MAT 343 MATLAB LAB 1 **NAME: _Hieu Pham____**

1. **Entering matrices:** Enter the following matrices:

$$A = \begin{bmatrix} 2 & 6 \\ 3 & 9 \end{bmatrix}, \quad B = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}, \quad C = \begin{bmatrix} -5 & 5 \\ 5 & 3 \end{bmatrix}$$

% Question 1

A=[2,6;3,9]; B=[1,2;3,4]; C=[-5,5;5,3];

2. **Check some linear algebra rules:**
   (a) **Is matrix addition commutative?** Compute $A + B$ and then $B + A$. Are the results the same?
   (b) **Is matrix addition associative?** Compute $(A + B) + C$ and $A + (B + C)$ in the order prescribed. Are the results the same?
   (c) **Is multiplication with a scalar distributive?** Compute $\alpha(A + B)$ and $\alpha A + \alpha B$, taking $\alpha = 5$ and show that the results are the same.
   (d) **Is multiplication with a matrix distributive?** Compute $A(B + C)$ and compare with $AB + AC$.
   (e) **Matrices are different from scalars!**
      (i) For scalars, $ab = ac$ implies that $b = c$ if $a \neq 0$. Is that true for matrices? Check by computing AB and AC for the matrices given above.
      (ii) In general, matrix products do not commute either (unlike scalar products). Check if AB and BA give different results.

% Question 2(a)

A + B

ans =

    3   8
    6   13

B + A

ans =

    3   8
    6   13

% Yes, Matrix addition is commutative

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```
% Question 2(b)
(A+B)+C
ans =
    -2    13
    11    16
A+(B+C)
ans =
    -2    13
    11    16
% Yes, Matrix addition is associattive
% Question 2(c)
alpha = 5
alpha =
     5
alpha*(A+B)
ans =
    15    40
    30    65
(alpha*A)+(alpha*B)
ans =
    15    40
    30    65
% Yes, multiplication with a scalar is distributive
% Question 2(d)
A*(B+C)
```

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```
ans =

    40    56

    60    84

(A*B)+(A*C)

ans =

    40    56

    60    84

% Yes, multiplication with matrix is distributive

% Question 2(e)

(A*B)

ans =

    20    28

    30    42

(A*C)

ans =

    20    28

    30    42

B

B =

     1     2

     3     4

C

C =

    -5     5

     5     3
```

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% AB = AC, but B != C . Matrix differs from scalar.

% (2e.2) Matrix product commutativeness

A*B

ans =

20 28

30 42

B*A

ans =

8 24

18 54

% Matrix products are not commutative

3. **Create matrices with `zeros`, `eye`, `ones`, and `triu`:** Create the following matrices with the help of the matrix generation functions `zeros`, `eye` , `ones`, and `triu`. See the on-line help on these functions if required (i.e. `help eye`)

$$M = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}, \quad N = \begin{bmatrix} 5 & 0 & 0 \\ 0 & 5 & 0 \\ 0 & 0 & 5 \end{bmatrix}, \quad P = \begin{bmatrix} 3 & 3 \\ 3 & 3 \end{bmatrix} \quad Q = \begin{bmatrix} 1 & 1 & 1 \\ 0 & 1 & 1 \\ 0 & 0 & 1 \end{bmatrix}.$$

% Question 3

M=zeros(2,3)

M =

0 0 0

0 0 0

N=(5*eye(3))

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N =

```
     5     0     0
     0     5     0
     0     0     5
```

P=(3*ones(2))

P =

```
     3     3
     3     3
```

Q=triu(ones(3),1)

Q =

```
     0     1     1
     0     0     1
     0     0     0
```

% Not right, try again below...

Q=triu(ones(3),0)

Q =

```
     1     1     1
     0     1     1
     0     0     1
```

% Question 3 complete

4. **Create a big matrix with submatrices:** The following matrix G is created by putting matrices A, B, and C from Exercise 1, on its diagonal and inserting 2×2 zeros matrices and 2×2 identity matrices in the appropriate position. Create the matrix using submatrices A, B, C, `zeros` and `eye` (that is, you are not allowed to enter the numbers explicitly).

$$G = \begin{bmatrix} 2 & 6 & 0 & 0 & 1 & 0 \\ 3 & 9 & 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 2 & 0 & 0 \\ 0 & 0 & 3 & 4 & 0 & 0 \\ 1 & 0 & 0 & 0 & -5 & 5 \\ 0 & 1 & 0 & 0 & 5 & 3 \end{bmatrix}$$

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% Question 4

% Create a big matrix by assembling submatrices

G=[A,zeros(2),eye(2);zeros(2),B,zeros(2);eye(2),zeros(2),C]

G =

2	6	0	0	1	0
3	9	0	0	0	1
0	0	1	2	0	0
0	0	3	4	0	0
1	0	0	0	-5	5
0	1	0	0	5	3

% Question 4 complete

5. **Manipulate a matrix:** Do the following operations on matrix G created above in Problem 4.

   (a) Extract the first 4×4 submatrix from G and store it in the matrix H, that is, create a matrix

   $$H = \begin{bmatrix} 2 & 6 & 0 & 0 \\ 3 & 9 & 0 & 0 \\ 0 & 0 & 1 & 2 \\ 0 & 0 & 3 & 4 \end{bmatrix}$$

   by extracting the appropriate rows and columns from the matrix G.

   (b) Replace `G(5,5)` with 4.

   (c) What happens if you type `G(:,:)` and hit return? Do not include the output in your lab report, but include a statement describing the output in words.
   What happens if you type `G(:)` and hit return? Do not include the output in your lab report, but include a statement describing the output in words.

   (d) What do you get if you type `G(7)` and hit return? Can you explain how MATLAB got that answer? Try `G(16)` to confirm your answer.

   (e) What happens if you type `G(12,1)` and hit return?

   (f) What happens if you type `G(G>5)` and hit return? Can you explain how MATLAB got that answer? What happens if you type `G(G>5) = 100` and hit return? Can you explain how MATLAB got that answer?

   (g) Delete the last row and the third column of the matrix G.

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```
% Question 5

% 5(a) Extract the first 4x4 submatrix grom G

H=G(1:4,1:4)

H =

     2     6     0     0
     3     9     0     0
     0     0     1     2
     0     0     3     4

% 5(b)

G(5,5)=4

G =

     2     6     0     0     1     0
     3     9     0     0     0     1
     0     0     1     2     0     0
     0     0     3     4     0     0
     1     0     0     0     4     5
     0     1     0     0     5     3

% 5(c)

G(:,:)

ans =

     2     6     0     0     1     0
     3     9     0     0     0     1
     0     0     1     2     0     0
     0     0     3     4     0     0
     1     0     0     0     4     5
     0     1     0     0     5     3
```

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% Another way to display matrix G entirely

G(:);

% This command connects matrix elements from first column

% to last column in a zigzag fashion in which the tail of

% one column connects to the head of another, resulting in

% a continuous vertical display of all elements.

% 5(c) complete

G(7)

ans =

    6

% Element 7 is in column 2 of the first row. G(16) should return a 3

G(16)

ans =

    3

% 5(d) complete

G(12,1)

??? Index exceeds matrix dimensions.

% We only have 6 rows here. Row 12-Column 1 does not exist.

% 5(e) complete

G(G>5)

ans =

    6

    9

% Matlab searches each element within matrix G for anything > 5

% If found, element location is marked. The process continued

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```
% until all elements have been searched and marked. Then Matlab
% displays the findings upon completion.
G(G>5)=100
G =
     2   100     0     0     1     0
     3   100     0     0     0     1
     0     0     1     2     0     0
     0     0     3     4     0     0
     1     0     0     0     4     5
     0     1     0     0     5     3
% Same search mechanism as in the step before, except
% the matrix is updated with values given in the search command.
% 5(f) complete
G(:,3)=[];G(6,:)=[];G
G =
     2   100     0     1     0
     3   100     0     0     1
     0     0     2     0     0
     0     0     4     0     0
     1     0     0     4     5
% Delete the last row and the third column of matrix G
% 5(g) complete
```

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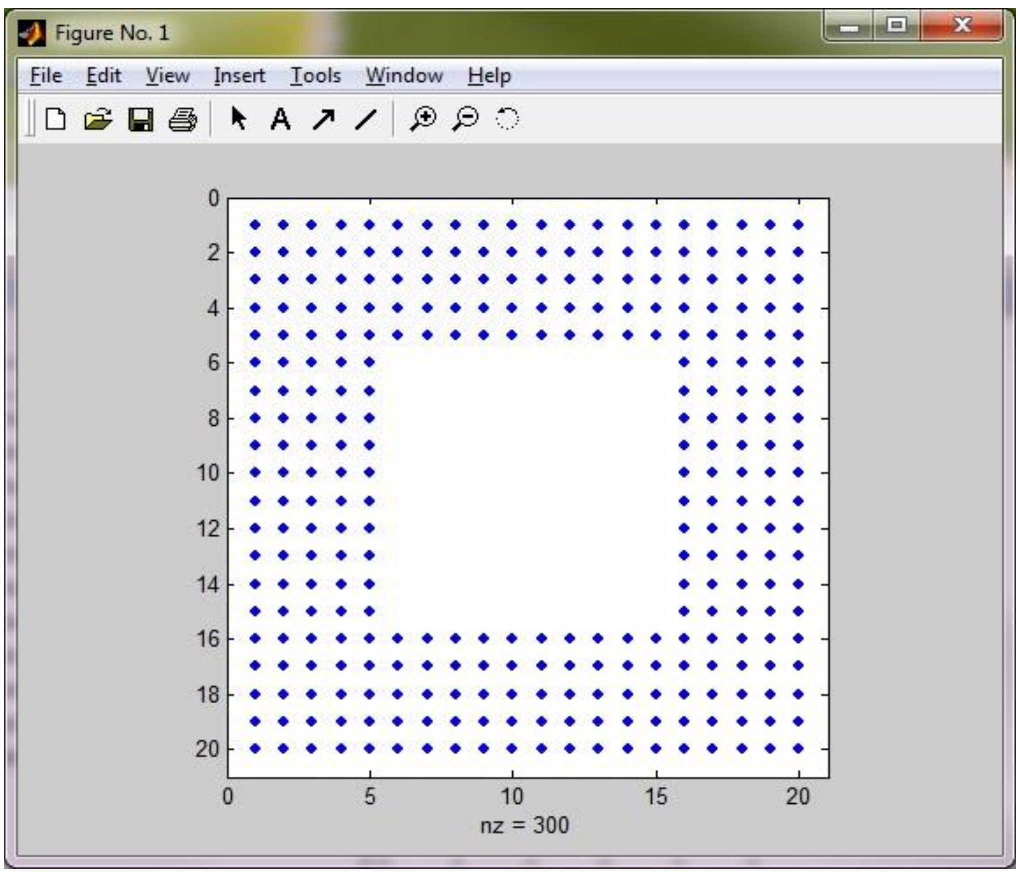
6. **See the structure of a matrix:** Create a 20×20 matrix with the command `A = ones(20);` Now replace the 10×10 submatrix between rows 6:15 and columns 6:15 with zeros. See the structure of the matrix (in terms of nonzero entries) with the command `spy(A)`.
   Set the 5×5 submatrices in the top right corner and bottom left corner to zeros and see the structure again.
   NOTE: Use semicolon to suppress the output for all the matrices in this problem. In your lab-write up include the pictures obtained with the `spy` command. To include the pictures, open your diary file using a word processor such as MS Word then, on the MATLAB figure, select "Edit" and "Copy Figure", and paste the picture into the Word file. Make sure you crop and resize the picture so that it does not take up too much space.

% Question 6

A=ones(20);

A(6:15,6:15) = zeros(10);

spy(A)



A(1:5,1:5) = zeros(5);

A(16:20,16:20) = zeros(5);

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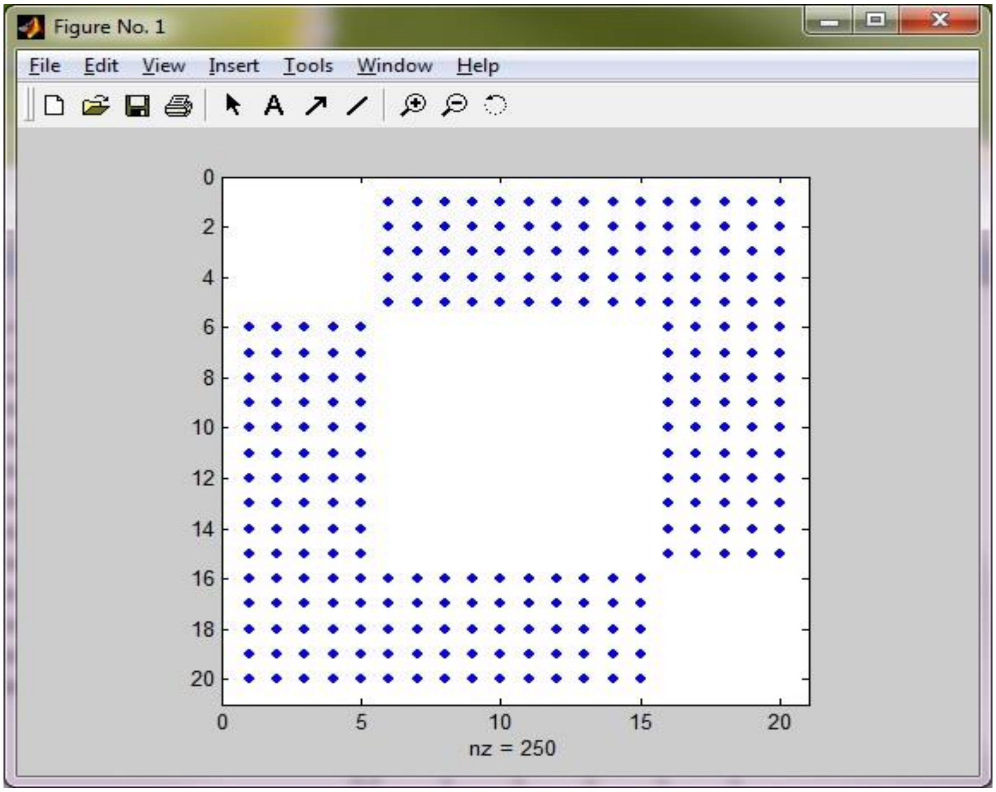
spy(A)

% Question 6 complete



7. **Create a symmetric matrix:** Create an upper triangular matrix with the following command:

```
A = diag(1:6) + diag(7:11, 1) + diag(12:15, 2)
```

Make sure you understand how this command works (see the on-line help on `diag`). Now use the upper off-diagonal terms of A to make A a symmetric matrix with the following command:

```
A = A + triu(A,1)'
```

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% Question 7

```
A=(diag(1:6) + diag(7:11,1) + diag(12:15,2))

A =

     1     7    12     0     0     0
     0     2     8    13     0     0
     0     0     3     9    14     0
     0     0     0     4    10    15
     0     0     0     0     5    11
     0     0     0     0     0     6

A=A + triu(A,1)'

A =

     1     7    12     0     0     0
     7     2     8    13     0     0
    12     8     3     9    14     0
     0    13     9     4    10    15
     0     0    14    10     5    11
     0     0     0    15    11     6
```

% Commands produced expected results.

% Question 7 complete

8. **Do some cool operations:** Create a 10×10 random matrix with the command `A = rand(10);` Now do the following operations:

   (a) Multiply all elements of A by 100 and store the result in the matrix A. Then round off all elements of the matrix to integers with the command `A = fix(A)`.

   (b) Replace all elements of A that are less than 10 with zeros (Hint: see exercise 5(f))

   (c) Replace all elements of $A > 90$ with infinity (inf)

   (d) Extract all $30 \leq a_{ij} \leq 50$ in a vector $\mathbf{b}$, that is, find all elements of A that are between 30 and 50 and put them in a vector $\mathbf{b}$. (Hint: the logical operator & (AND) may be useful).

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```
% Question 8
A=rand(10);
A=100*A;
A=fix(A)
A =
    58    20    41    21    68    45    60     8    12    23
    42    37    30    64    21     4     1    45    45    23
    51    78    87    32    83     2     1    44    71     4
    33    68     1    96    62    31    19    35    89     7
    43    46    76    72    13     1    58    15    27    64
    22    56    97    41    20    38     5    67    25    19
    57    79    99    74    60    68    36    69    86    84
    76     5    78    26    62     9    63    72    23    17
    52    60    43    43    37     3    71    47    80    17
    64     5    49    93    57    61    69    55    90    99
A(A<10)=0
A =
    58    20    41    21    68    45    60     0    12    23
    42    37    30    64    21     0     0    45    45    23
    51    78    87    32    83     0     0    44    71     0
    33    68     0    96    62    31    19    35    89     0
    43    46    76    72    13     0    58    15    27    64
    22    56    97    41    20    38     0    67    25    19
    57    79    99    74    60    68    36    69    86    84
    76     0    78    26    62     0    63    72    23    17
    52    60    43    43    37     0    71    47    80    17
```

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```
    64     0    49    93    57    61    69    55    90    99
A(A>90)=inf
A =
    58    20    41    21    68    45    60     0    12    23
    42    37    30    64    21     0     0    45    45    23
    51    78    87    32    83     0     0    44    71     0
    33    68     0   Inf    62    31    19    35    89     0
    43    46    76    72    13     0    58    15    27    64
    22    56   Inf    41    20    38     0    67    25    19
    57    79   Inf    74    60    68    36    69    86    84
    76     0    78    26    62     0    63    72    23    17
    52    60    43    43    37     0    71    47    80    17
    64     0    49   Inf    57    61    69    55    90   Inf
b=A((A>=30) & (A<=50))
b =
    42
    33
    43
    37
    46
    41
    30
    43
    49
    32
    41
```

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45

% Question 8 complete. The logical AND (&) is helpful indeed.