Tutorial- 5a Submission

MA 201 Probability and Statistics (2021-22) (3-1-0-4)

B. Tech. II year CSE & IT

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Qus - 3 Estimate the value of the following integral $I = \int_{x=0}^{2} \frac{3}{16}(4 - x^2)\, dx$

Ans - Since $f_X(x) = \frac{3}{16}(4 - x^2)$ is a valid density for $0 \le x \le 2$, we will get $I = 1$ from the following code:

```
%For answer verification, we will get I = 1 from the following code:
clear all
syms x
I = int(3/16*(4-x^2),x,0,2)
```

```
I = 1
```

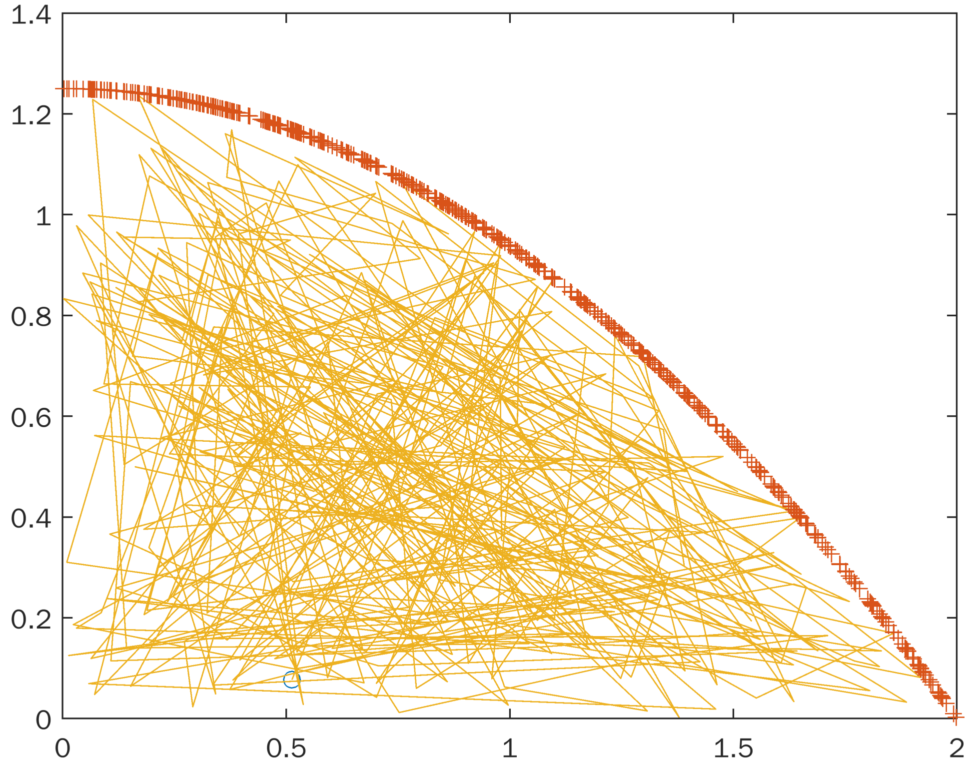
```
clear all;
close all;
%f = @(x)(3/16*(4 - x.^2));
f = @(x)(5/16*(4 - x.^2));
xlower = 0; xupper = 2;


%N = 10^3;
N = 5*10^2;
U = rand(1,N);
x = xlower + (xupper-xlower)*U;
V = rand(1,N);
ylower = min(f(x)); yupper = max(f(x)); % obviously min(f) =0 and max(f) = 3/16;
y = ylower + (yupper-ylower)*V;
zindex = find(y<f(x));
znotindex = find(y>f(x));
z = y(zindex); %reject samples y>f
I = (xupper-xlower)*(yupper-ylower)*length(zindex)/N
```

```
I = 1.7069
```

```
%Visualization
```

```
figure(1)
plot(x,f(x),'+')
hold on
comet(x(zindex),y(zindex))
%comet(x(znotindex),y(znotindex))
plot(x,f(x),'+')
```



Qus -4 Try to generate marks of the students with left skewed beta distribution with maximum marks 10 and maximum students got 8 marks.

$$Mode = \frac{\alpha - 1}{\alpha + \beta - 2} = 0.8 \quad \Rightarrow \alpha = 17, \beta = 5, \quad Mean = \frac{\alpha}{\alpha + \beta} = 17/22 = .7727$$

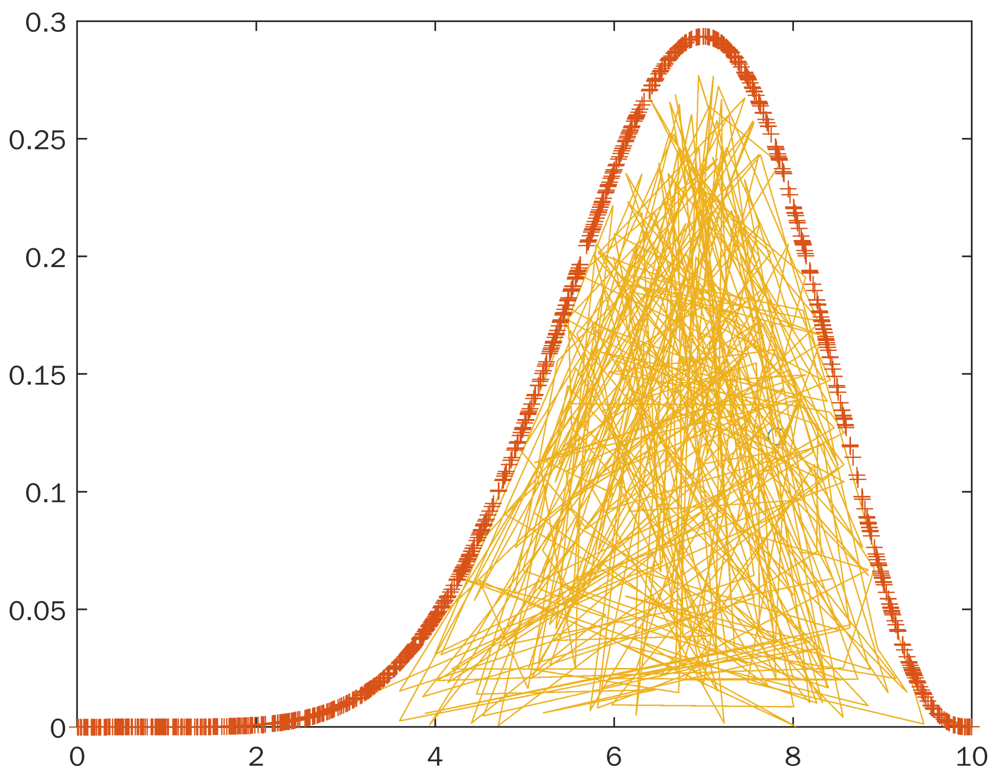
```
clear all
close all;
MaxMarks = 10;
%alpha = 9; beta = 3;
alpha = 8; beta = 4;
f = @(x)(1/MaxMarks*gamma(alpha+beta)/gamma(alpha)/gamma(beta).*(x/MaxMarks).^(alpha-1)
xlower = 0; xupper = MaxMarks;


N = 10^3;
U = rand(1,N);
x = xlower + (xupper-xlower)*U;
V = rand(1,N);
ylower = min(f(x)); yupper = max(f(x)); % obviously min(f) =0 and max(f) = 3/16;
```

```
y = ylower + (yupper-ylower)*V;
zindex = find(y<f(x));
znotindex = find(y>f(x));
z = y(zindex); %reject samples y>f
I = (xupper-xlower)*(yupper-ylower)*length(zindex)/N
```

```
I = 0.9891
```

```
%Visualization
figure(2)
plot(x,f(x),'+')
hold on
comet(x(zindex),y(zindex))
plot(x,f(x),'+')
```



Qus - 5 Estimate the integral $I = \int_{\infty}^{\infty} \frac{\lambda}{2} e^{-\lambda|x|} dx$ for $\lambda = \frac{1}{5}, \frac{1}{2}, 1, 2, 5.$ Explain why the results are inaccurate for small λ.

```
clear all
close all
syms x
syms lam positive
I = lam/2* int(exp(-lam*abs(x)),x,-inf,inf)
```

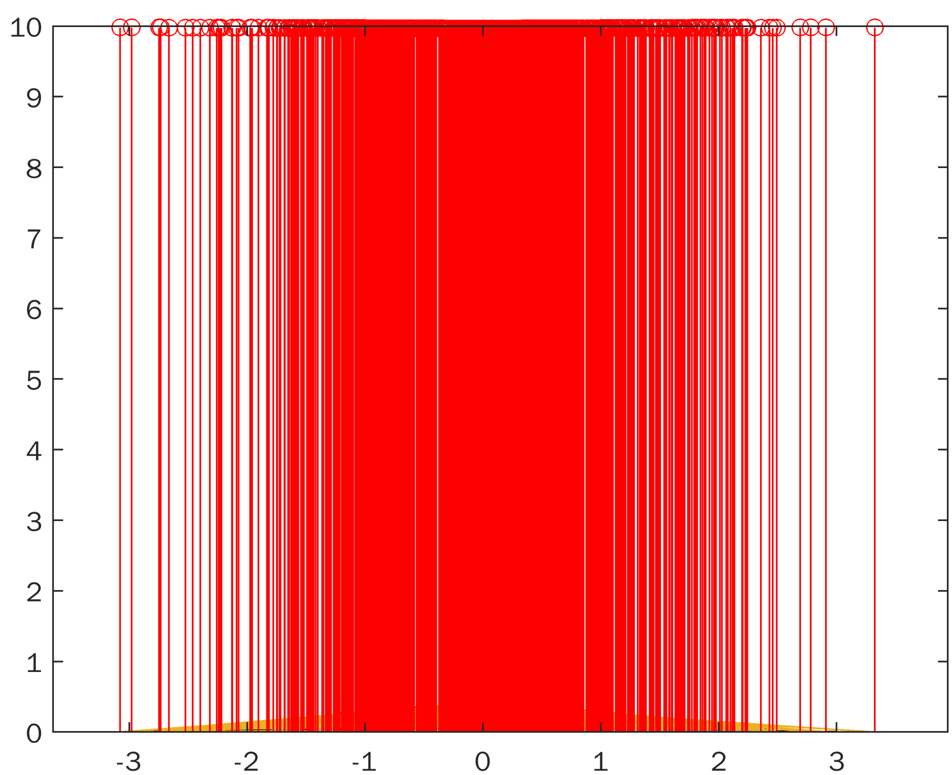
```
I = 1
```

```
lambda = 1/5;  %check for lambda = 1/5 and answer for inaccuracy
N = 10^3;
x = randn(1,N);
f = @(x) (1/sqrt(2*pi)*exp(-x.*x/2));
figure(3)
histogram(x,'normalization','pdf');
hold all
comet(x,f(x)); hold all


%g = @(x) (lambda/2*exp(-lambda*abs(x)));
g = @(x) (10 - (lambda/5*exp(-lambda*abs(x))))
```

```
g = function_handle with value:
    @(x)(10-(lambda/5*exp(-lambda*abs(x))))
```

```
stem(x,g(x), 'r'); hold all
```




```
I = mean(g(x)./f(x))
```

```
I = 67.8263
```

Tutorial- 5b Submission

MA 201 Probability and Statistics (2021-22) (3-1-0-4)

B. Tech. II year CSE & IT

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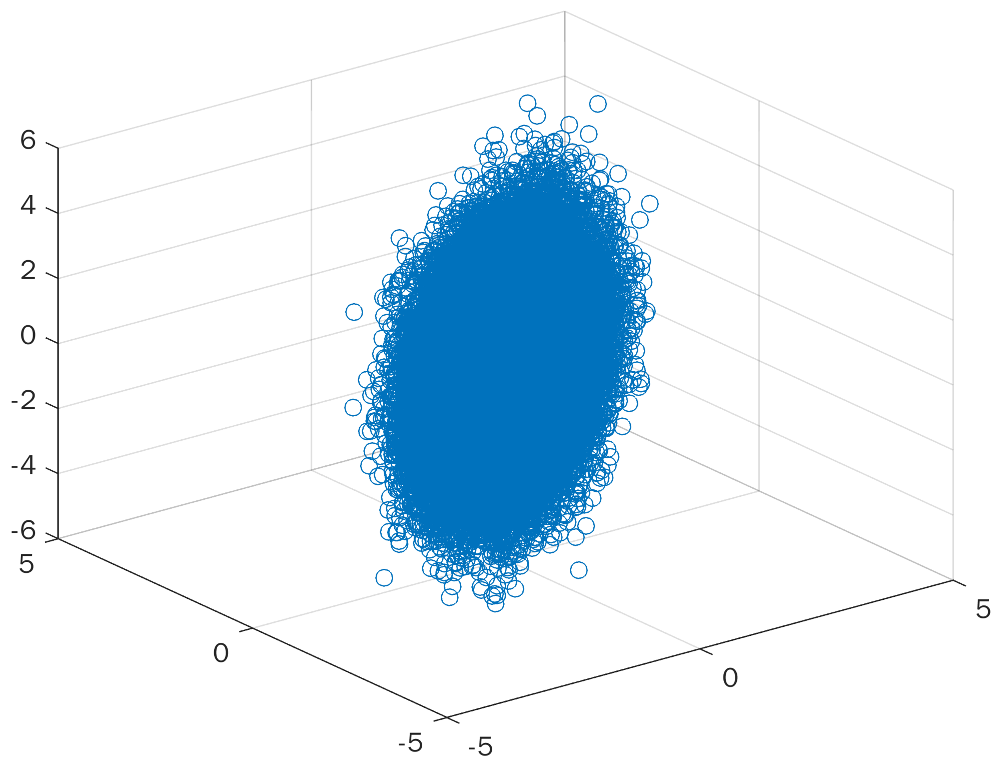
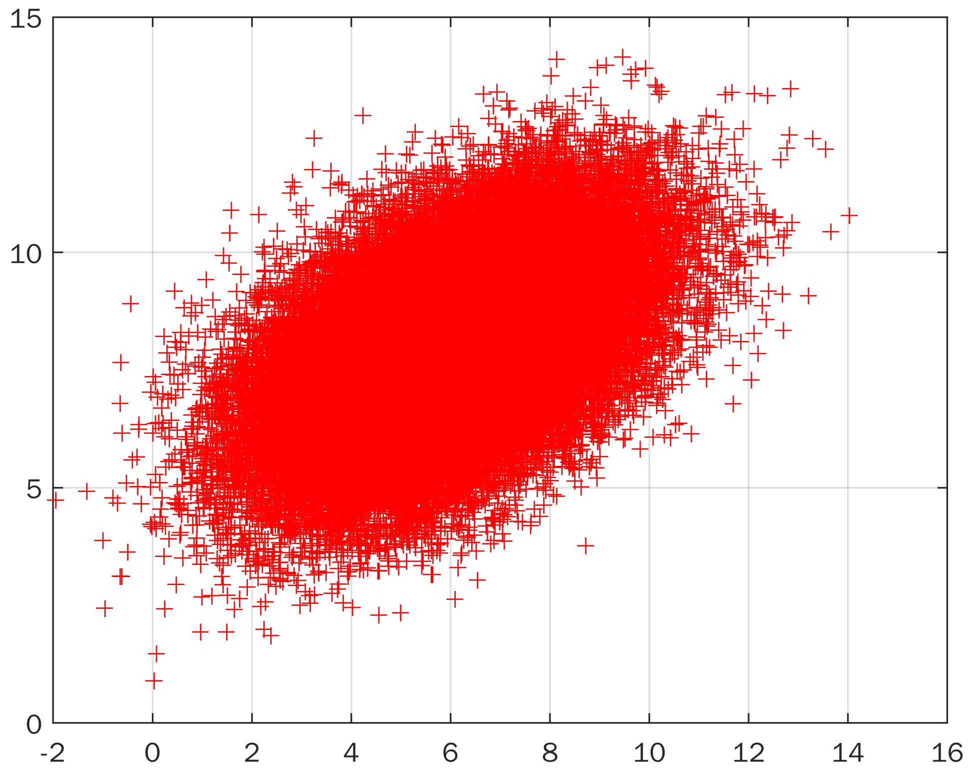
Qus-1 Generate the correlated random variable $\mu = [0 \quad 0 \quad 0]$, $K = \begin{bmatrix} 1.0 & 0.9 & 0.9 \\ 0.9 & 1.0 & 0.9 \\ 0.9 & 0.9 & 1.0 \end{bmatrix}$

```
mu = [0 0 0];
%r = 0.9;
r = 0.7;
%N = 5*10^4;
N = 10^5;
K = [1 r r; r 1 r; r r 1];
rng('default') % For reproducibility
x = mvnrnd(mu,K,N);
scatter3(x(:,1),x(:,2),x(:,3))
```



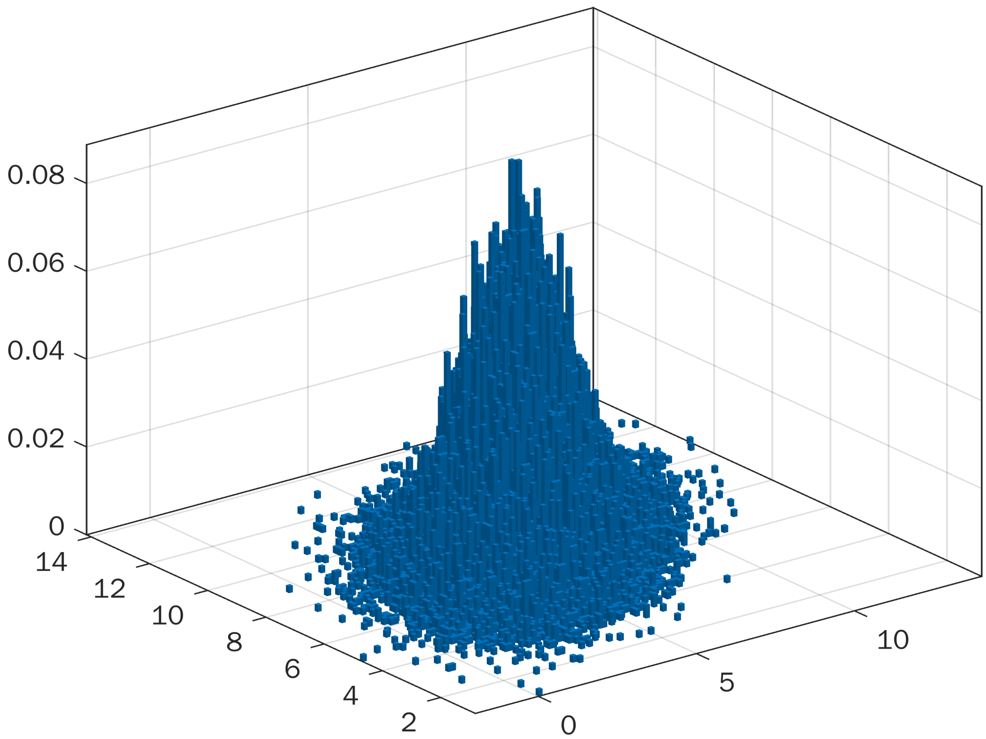
Qus - 2 Generate the correlated normal random variable with $\mu = [6 \quad 8]$, $K = \begin{bmatrix} 5/2 & 3/2 \\ 3/2 & 5/2 \end{bmatrix}$ using mvnrnd command. Plot the scatter plot and histogram.

```
close all
clear all
clc

rng('default') % For reproducibility
N = 5*10^4;
mu = [6; 8];
%K = [5/2 3/2; 3/2 5/2];
K = [7/2 3/2; 3/2 5/2];
x = mvnrnd(mu,K,N);

% simulation
x1 = x(1,:);
x2 = x(2,:);
figure(1)
plot(x(:,1),x(:,2),'r+')
grid on
```




```
figure(2)
```

```
histogram2(x(:,1),x(:,2),128,'normalization','PDF')
```



Qus -3(a) Generate the correlated normal random variable $\mathbf{x}$ with $\mu = [6 \quad 8]$, $K = \begin{bmatrix} 5/2 & 3/2 \\ 3/2 & 5/2 \end{bmatrix}$ using standard method. Convert the samples of $\mathbf{x}$ into standard normal random variable $\mathbf{y}$ using Cholskey Decomposition.

```
close all
clear all
clc
mvnrnd_enable=0;


N = 5*10^4;
%mu = [6; 8];
mu = [5; 10];
K = [5/2 3/2; 3/2 5/2];

if mvnrnd_enable ==1
    x = mvnrnd(mu,K,N)';
else
    z1 = randn(1,N); z2 = randn(1,N); z = [z1; z2];
    [U D] = eig(K);
    x = mu + U*D.^0.5*z;
end
```

```
x1 = x(1,:);
x2 = x(2,:);

%Cholskey Decomposition
L = [1 0; K(1,2)/K(1,1) 1];
Dia = [K(1,1) 0; 0, K(2,2)*(1- K(1,2)^2/(K(1,1)*K(2,2)))];
y = Dia^-(0.5)*L^-1*(x-mu);
y1 = y(1,:);
y2 = y(2,:);

figure(1)
if mvnrnd_enable ==0
plot(z1,z2,'b*')
end
axis([-5, 15, -5, 15])
grid on
hold on
pause(2)
plot(x1,x2,'r+')
pause(2)
plot(y1,y2,'k.')
legend('Standard Normal','Correlated Normal','Cholskey-Decompose')
```