Midterm Exam 1
Instructor: Prof. Raja Sengupta

March 4, 2020
25 questions, 100 points, 50 minutes
11 pages

Name: _____

Student ID: _____

Statement of Academic Integrity

UC Berkeley Honor Code: "As a member of the UC Berkeley community, I act with honesty, integrity, and respect for others."

On my honor, I will neither give nor receive any assistance in taking this exam. I will not use any program other than MATLAB on my computer and have turned off all my internet connections.

Signed: _____

Instructions

1. Write your full name and SID in the blanks above and on the top of the bubble sheet.

2. Read and sign the above statement of academic integrity.

3. Bring your Cal ID to the exam room.

4. Mark your answers on the bubble sheet (pen or pencil is fine). There is one and only one correct choice for each question. Multiple bubbles, incomplete bubbles, or stray marks will be marked incorrect.

5. You may bring notes for this exam provided they are not loose leaf.

6. Only one laptop is allowed per student and only MATLAB should be running on that computer. The use of any other program or electronic device during the exam constitutes cheating and subjects the offender to immediate dismissal from the exam.

7. Please do not get up to leave until the exam is over.

8. You will be photographed during the exam as verification of who is taking the exam.

9. At the end of the exam, hand in the completed bubble sheet AND the exam to the GSIs at the rear of the room.

   Do not open the exam book until instructed to do so.

1. If you would like to interrupt computation in an infinite loop, what would you press?

    (a) `Ctrl + C`
    (b) `Ctrl + K`
    (c) `Ctrl + Q`
    (d) `Ctrl + P`
    (e) `Ctrl + S`

2. For the following function, identify the inputs, the function name, and the outputs.

```
function [a, g, e] = ageCalc(age)
    a = age/100;
    birthYear = 2020 - age;
    g = a*10;
    e = age - (a + g);
    month = (birthYear + a + g + e)/12;
end
```

    (a) inputs: `birthYear, month`   func. name: `age`   outputs: `a, g, e`
    (b) inputs: `age`   func. name: `ageCalc`   outputs: `a, g, e`
    (c) inputs: `age`   func. name: `ageCalc`   outputs: `birthYear, month`
    (d) inputs: `birthYear, month`   func. name: `age`   outputs: `ageCalc`
    (e) inputs: `a, g, e`   func. name: `age`   outputs: `ageCalc`

3. For single precision floating point numbers, how many bits are allocated to the sign, exponent and fraction values, respectively ?

    (a) 1 , 9 , 22
    (b) 1 , 11, 52
    (c) 1 , 8 , 23
    (d) 1 , 10, 53
    (e) 1 , 7 , 24

4. What is the decimal equivalent of the following floating point number in double precision?

    `arr = [0 11111111111 0000000000000000000000000000000000000000000000000000]`

    (a) NaN
    (b) 0
    (c) ∞
    (d) ≈ 2
    (e) None of the above

5. What is the maximum stack depth when calling myFactorial(6)?

```
function F = myFactorial(x)
    if x == 1
        F = 1;
    else
        F = x*myFactorial(x-1)
    end
end
```

(a) 4

(b) 5

(c) 6

(d) 7

(e) 8

6. What is the worst case computation time (WCCT) of the following program?

```
for i = 1:n
    for j = 1:n
        for k = 1:n
        if i == j
            k = k^2;
        end
        if i == k
            j = floor(sqrt(j));
        end
        end
    end
end
```

(a) $O(n)$

(b) $O(n^2)$

(c) $O(n^3)$

(d) $O(1)$

(e) $O(nlog(n))$

7. In Big O Notation, which of the following statement(s) are true?

(a) $O(n^2 + n)$ can be written as $O(n^2)$

(b) $O(nlog(n) + n)$ can be written as $O(nlog(n))$

(c) $O(34n)$ can be written as $O(n)$

(d) $O(2^n + n^2)$ can be written as $O(2^n)$

(e) All of the above

8. You try to execute the following script `myTester.m`:

```
1 global a
2 a = 5;
3 seed = 10;
4 result = encoder(seed)
5 function y = encoder(x)
6 y = x + a;
7 end
```

However, when you run this program, you receive the following error messages:

```
Unrecognized function or variable 'a'.
Error in myTester>encoder (line 6)
y = x + a
Error in myTester (line 4)
result = encoder(seed)
```

Which of the following can resolve all errors?

(a) insert `global a;` between line 5 and line 6

(b) remove line 2

(c) remove line 1

(d) insert `y = x` between line 5 and line 6

(e) do (b) and (d)

9. Consider the following code:

```
function ratio = myRatio(input)
    m = input ;
    array = zeros(1,m);
    for m = 1:m-1
        array(m) = m + 1;
    end
    ratio = array(m)/array(m-1);
end
```

If `input` is an integer such that $input > 1$, what is the closed form expression of the output `ratio` of `myRatio(input)` ?

(a) $ratio = 0$

(b) $ratio = \frac{input+1}{input}$

(c) $ratio = \frac{input}{input-1}$

(d) $ratio = input$

(e) This function has no closed form expression!

10. This function performs a binary search on sorted arrays (increasing order).

```
function index = binarySearch(array,val)
    middle = ceil(length(array)/2);
    if array(middle) == val
        index = middle;
    elseif array(middle) < val
        index = middle + binarySearch(array(middle+1:length(array)),val);
    else
        index = binarySearch(array(1:middle-1),val);
    end
end
```

What is the worst case computation time for binarySearch where n is the length of the array?

(a) O(n)

(b) O(n^2)

(c) O(2^n)

(d) O($\frac{n}{2}$)

(e) O($log(n)$)

11. What is the worst case computation time of the following code?

```
function x = myLoop(k)
    x = 0;
    for i = 1: k
        for j = 1: k
            if i == 15
                return
            else
                x = x + i;
            end
        end
    end
end
```

(a) O(k^2)

(b) O(k)

(c) O(1)

(d) O($log(k)$)

(e) O($klog(k)$)

12. What are the outputs of the following code?

```
A = true(3); B = randi(500,3);
X = size([A;B])
Y = class([A;B])
```

(a) X = 3 6
    Y = 'logical'

(b) X = 3 3
    Y = 'logical'

(c) X = 3 6
    Y = 'double'

(d) X = 6 3
    Y = 'double'

(e) X = 6 3
    Y = 'logical'

13. Consider the following excerpt from the ASCII table:

```
Dec Char
---------
69  E
70  F
71  G
72  H
73  I
74  J
75  K
76  L
77  M
78  N
79  O
```

What is the output of the following code?

```
array = [72 69 76 76 79];
char(array)
```

(a) ans = 'HELLO'

(b) ans = HELLO

(c) ans = ['H';'E';'L';'L';'O']

(d) ans = ["H","E","L","L","O"]

(e) ans = [H,E,L,L,O]

14. Say I define functions `f` and `g`:

```
function [y] = f(x)
    if x > 2
        y = x^2-1;
    end
end

function [z] = g(x)
    z = f(x)-1;
end
```

I save the two functions in the same folder and then call `g(1)` in the command window. Why do I receive an error?

  (a) The output is NaN, which cannot be assigned to a variable.

  (b) No output is produced when function `f` is called.

  (c) The output of `f` is 0, which cannot be used as an input into `g`.

  (d) The output of `g` cannot be defined in terms of another function.

  (e) None of the above

15. How much total memory will be utilized by running the following code?

```
A = [1, 6, 5, 13];
B = [5, 2, 12, 8];
disp(sum(A.*B));
```

  (a) 8 bytes

  (b) 9 bytes

  (c) 32 bytes

  (d) 64 bytes

  (e) 72 bytes

16. Which of the following worst case computation times is the worst?

  (a) O(n)

  (b) O(n^2)

  (c) O(n^3)

  (d) O(2^n)

  (e) O($nlog(n)$)

17. Recall the `cellConcatenate` function you wrote for Lab 2. Suppose I have the following variables in memory

```
C1 =                                        C2 =
      {["Hello]}   {2x3 double}                    100
      {'World' }   {3x2 cell  }                    999
```

If I type {C1, C2} into my command window, what will the size and class of the output be?

(a) `Error using horzcat`

(b) a 1x2 cell array

(c) a 2x3 cell array

(d) a 1x2 double

(e) a 2x3 double

18. What will the value of x be after running the code below if the user inputs a 6?

```
x = input("Input a positive integer value for x.");
while x < 10 && mod(x,2) == 1
    x = x + 2;
end
```

(a) 6

(b) 7

(c) 8

(d) 10

(e) 12

19. Why would the following function result in an error when called?

```
function [y1, y2] = fcn(x1, x2, x3)
y1 = y2 + x1;
y2 = x1 + x2;
end
```

(a) `x3` is unused

(b) `y2` is used before it is defined

(c) `x1` is used repeatedly

(d) both (a) and (b)

(e) both (b) and (c)

20. The following recursive function `Aurebesh` parses a given sentence. Suppose `Ummm` is another function used to break sentences into the first word and rest of the sentence.
    For example, `'What does this do'` is parsed into `word` = `'What'` and `rest` = `'does this do'`.
    For the following program, what is the first word displayed to the screen?

```
sentence = 'What does this do'
function output = Aurebesh(sentence)
    [word,rest] = Ummm(sentence);
    if isempty (rest) == 0
        output = Aurebesh(rest);
    else
        output = word;
    end
    disp(word)
end
```

    (a) What
    (b) does
    (c) this
    (d) do
    (e) Nothing will be displayed

21. You are given the following recursive function:

```
function output = bottom_up_recursion(n)
    if n == 49
        output = 0;
    else
        output = n + bottom_up_recursion(n+1);
    end
end
```

    Which function call will return the following error message:

    Out of memory. The likely cause is an infinite recursion within the program.

    (a) `bottom_up_recursion(0)`
    (b) `bottom_up_recursion(-1)`
    (c) `bottom_up_recursion(49)`
    (d) `bottom_up_recursion(50)`
    (e) None of the above.

22. Suppose I have a function `calculator`.

```
function result = calculator(a,b)
    a = a + 5;
    b = b + 3;
    result = a + b;
end
```

What would the outputs be for the following script?

```
a = 5; b = 3;
X = calculator(3, 5)
Y = a
Z = b
```

(a) X = 8
    Y = 5
    Z = 5

(b) X = 16
    Y = 3
    Z = 5

(c) X = 16
    Y = 5
    Z = 3

(d) X = 8
    Y = 3
    Z = 5

(e) X = 16
    Y = 8
    Z = 8

23. Suppose I have a function `myCalculator`.

```
function x = myCalculator(a,b,c)
    a = int16(a);
    c = int16(c);
    x = int32((a-c)^b);
end
```

What would be the class and value of x? Hint: Type casting a floating point as an integer will round the floating point.

```
x = myCalculator(53.5, 3, 50)
```

(a) int16, 43
(b) int16, 64
(c) int32, 64
(d) int32, 43
(e) double, 42.875

24. The value 30,000 can precisely be saved using the least amount of memory as which data type?

    (a) `int8`
    (b) `uint8`
    (c) `int16`
    (d) `single`
    (e) `double`

25. Executing the following script:

    ```
    A = ["str" "ing"]
    B = ['str' 'ing']
    ```

    You will get the following:

    ```
    A = 1×2 string array
    "str"    "ing"
    B ='string'
    ```

    What are the outputs of executing following code?

    ```
    C = ["ra";"ja"]
    D = ['ra';'ja']
    ```

    (a)   C =   D =
    ```
         2×1 string array              2×2 char array
           "ra"                          'ra'
           "ja"                          'ja'
    ```

    (b)   C =   D =
    ```
         2×1 string array              1x4 char array
           "ra"                          'raja'
           "ja"
    ```

    (c)   C =   D =
    ```
         1×2 string array              2x2 char array
           "ra"     "ja"                 'ra'
                                         'ja'
    ```

    (d)   C =   D =
    ```
         1×2 string array              1x4 char array
           "ra"     "ja"                 'raja'
    ```

    (e) None of the above