MATLAB assignment 4 solution

Introduction to Linear Algebra (Week 4) **Fall, 2019**

1. (*Graphics in* MATLAB)

   (a) In this problem, we plot the **contour lines(level curves)** of a surface which is represented by the equation

   $$z = y \sin x - x \cos y,$$

   over a region in the xy-plane which is defined by $\mathcal{D} = \{(x, y) : -3 \leq x \leq 3, -3 \leq y \leq 3\}$.

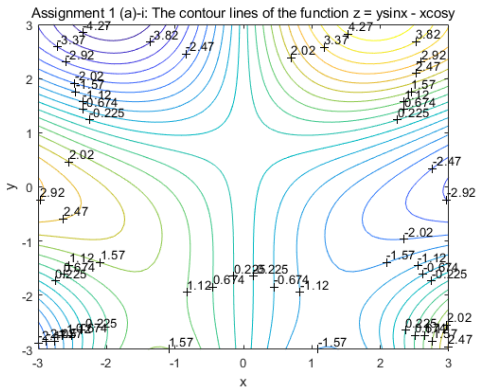
   i. Using the MATLAB command `contour`, plot contour lines of the given surface, and label the height value of each contour line by using the command `clabel`.

   Solution.

```
% assignment 4_1_(a)_i
x = -3 : 0.1 : 3; y = -3 : 0.1 :3;
% To create a grid as two matrices X and Y
% and write the xy-coordinates of each point in these matrices.
[X, Y] = meshgrid(x,y);          % Create a grid over the
    specified domain.

Z = Y.*sin(X) - X.*cos(Y);       % Evaluate Z with the given
    function.

figure;                          % Open the figure window.
C = contour(X, Y, Z, 20);            % Draw contour lines.
clabel(C);                       % Label the height of each
    contour line.
xlabel('x'); ylabel('y');
title('Assignment 1 (a)-i: The contour lines of the function z
    = ysinx - xcosy');
```



□

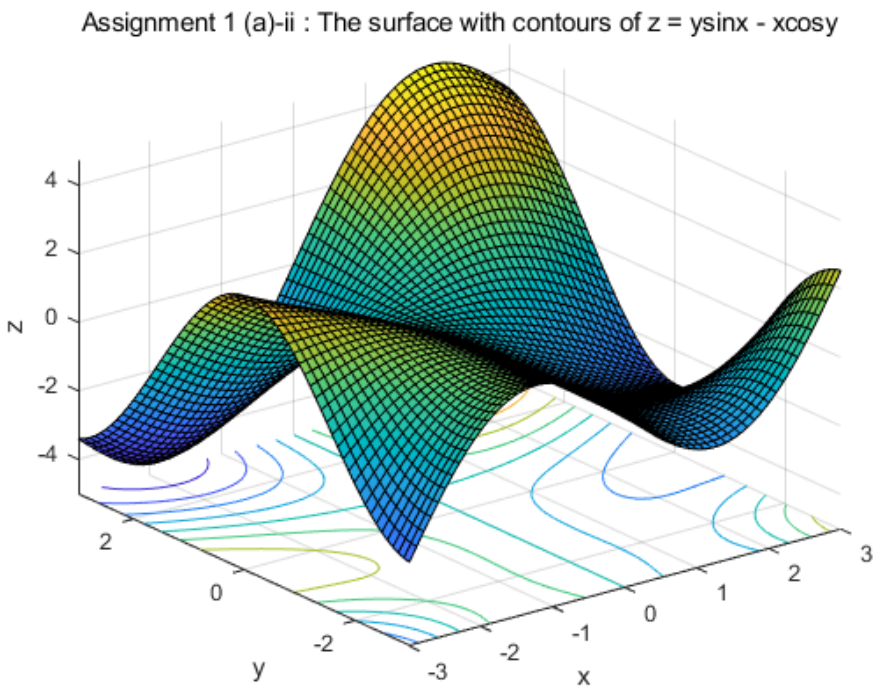
ii. Using the MATLAB command `meshc` or `surfc`, plot the contour lines together with its 3D surface in the same figure.

Solution.

```
% assignment 4_1_(a)_ii
x = -3 : 0.1 : 3; y = -3 : 0.1 :3;
% To create a grid as two matrices X and Y
% and write the xy-coordinates of each point in these matrices.
[X, Y] = meshgrid(x,y);          % Create a grid over the
    specified domain.
Z = Y.*sin(X) - X.*cos(Y);       % Evaluate z with the given
    function.

figure;                          % Open the figure window.

surfc(X,Y,Z); % Or you may use meshc(X,Y,Z).
xlabel('x'); ylabel('y'); zlabel('z');
title('Assignment 1 (a)-ii : The surface with contours of z =
    ysinx - xcosy');
```



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(b) Considering the items below, plot the contours of the surface and the gradient vector field of the two variable function given by

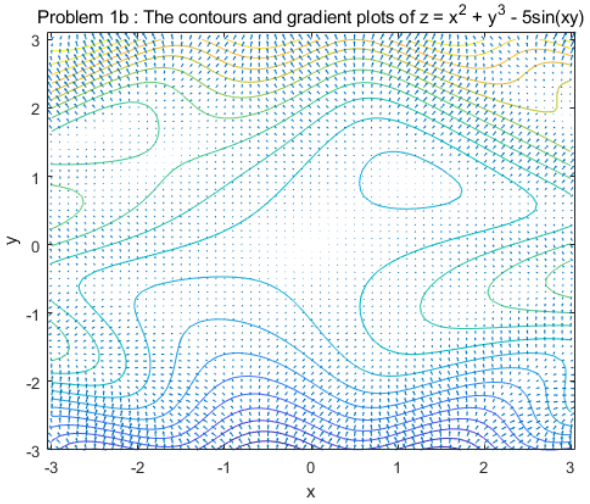
$$z = x^2 + y^3 - 5\sin(xy),$$

over the region in the xy-plane defined by $\mathcal{D} = \{(x, y) : -3 \leq x \leq 3, -3 \leq y \leq 3\}$.

Solution.

```
% assignment 4_1_(b)
x = -3 : 0.1 : 3; y = -3 : 0.1 : 3;
% To create a grid as two matrices X and Y
% and write the xy-coordinates of each point in these matrices.
[X, Y] = meshgrid(x,y);              % Create a grid over the
    specified domain.
Z = X.^2 + Y.^3 - 5*sin(X.*Y);       % Evaluate z with the given
    function.

[dx, dy] = gradient(Z, 0.1, 0.1);    % Approximated gradient vector.
% When approximately calculated, the increment of each direction is
     0.2.
figure;  axis equal;     % Open the figure window and make axis
    equal.
contour(X, Y, Z, 20);        % Draw contour lines.
hold on; % Hold the current plot, and subsequent plots will be
    added to
          % the existing graph.
quiver(X, Y, dx, dy);    % Plot gradient vector field at the points
    (x,y).
hold off;                % Return to the default mode.
xlabel('x'); ylabel('y');
title('Problem 1b : The contours and gradient plots of z = x^2 + y
    ^3 - 5sin(xy)');
```



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2. *Symbolic Computation in* MATLAB

In addition to basic built-in functions of MATLAB, there are many supplementary toolboxes to be used in a variety of numerical computations. In order to use a specific MATLAB toolbox, you are required to install it separately. Fortunately, KAIST TAH license provides nearly 15 toolboxes which have already installed together with your MATLAB. Among these, we use the **Symbolic Math Toolbox** which enables us to do symbolic computation in MATLAB.

(a) In this problem, we find the roots of the following polynomial:

$$f(x) = x^6 - 11x^5 + 7x^4 + 163x^3 - 164x^2 - 476x + 480.$$

i. Using the MATLAB command *syms*, declare a variable x as a symbolic object.

ii. Using the MATLAB command *factor*, find the factors of the given polynomial.

iii. Using the MATLAB command *solve*, find the roots of the given polynomial.

iv. Using the MATLAB command *subs*, check that all the roots obtained from (iii) solve the equation $f(x) = 0$.

Solution.

```
% assignment 4_2_(a)
syms x; % Declare x as symbolic.
y = x^6 - 11*x^5 + 7*x^4 + 163*x^3 - 164*x^2 - 476*x + 480;
% Factorize y with the command factor.
disp('The factorization of f(x) is'); disp(factor(y));
% Find the roots of f(x)=0 by using the command solve.
roots = solve(y);
disp('The roots of f(x)=0 are'); disp(roots);
% Substitute each output of solve(y) into x,
% and calculate each function value.
for i = 1:6
    check(i) = subs(y, x, roots(i));
    fprintf('f(%d)= %g\t', i, check(i));
end
fprintf('\n');
```