<u>% In-Lecture Assignment #4 Related to Homework #6</u>

% Consider performing an iterative ***maximization*** of
% $J(x) = 8 - x^2 + 6\cos(6x)$
% via the steepest descent (***ascent***) algorithm (JSK equation (6.5) on page 116)
% with the sign on the update reversed from negative to positive so that
% the algorithm will ***maximize*** rather than minimize; i.e.
% $x[k+1] = x[k] + \mu \left.\frac{dJ(x)}{dx}\right]_{x=x[k]}$

% a. Visualize and analyze the shape of the objective function $J(x)$.
% 1) Plot $J(x)$ for $-5 < x < 5$. Give the Matlab code for your answer.

```
x = [-5 : 0.01 : 5];
J = 8 - x .^ 2 + 6 * cos(6*x);
plot(x, J);    %% At end of document
```

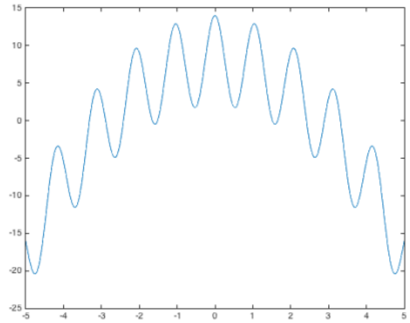
% 2) Describe the plot.
% Sum of concave down parabola and cosine creates many local maxima -OR-
% Headband-like rainbow shape composed in a parabolic wavy pattern -OR-
% Comic (graphical novel) sketch of a head with hair or crown
% 3) How many local maxima do you see?
% 11, which are the 9 peaks with valleys plus the two end points.
% 4) Of these local maxima, how many are global maxima?
% Only one, located at $x = 0$.

% b. Derive the steepest descent (***ascent***) update equation
% dJ(x)/dx = -2x - 36*sin(6*x)
% and modify the code below to include the derivative of dJ(x)/dx

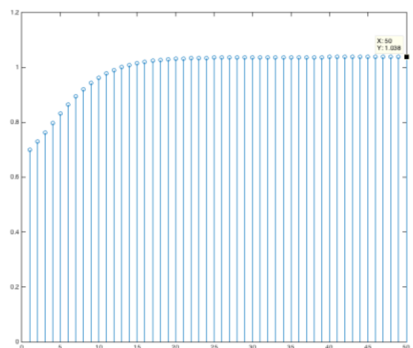
```
% Code below modified from a solution by a Spring 2019 student
% polyconverge.m find the maximum of J(x)=x via steepest descent
N=50;                        % number of iterations
mu=0.001;                    % algorithm stepsize
x=zeros(1,N);                % initialize sequence of x values to zero
x(1)=0.7;                    % starting point x(1)
for k=1:N-1
  x(k+1)= x(k) + (-36*sin(6*x(k)) - 2*x(k))*mu;     % update equation
end
figure();
stem(x);           % to visualize approximation of x
x(N)
```

% c. Implement the steepest descent (***ascent***) algorithm in Matlab with $x[0] = 0.7$.
% 1) To what value does the steepest descent algorithm converge?
% x = 1.0376
% 2) Is the convergent value of x in the global maximum of $J(x)$? Why or why not?
% No. The only global maximum of $J(x)$ occurs at $x = 0$.

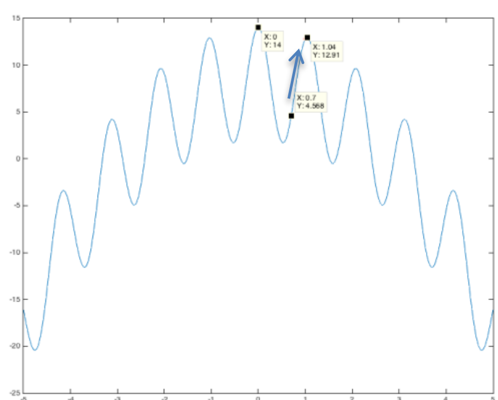
% The objective function *J*(*x*) is plotted below vs. *x*



% The plot below shows the trajectory of *x*[*k*] values vs. *k*



% Below, the objective function *J*(*x*) is highlighted with the global maximum at *x* = 0,
% the starting point of the steepest descent (ascent) algorithm at *x* = 0.7, and
% the point where the steepest descent (ascent) algorithm converges at *x* = 1.0376.



% *Debugging hint:* What happens if one makes a mistake computing
% the derivative? How I can tell that there's a mistake? The steepest
% descent (ascent) will not correctly find the minimum (maximum).