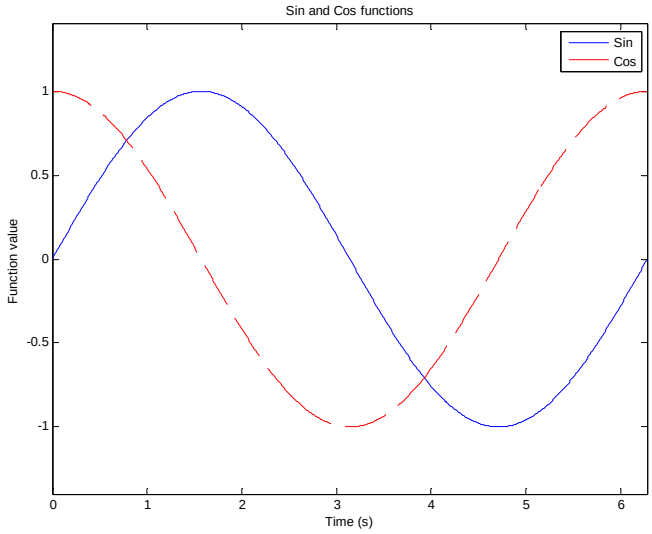
Homework 1 Solutions

```
% shortProblems.m
% Homework 1, problems 1 through 7

% 1a
a=10;

% 1b
b=2.5e23;

% 1c
c=2+3*1i; %2+3*1j is also ok

% 1d
d=exp(1j*2*pi/3); % i instead of j is also ok

% 2a
aVec=[3.14 15 9 26];

% 2b
bVec=[2.71; 8; 28; 182];

% 2c
cVec=5:-0.2:-5;

% 2d
dVec=logspace(0,1,101); % there are 101 values here, not 100
% can also do dVec=10.^(0:.01:1);

% 2e
eVec='Hello';

% 3a
aMat=2*ones(9); % or aMat=2+zeros(9);

% 3b
temp=[1:5 4:-1:1];
bMat=diag(temp,0);

% 3c
cMat=reshape(1:100,10,10);

% 3d
dMat=nan(3,4);

% 3e
eMat=[13 -1 5; -22 10 -87];

% 3f
fMat=floor(rand(5,3)*7)-3; % should be *7 not *6, because of the floor
% fMat=ceil(rand(5,3)*7)-4; is also ok.
```

```
% 3f Cont'd.
fMat=randi(7 , [5,3])- 4; % exploiting randi, you are using one less
function.

% 4a
x=1/(1+exp(-(a-15)/6));

% 4b
y=(sqrt(a) + b^(1/21))^pi;

% 4c
z=log(real((c+d)*(c-d))*sin(a*pi/3))/(c*conj(c));

% 5a
xVec=1/(sqrt(2*pi*2.5^2))*exp(-cVec.^2/(2*2.5^2));

% 5b
yVec=sqrt((aVec.').^2+bVec.^2);

% 5c
zVec=log10(1./dVec);

% 6a
xMat=(aVec*bVec)*aMat^2;

% 6b
yMat=bVec*aVec;

% 6c
zMat=det(cMat)*(aMat*bMat).';

% 7a
cSum=sum(cMat,1);

% 7b
eMean=mean(eMat,2);

% 7c
eMat(1,:)=[1 1 1];

% 7d
cSub=cMat(2:9,2:9);

% 7e
lin=1:20;
lin(2:2:end)=-lin(2:2:end);

% 7f
r=rand(1,5);
r(find(r<0.5))=0; (using the find function)
or you could've done this instead of the second line: r(r<0.5)=0; (w/o find)
```

8. The twoLinePlot script is pasted below

```
% twoLinePlot
% a plot that has two lines in two different colors

% make a new figure
figure

% make a time vector
t=0:.01:2*pi;

% plot a sine wave
plot(t,sin(t))

% hold on and plot a cosine wave on top of it in a red dashed line
hold on
plot(t,cos(t),'r--')

% label everything
xlabel('Time (s)');
ylabel('Function value');
title('Sin and Cos functions');
legend('Sin', 'Cos');

xlim([0 2*pi]);
ylim([-1.4 1.4]);
```



9. The calculateGrades script is pasted below

```
% calculateGrades
% load a matrix of student grades, normalize each assignment to have a b
% average and then calculate the average grade for each student

% load the grades
load classGrades

% look at the first 5 rows
namesAndGrades(1:5,:)

% get just the grades out
grades=namesAndGrades(:,2:end);

% calculate the mean of each assignment
meanGrades=mean(grades);

% show the meanGrades
meanGrades

% calculate nanmean grades and nanmax grades
meanGrades=nanmean(grades)

% compress the range so the mean is 3.5
meanMatrix=ones(size(grades,1),1)*meanGrades
curvedGrades=(grades./meanMatrix)*3.5;
nanmean(curvedGrades)
curvedGrades(curvedGrades>5)=5;

% calculate the total grade for each student
totalGrade=ceil(nanmean(curvedGrades,2));
letters='FDCBA';
letterGrades=letters(totalGrade);

disp(['Grades: ' letterGrades]);
```

Screen output:

```
ans =
    1.0000    2.5064    3.6529    2.4617    3.3022    2.5189    0.0963    4.6502
    2.0000    2.1586    3.2324    3.4737    0.2378    2.4480    0.4194    1.9951
    3.0000    4.9878       NaN    4.8637    1.7439    4.3852    4.8740    0.2370
    4.0000    4.0580    1.9914    1.6388    2.2567    1.7657    3.2567    1.7119
    5.0000    2.4283    3.7491    4.1890       NaN    2.2472    1.1562    3.6798
meanGrades =
       NaN       NaN    2.8361       NaN    2.8540    1.6481       NaN
meanGrades =
    2.9690    2.9445    2.8361    2.4879    2.8540    1.6481    2.5677
meanMatrix =
    2.9690    2.9445    2.8361    2.4879    2.8540    1.6481    2.5677
    2.9690    2.9445    2.8361    2.4879    2.8540    1.6481    2.5677
    2.9690    2.9445    2.8361    2.4879    2.8540    1.6481    2.5677
    2.9690    2.9445    2.8361    2.4879    2.8540    1.6481    2.5677
    2.9690    2.9445    2.8361    2.4879    2.8540    1.6481    2.5677
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    2.9690    2.9445    2.8361    2.4879    2.8540    1.6481    2.5677
    2.9690    2.9445    2.8361    2.4879    2.8540    1.6481    2.5677
    2.9690    2.9445    2.8361    2.4879    2.8540    1.6481    2.5677
    2.9690    2.9445    2.8361    2.4879    2.8540    1.6481    2.5677
    2.9690    2.9445    2.8361    2.4879    2.8540    1.6481    2.5677
    2.9690    2.9445    2.8361    2.4879    2.8540    1.6481    2.5677
ans =
    3.5000    3.5000    3.5000    3.5000    3.5000    3.5000    3.5000
Grades: BCBBBACCBCCCCAB
```
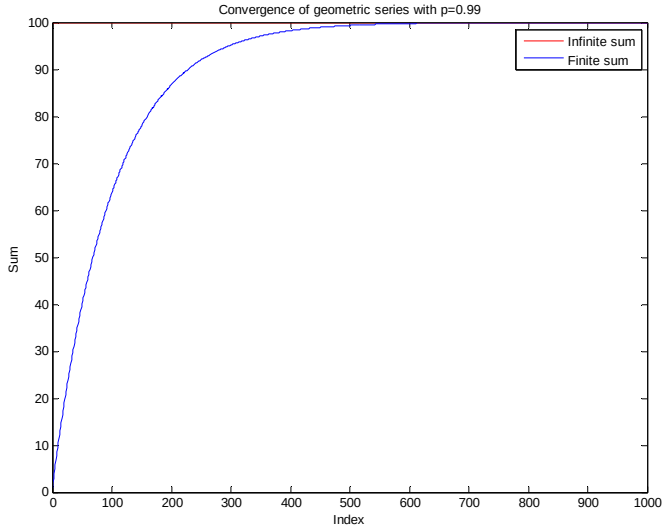
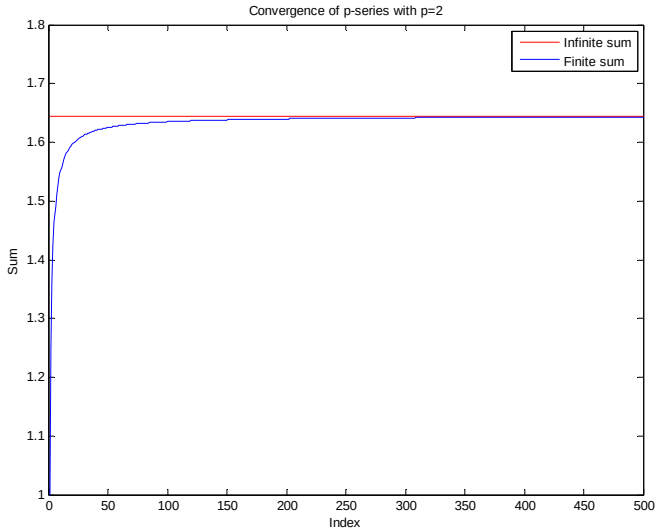

10. The seriesConvergence script is pasted below

```
% seriesConvergence
% this script plots two series to verify that they converge to the
% analytical value

% define the constants
p=0.99;
k=0:1000;

% calculate each term in the series
geomSeries=p.^k;

% calculate the infinite sum
theoreticalValue=1/(1-p);

% plot theory and cumulative sum
figure
plot([0 max(k)],theoreticalValue*ones(1,2),'r');
hold on
plot(k,cumsum(geomSeries));
xlabel('Index');
ylabel('Sum');
title(['Convergence of geometric series with p=' num2str(p)]);
legend('Infinite sum','Finite sum');


% define the new constants
p=2;
n=1:500;

% calculate each term in the p-series
pSeries=(1./n).^p;

% calculated theoretical answer, which is the solution to the basel problem
baselValue=pi^2/6;

% plot theory and cumulative sum
figure
plot([1 max(n)],baselValue*ones(1,2),'r');
hold on
plot(n,cumsum(pSeries));
xlabel('Index');
ylabel('Sum');
title('Convergence of p-series with p=2');
legend('Infinite sum','Finite sum');
```

The figures generated by seriesConvergence are below





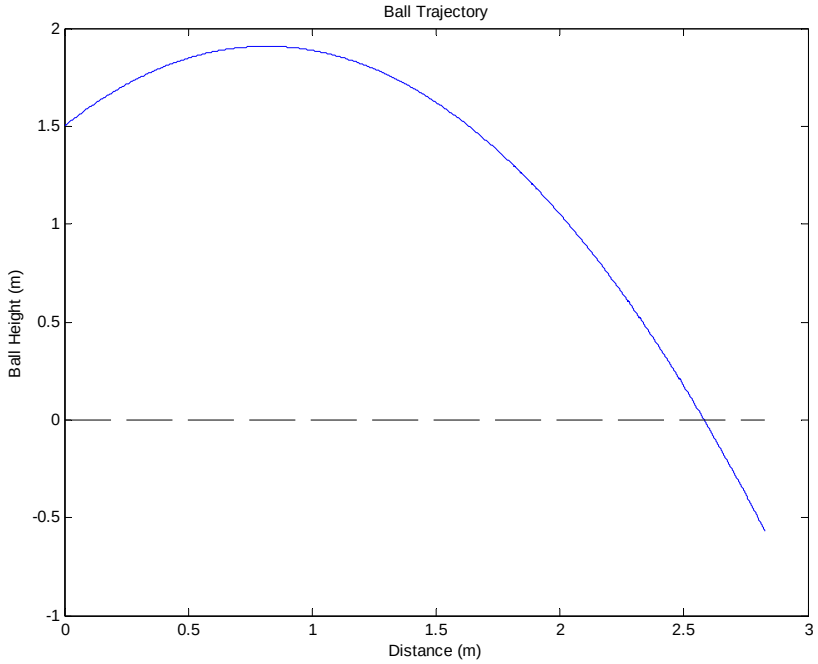
11. The throwBall script is pasted below

```
% throwBall
% this is a script that throws a ball of a set mass at a specified angle
% and with a specified initial velocity and calculates where the ball lands

% define the constants
h=1.5; %meters
g=9.8; %gravitational acceleration in m/s^2
v=4; %m/s
theta=45; % degrees

% make a time vector
t=linspace(0,1,1000);

% calculate the x and y positions as a function of time
x=v*cos(theta/180*pi)*t;
y=h+v*sin(theta/180*pi)*t-1/2*g*t.^2;

% find when it hits the ground
ind=find(y<0,1,'first');
distance=x(ind);
disp(['The ball hits the ground at a distance of ' num2str(distance) '
meters']);

% plot the ball's trajectory
figure
plot(x,y)
xlabel('Distance (m)');
ylabel('Ball Height (m)');
title('Ball Trajectory');

% plot the ground
hold on
plot([0 max(x)],[0 0],'k--');
```

The output printed to the screen upon running throwBall is:

The ball hits the ground at a distance of 2.5821 meters

The throwBall script generates this figure:



12. The encrypt script is pasted below:

```
% encrypt
% this is a simple encryption script that takes a string and shuffles the
% letters around and then replaces the letters

% define the original string
original='This is my top secret message!';

% make the encoding indices vector
encodeInds=randperm(length(original));

% apply the shuffled indices vector to the original
encoded=original(encodeInds);

% make the decode indices vector
temp=[encodeInds;1:length(original)].';
temp=sortrows(temp);
decodeInds=temp(:,2);

% unshuffle the shuffled message
decoded=encoded(decodeInds);

% display all three phrases
disp(['Original: ' original]);
disp(['Encoded : ' encoded]);
disp(['Decoded : ' decoded]);

% verify that the decoding happened correctly
correct=strcmp(original,decoded);
disp(['Decoded correctly (1 true, 0 false): ' num2str(correct)]);
```

The screen output of encrypt.m is:

```
Original: This is my top secret message!
Encoded :  iis !sgep  etsasr Tmhsceomeyt
Decoded : This is my top secret message!
Decoded correctly (1 true, 0 false): 1
```