

1. (10) Consider the following source code

```
a = {1, -1, 0};
b = {1, 1, 1};
c = {{}, {{1, 0, 0}, {0, 0, 1}, {0, 1, 0}}, {a, b}};
d = {a, b, b+3};
```

Write the output of each of the following:

- (a) `c[[3]].c[[2]]`
 (b) `d.c[[2]]`
 (c) `c[[3]].d[[1]]`
 (d) `d[[3]].d[[2]]`
2. (10) Given the function $f(x) = x^2e^x - .1$
- (a) Write this function in Mathematica syntax.
 (b) Write the Mathematica syntax for the first derivative of this function evaluated at $x = 3$.

3. (10) Consider this code and its output

```
a = {{1, 5, 3}, {2, 4, 6}, {7, 9, 8.}};
LUdecomposition[{{1, 5, 3}, {2, 4, 6}, {7, 9, 8}}]
Eigensystem[a]
```

```
{{{1, 5, 3}, {2, -6, 0}, {7, 13/3, -13}}, {1, 2, 3}, 1}
```

```
{{15.8893, -1.44465 + 1.67987 I, -1.44465 - 1.67987 I},
 {{0.323138, 0.469128, 0.821888},
 {0.612912, -0.195468 + 0.524126 I, -0.173672 - 0.530341 I},
 {0.612912, -0.195468 - 0.524126 I, -0.173672 + 0.530341 I}}}
```

- (a) Using the output, write the factors of $a = LU$ such that L is lower triangular and U is upper triangular (if any).
 (b) Using the output, write the real eigenvalues and their eigenvectors (if any).
4. (10) Write code to graph the function $1/x$ and its derivative on the same graph on the domain $[-2, 2]$ with the function in blue and the derivative in red.
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5. (10) Consider the following source code

```
e = 10^-5; (*error tolerance*)
left = 0.; (*left bound*)
right = 2; (*right bound*)
mid = 1; (*midpoint of bounds*)
```

```
While[mid^2 - 3 > e,
  mid = (left + right)/2;
  (*assign to mid the midpoint of the two bounds*)
  If[mid^2 - 3 > 0, mid = right,
    mid = left](*reassign right or left bound depending on sign*)
]
mid(*output answer*)
```

The program, when run, outputs “1”. This is not the desired behavior.

- (a) Assuming this program worked right, what does this program do? Describe the “correct” output.
- (b) Fix this program’s problems.
6. (10) Consider the following code

```
x = 2;
y = 3;
For[i = 1, i < 5, i++,
  x = x - i;
  y = y + i*x;
]
y
```

What is the value of y ?

7. (10) Given this list $list = \{1, -4, 2.1, -3.3, 3, 10, -2, 3\}$: write a For loop to sum all the negative elements of this list.
8. (EC) A Pythagorean triplet is a set of three natural numbers, a, b, c , for which $a^2 + b^2 = c^2$. There exists exactly one Pythagorean triplet such that $a + b + c = 1000$. Find it using nested For loops and the IntegerQ[] function (*usage*: IntegerQ[expr] returns boolean True if expr is an integer, False if not).
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1. (10) Consider the following source code:

```
a = {1, -1, {2, 3}};
b = {1, {4, 1}, 1};
c = {{}, {{1, 0, 0}, {0, 0, 1}, {0, 1, 0}}, {a, b}};
d = {a, b, b + 3};
```

Write the output of each of the following:

- (a) `b[[2]]-(c[[3,1]]-a)[[3]]`
 (b) `d[[1,3]].c[[3]][[1,3]]`
 (c) `{a[[3]][[1]], a[[3]][[2]], b[[1]]}.c[[2, 1]]`
 (d) `(d[[3]]*d[[3]])[[2]] + a[[3]]`
2. (10) Given the function $f(x, y) = x^2 - 2xy + y^2$
- (a) Write this function in Mathematica syntax.
 (b) Write the Mathematica code for the partial derivative of this function with respect to x evaluated at $(x, y) = (1, 1)$.

3. (10) Consider this code and its output

```
a = {{1, 5, 3}, {2, 4, 6}, {7, 9, 8.}};
LUdecomposition[{{7, 9, 8}, {2, 4, 6}, {1, 5, 3}}]
Eigensystem[a]
```

```
{{{1, 5, 3}, {2, -6, 0}, {7, 13/3, -13}}, {3, 2, 1}, 1}
```

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{{15.8893, -1.44465 + 1.67987 I, -1.44465 - 1.67987 I},
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- (a) Using the output, write the factors of $a = LU$ such that L is lower triangular and U is upper triangular (if any).
 (b) Using the output, write the real eigenvalues and their eigenvectors (if any).
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- (a) Assuming this program worked right, what does this program do? Describe the “correct” output.
- (b) Fix this program’s problems.
6. (10) Consider the following code

```
b = 10;
c = 0;
For[i = 1, i < 5, i++,
  a = 2 i;
  b = b - a;
  c = c + a*b;
]
c
```

What is output?

7. (10) Given the list $list = \{1, -4, 2, 5, 11, -1.5\}$: write a For loop to sum all of the positive elements of this list.
8. (EC) A Pythagorean triplet is a set of three natural numbers, a, b, c , for which $a^2 + b^2 = c^2$. There exists exactly one Pythagorean triplet such that $a + b + c = 1000$. Find it using nested For loops and the IntegerQ[] function (*usage*: IntegerQ[expr] returns boolean True if expr is an integer, False if not).
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