NJIT New Jersey's Science & Technology University

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Exam 1(345 points)

CS 101
Fall 2015
90 minutes

Name: .....

ID Number: ..... **Exam Number:** .....

Grade: 1: ... 2: ... 3: ... 4: ... 5: ... 6: ... 7: ... 8: ... 9: ... Total: .....

Solve **ALL the problems** in the space provided

Read the Problems CAREFULLY!

There are 6 (SIX) pages this page included

In the exam, the following matrices MAY be used. Do not get puzzled if a reference to matrix X, Y or Z or etc arises! No problem modifies X, Y, Z, R, S in a way that missing that problem would change the answer of any other problem of the exam.

If you are asked to evaluate a MATLAB expression, and you think the result would generate an ERROR because a variable is undefined you could write `ERROR` instead of giving an answer. For example `five == 5` generates an `ERROR` since variable `five` is never defined anywhere in the exam.

$$X = \begin{bmatrix} 2 & 1 & 2 \\ 2 & 1 & 2 \\ 1 & 0 & 1 \end{bmatrix}, Y = \begin{bmatrix} 1 & 1 & 2 \\ 2 & 1 & 1 \end{bmatrix}, Z = \begin{bmatrix} 1 & 2 & 1 & 2 \end{bmatrix}, R = \begin{bmatrix} 1 \\ 2 \\ 1 \end{bmatrix}, S = \begin{bmatrix} 1 & 2 & 3 \end{bmatrix}.$$

Problem 1. (60 POINTS)
Give short answers to the following questions.

(1) How many bytes in 2KiB?

(2) What is an 1Kib?

(3) How many bytes is a MATLAB `int32` ?

(4) How many bytes is a MATLAB `char` ?

(5) How many bytes is a MATLAB `logical`?

(6) What is the range of values for `uint8` in MATLAB? (give number of values,lowest and highest value in the range.)

(7) What is array element $Y(end-1, end-1)$?

(8) What is array element $X(end-3)$?

(9) Represent decimal (i.e. base-10) integer 40 in hexadecimal.

(10) How many bits in a byte nowadays?

(11) How much is $i * i * i * i$ in MATLAB?

(12) Represent decimal (i.e. base-10) integer 40 in 8-bit binary.

Problem 2. (30 POINTS)
What is the **value**, **Size** (i.e geometry/shape), number of **Bytes**, and the **Class** (i.e. data type) of variables `p2a,p2b,p2c,p2d,p2e,p2f`, as needed for the MATLAB program below.

```
>>  clear
>> p2a =  5 == 5 == 5;
>>  p2a
>>  whos p2a         %p2a= ............  Size ... x ...  Bytes ......   Class    .........
>> p2b =  int32(5*5-5);
>>  p2b
>>  whos p2b         %p2b= ............  Size ... x ...  Bytes ......   Class    .........
>> p2c =  5 > 5 + 5;
>>  p2c
>>  whos p2c         %p2c= ............  Size ... x ...  Bytes ......   Class    .........
>> p2d = 5&5+5;
>>  p2d
>>  whos p2d         %p2d= ............  Size ... x ...  Bytes ......   Class    .........
>> p2e = 12:-2:1;
>>  p2e
>>  whos p2e         %p2e= ............  Size ... x ...  Bytes ......   Class    .........
>> p2f =  R*S;
>>  p2f
>>  whos p2f         %p2f= ............  Size ... x ...  Bytes ......   Class    .........
```

Problem 3. (90 POINTS)
Evaluate the following MATLAB expressions.

(example) $z = ones(2)$ **Answer** $z = [1 \quad 1; 1 \quad 1]$.

```
>>  clear;
>>  p3a =  2:2:11
>>  p3a

>>  p3b =  size(Y);
>>  p3b

>>  p3c =length(Y);
>>  p3c

>>  p3d = 2*eye(3)+4*ones(3)-2;
>>  p3d

>>  p3e = sum(Y);
>>  p3e

>>  p3f = diag(Y);
>>  p3f

>>  p3g = X(1:3, 2:end);
>>  p3g

>>  p3h = X .* transpose(X);
>>  p3h

>>  p3i = diag(diag(Y));
>>  p3i
```

Problem 4. (24 POINTS)
(a) List the elements of X in column-major order/filin/form.

(b) List the elements of X in row-major order/filin/form.

Problem 5. (36 POINTS)
(a) Write MATLAB code that copies matrix X into matrix B.
Then, write MATLAB code that uses the colon operator and extracts/prints
(b) the third row of B,
(c) the second column of B, and
(d) deletes from B its first row
(e) prints X in column major form in the form of a column,
(f) that defines row vector $[1, 8, 27, 64, 125, \ldots, 1000]$ in as short a way as possible (fewer than 15 characters).

```
(a)   ......................

(b)   ......................

(c)   ......................

(d)   ......................

(e)   ......................

(f)   ......................
```

Problem 6. (36 POINTS)
What is the value of `p6a, p6b, p6c,p6d,p6e,p6f` after the execution of the following code?

```
>>  p6a=10;
>>  p6b=15;
>>  p6c=20;
>>  p6c=p6a;
>>  p6a=p6b;
>>  p6b=p6c;
>>  p6a                                  % p6a =  ................
>>  p6b                                  % p6b =  ................
>>  p6c                                  % p6c =  ................

>>  p6d=10;p6e=15; p6f=25;
>>  p6d= p6d+p6e+p6f;
>>  p6e= p6d+p6f;
>>  p6f= p6d+p6e+p6f;
>>  p6d                                  % p6d =  ................
>>  p6e                                  % p6e =  ................
>>  p6f                                  % p6f =  ................
```

Problem 7. (24 POINTS)
The sum is approximately equal to $\ln n$ up to an additive constant γ that is known as Euler's constant.

$$S(n) = 1 + \frac{1}{2} + \frac{1}{3} + \ldots + \frac{1}{n} = \sum_{k=1}^{n} \frac{1}{k} \approx \ln n + \gamma$$

We are interested in finding the value of γ. An n-term approximation of γ is $c(n)$ which is $S(n) - \ln n$.

$$c(n) = \left(1 + \frac{1}{2} + \frac{1}{3} + \ldots + \frac{1}{n}\right) - \ln n$$

Then $\lim_{n\to\infty} c(n) = \gamma$. Use the formula for $c(n)$ to compute in MATLAB an approximation to γ using array operations. Fill the lines missing or are otherwise incomplete.

```
% Compute gamma approximation to order n          Comment Line 1
n = input('Order of approximation ' );             % Line 2
a =              ;                                 % Line 3
a =              ;                                 % Line 4
a = sum(a)       ;                                 % Line 5
c = a            ;                                 % Line 6
disp(c)          ;                                 % Line 7
```

Problem 8. (30 POINTS)

(a) Use the colon operator to create row vector variable `p8a` such that

$$\text{p8a} = [25 \quad 21 \quad 17 \quad 13 \quad 9 \quad 5 \quad 1 \quad -3].$$

(b) Create a MATLAB variable `p8b` that computes using MATLAB functions the number of 2s of matrix `3*ones(400,400)+2*eye(400)-1`.

(c) Create matrix variable `p8c` such that it is a 5×5 matrix of the numbers from 1 to 25 in column major order as shown below. (You may not use more than two times the colon operator.)

$$\text{p8c} = \begin{bmatrix} 1 & 6 & \ldots & 21 \\ 2 & 7 & \ldots & 22 \\ 3 & 8 & \ldots & 23 \\ 4 & 9 & \ldots & 24 \\ 5 & 10 & \ldots & 25 \end{bmatrix}$$

Problem 9. (15 POINTS)
A matrix a is given. We want to create b from a as follows. Provide array operations to achieve this.

$$b(i,j) = \begin{cases} a(i,j) & \textbf{if } a(i,j) > 10 \\ -10 & \textbf{if } a(i,j) == 10 \\ +20 & \textbf{if } a(i,j) < 10 \end{cases}$$

```
>>          % matrix a already defined ... definition hidden
>>
>>
>>
>>
>>
```

$$X = \begin{bmatrix} 2 & 1 & 2 \\ 2 & 1 & 2 \\ 1 & 0 & 1 \end{bmatrix}, Y = \begin{bmatrix} 1 & 1 & 2 \\ 2 & 1 & 1 \end{bmatrix}, Z = \begin{bmatrix} 1 & 2 & 1 & 2 \end{bmatrix}, R = \begin{bmatrix} 1 \\ 2 \\ 1 \end{bmatrix}, S = \begin{bmatrix} 1 & 2 & 3 \end{bmatrix}.$$

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You may tear-off this last page and use it as scratch paper; do not turn IT in

End of Exam 1