
q=b-(sum(D))^2/8;q

S2=(1/(8+8-2))*(p+q)
S2

t=(mx-my)/sqrt(S2*(1/8+1/8))
t

sprintf("Null hypothesis rejected")
sprintf("Food B is superior to Food A")

# Part (ii)
X
Y
d=X-Y
data.frame(X,Y,d,d^2)

n=length(X)
md=sum(d)/n
md
S2=1/(n-1)*(sum(d^2)-(sum(d))^2/n)
S2

t= abs(md/sqrt(S2/n))
round(t,3)

```

```
sprintf("Food B is superior to Food A")
```

R code Exa 16.18 Random Sample Of 625 Pairs Of Observations

```
#Page number--16.25
#Example number--16.18

#H0::Null Hypothesis ------>p=0
#H0::The value of r=0.2 is not significant

r=0.2
n=625
t=r*sqrt(n-2)/sqrt(1-r^2)
t

sprintf("Null hypothesis is rejected")
sprintf("The sample correlation is significant of
   correlation in the population.")

#95% confidence limits
ll=r - 1.96*(1-r^2)/sqrt(n)                    # lower
   limit
ll
ul=r + 1.96*(1-r^2)/sqrt(n)               # upper limit
ul

#99% confidence limits
ll=r - 2.58*(1-r^2)/sqrt(n)                    # lower
   limit
round(ll,3)
ul=r + 2.58*(1-r^2)/sqrt(n)               # upper limit
ul
```

R code Exa 16.26 F Test

```
#Page number--16.38
#Example number--16.26

n1=8
n2=10
dx=84.4
dy=102.6
SX2=dx/(n1-1);SX2
SY2=dy/(n2-1);SY2

F=SX2/SY2
F

if(F<3.29) print("H0 may be accepted")
```

R code Exa 16.27 F Test And T Test

```
#Page number--16.38
#Example number--16.27

n1=10
n2=12
mx=15
my=14
dx=90
dy=108

# F-Test
SX2=dx/(n1-1);SX2
SY2=dy/(n2-1);SY2

F=SX2/SY2
F
```

```
if(F<2.90) print("H0 of equality of populatin may be
    accepted")

# T-Test
S2=1/(n1+n2-2)*(dx+dy)
S2
t=(mx-my)/sqrt(S2*(1/n1+1/n2))
t

sprintf("Samples have been drawn from the same
   normal population")
```

Chapter 20

Some Additional Topics

R code Exa 20.1 Fit A Straight Line

```
#Page number--20.8
#Example number--20.1

x=seq(0,4,1)
e=x-2
y=c(1,1.8,3.3,4.5,6.3)
q=e
y0=y*e
data.frame(x,e,y,q,y0)

b0=sum(y)/length(x)
b0
b1=sum(y0)/sum(e^2)
b1
#WE get the following equation
# y = 1.33*x + 0.72
```

R code Exa 20.2 Fit A Second Degree Parabola

```
#Page number--20.9
#Example number--20.2

x=seq(0.5,3,0.5)
e=4*x-7
y=c(72,110,158,214,290,380)
q=e
q2=c(5,-1,-4,-4,-1,5)
y0=y*q
y1=y*q2
data.frame(x,e,y,q,q2,y0,y1)

b0=sum(y)/length(x)
b0
b1=sum(y0)/sum(e^2)
b1
b2=sum(y1)/sum(q2^2)
b2

#WE get the following equation
# y = 106.32*x^2 - 128.04*x + 83.08
```