MATLAB Midterm

Introduction to Linear Algebra **Spring, 2021**

10. (MATLAB Programming Problem)

(1) (10 points)

The following is contents of a MATLAB script file `operations.m`:

```
% Declare two matrices, A and B.
A = [5, -2, -3; -5, 1, 1; 0, 1, 7];
B = [3, 1, 2; -1, 1, -2; 1, 1, 4];

%--------- operations ----------
M1 = A * B;     M2 = A .* B;
D1 = A / B;     D2 = A ./ B;
% ------------------------------

% some calculations.
a = min(M1(:)) * sum(M2(2, :));
b = sum(D1 > D2, 'a');

answer = a + b;          % compute 'answer'.
disp(answer)             % print the 'answer' on 'Command Window'.
```

Choose the number printed when running this script file, `operations.m`.

(a) -120 (b) -55 (c) 5 (d) 125 (e) 536

(2) (10 potins in total, 2 points for each of blank.)

Let $g(x, y)$ be a function obtained by rotating the function $f(x, y) = e^{-x^2-y}\sin 2x^4 + 3\cos xy$ counterclockwise 17 degrees about the z-axis. In this problem, we write a script file `rotFunc.m` to find and draw the surface represented by the function $g(x, y)$ on a domain $D = \{(x, y) | -1 \le x \le 1, -1 \le y \le 1\}$ with increments of 0.01 for x and 0.05 for y. Fill in the blanks (1) - (5).

```
% ---------- The following is the script file 'rotFunc.m'.----------
hx = 0.01;   hy = 0.05; % Set the increment as described in the problem.

x = -1:___(1)___:1;      % A vector x of specified interval and increment.
y = -1:hy:1;             % A vector y of specified interval and increment.

% Construct a grid over the domain D in the problem.
[X, Y] = ___(2)___(x, y);
```

```
theta = ___(3)___;      % Set the theta as an appropriate radian value.
C = cos(theta);         % Store the value of cos(theta)
S = sin(theta);         % Store the value of sin(theta)

% Construct clockwise rotated grids, rotX and rotY.
rotX = C.*X - ___(4)___.*Y;
rotY = ___(4)___.*X + C.*Y;

% Evaluate the function g(x,y) discribed in the problem.
gxy = exp(-rotX.^2-rotY).*sin(2*rotX.^4) + 3*cos(rotX.*rotY);

figure(1);              % Open the figure 1.
___(5)___(X, Y, gxy);   % Draw the surface.
grid on;                % Turn the grid on.
```

(a) (1) `hx`, (2) `meshgrid`, (3) `-17 * pi / 180`, (4) `-S`, (5) `surf`
(b) (1) `hx`, (2) `meshgrid`, (3) `17 * pi / 180`, (4) `S`, (5) `mesh`
(c) (1) `hx`, (2) `meshgrid`, (3) `-17 * pi / 180`, (4) `S`, (5) `plot3`
(d) (1) `hy`, (2) `grid on`, (3) `-17 * pi / 180`, (4) `-S`, (5) `mesh`
(e) (1) `hx`, (2) `meshgrid`, (3) `17 * pi / 180`, (4) `-S`, (5) `mesh`

Solution.

(1) answer : (b) -55

In the first two lines, matrices A and B are declared:

$$A = \begin{bmatrix} 5 & -2 & -3 \\ -5 & 1 & 1 \\ 0 & 1 & 7 \end{bmatrix}, \quad B = \begin{bmatrix} 3 & 1 & 2 \\ -1 & 1 & -2 \\ 1 & 1 & 4 \end{bmatrix}.$$

In the MATLAB, dot(`.`) operators do element-wise operations. Furthermore, `A/B` is the same as `A * inv(B)`. Thus in the above operations,

$$M1 = \begin{bmatrix} 14 & 0 & 2 \\ -15 & -3 & -8 \\ 6 & 8 & 26 \end{bmatrix} \quad \text{and} \quad M2 = \begin{bmatrix} 15 & -2 & -6 \\ 5 & 1 & -2 \\ 0 & 1 & 28 \end{bmatrix},$$

$$D1 = \begin{bmatrix} 2 & -3/2 & -5/2 \\ -15/8 & 9/8 & 7/4 \\ -3/4 & -1/4 & 2 \end{bmatrix} \quad \text{and} \quad D2 = \begin{bmatrix} 5/3 & -2 & -3/2 \\ 5 & 1 & -1/2 \\ 0 & 1 & 7/4 \end{bmatrix}.$$

Then, variables $a = -60$ and $b = 5$ are easily calculated. Therefore, $a + b = -55$ will be printed.

(2) answer : (e)

(1) `hx`

(2) `meshgrid`

(3) `17 * pi / 180`

(4) `-S`

(5) `mesh` *or* `surf`