Part I: What will this print?

1. What will the following program print?

```
a = range(20,0,-2)

print a[::2]
```

2. What will the following program print?

```
lst = ["oh, I'm a lumberjack, and I'm okay,",
       "I sleep all night and I work all day."]

chorus =  lst + [lst[0].replace("oh, ","")                    \
                      .replace("I'm","he's")]                 \
              + [lst[1].replace("I sleep","he sleeps")        \
                      .replace("I work","he works")]

for line in chorus:
    print line[0].upper()+line[1:]
```

3. What will the following program print?

```
n = 0
for i in range(4):
    for j in range(1,4):
        n = n + 1

print n
```

4. What will the following program print?

```
a  = 12
b  = 20
va = a
vb = b

while not va==vb:
    if va<vb:
        va = va + a
    elif vb<va:
        vb = vb + b

print va
```

5. What will the following program print?

```
from numpy import *

t = arange(0.,10.)
x = t*t-25.
y = (x>0.01)*x

print sum(y)
```

6. What will the following program print?

```
from numpy import *

x = arange(-10,10,0.01)
y = sin(x)

print int(max(y))
```

Part II: Debug the program

7. Which statement is true about the following program?

```
def f(x):
    if x>0:
    y = x*x
    else:
    y = -x*x
    return y

x = -1
y = 5
print f(y)
```

(A) The program will give an error message NameError: name 'x' is not defined
(B) The program has an indentation error
(C) The program runs correctly, and prints "- 5"
(D) The program runs correctly, and prints "- 25"

8. Which statement is true about the following program?

```
for i in range(0.5,2.5,0.5):
    print i,
print
```

(A) The program will give an error message TypeError: integer expected
(B) The program has an indentation error
(C) The program runs correctly, and prints " 0.5 1.0 1.5 2.0 "
(D) The program runs correctly, and prints " 0.5 1.0 1.5 2.0 2.5 "

9. Which statement is true about the following program?

```
from numpy import *
from matplotlib.pyplot import plot,show

x = arange(-10.,10.01,0.01)
y = sin(x) + cos(x)

plot(x,y)
show()
```

(A) The program will give an error message ImportError: cannot import name plot
(B) The program will give an error message TypeError: integer expected
(C) The program has an indentation error
(D) The program will show an empty plot window
(E) The program will show a plot window with a periodic function

10. Which statement is true about the following program?

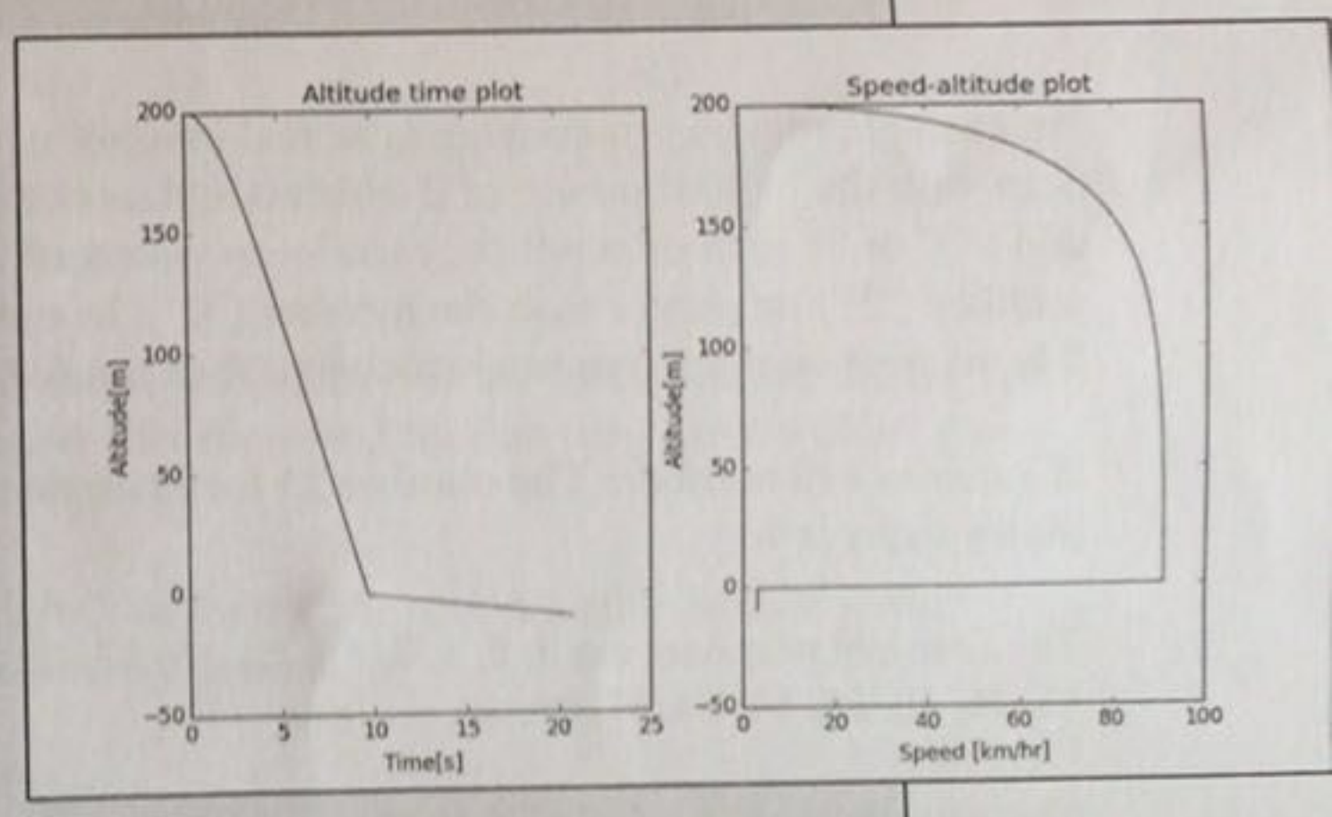
```
i = 0
j = 1

while i<10:
    i = i + j/10

print i,j
```

(A) The program will give an error message NameError: variable j not defined in loop
(B) The program has an indentation error
(C) The program will never print anything
(D) The program will print "0 10"
(E) The program will print "10 1"
(F) The program will print "10.00000001 1"

Part III: Complete the program

11. The program below simulates and plots a ball falling from 200 meters altitude. First it falls through the air and then another 10 meters through water when the altitude is below zero. This is done by increasing the density used in the drag to 1000.

```
import matplotlib.pyplot as plt

g   = 9.80665 # [m/s2]

m   = 10.0    # [kg]
rho = 1.225   # [kg/m3]
V   = 0.0     # [m/s]
h   = 200.0   # [m]
S   = 0.25    # [m2]

t   = 0.0     # [s]
dt  = 0.001   # [s]

ttab = []
htab = []
vtab = []

while ___(a)___:
    Fg = m*g

    ____(b)____:
        rho = 1000.0 # [kg/m3]

    Fd = .5*rho*V*V*S

    ay = (Fd-Fg)/m
    V = ____(c)____
    h = h + V*dt

    ttab.append(t)
    htab.append(h)
    vtab.append(3.6*abs(V))

    t = t + dt

plt.subplot(121)

plt.title("Altitude time plot")
plt.xlabel("Time[s]")
plt.ylabel("Altitude[m]")
plt.plot(___(d)___,htab)

plt.subplot(____(e)____)

plt.title("Speed-altitude plot")
plt.xlabel("Speed [km/hr]")
plt.ylabel("Altitude[m]")
plt.plot(vtab,htab)

plt.show()
```



Part IV Programming Python

12. Root finding of functions

Two functions *f(x)* and *g(x)* are given below:

$$f(x) = x^4 - 4x^3 + 3x^2 + 2x - 1$$
$$g(x) = x^4 - 3x^3 + 5x^2 - 5x - 1$$

The two real roots of the function *g(x)* are given in 5 decimals:

$$x = -0.16855$$
$$x = 1.89943$$

What are the four real roots of the other function *f(x)*? Give your answers in 4 decimals (so 4 digits after the decimal point).

13. Evil numbers

A positive number n is called evil if the sum of its binary digits is even. A binary number is a number using only 0 and 1 with the base 2. This means that 10111 is translated to decimal as follows:

$1 \times 2^0 = 1 \times 1 = 1$
$0 \times 2^1 = 0 \times 2 = 0$
$1 \times 2^2 = 1 \times 4 = 4$
$1 \times 2^3 = 1 \times 8 = 8$
$1 \times 2^4 = 1 \times 16 = 16$
=======+
23

An example of a way to convert a decimal number to binary:
Start with the highest power of 2 which is still less or equal to the number. Then from left to right add a '1' or '0' to your result for each lower power of 2 as long as this power of 2 is less than the number ("1") or greater than the number ("0"). In case of a "1" being added, subtract the power of 2 from your working number, which you then use for the next step.

What is an evil number? The number 23 for example is 10111and this is "evil" since the sum of its binary digits is 4.

The first evil numbers are 3, 5, 6, 9, 10, 12, 15, 17, 18, 20, 23, 24, 27, 29, 30, 33, 34, 36, 39, 40, 43, 45, 46, 48, 51, 53, 54, 57, 58, 60, ….. etc.

This means the sum of all evil numbers n<50 is 612.

What is the sum of all positive, evil numbers less than 1000?

14. Squared index checksum

Make a program which assigns an index to each letter, so each alphabetic character) in the following text, starting with 0 for "a" (or "A") to 25 for "z" or "Z". ignore non-alphabetic characters such as spaces, commas, exclamation marks, etc. To calculate this squared-index-checksum, the program then squares the index a and sums these squares (I know, we also do not know why it's squared, but it's what the contract says.)

So the text "**Mr. Gumby**" gives **1590**

What is this checksum for the following short text? Carefully type it into a string in your program and calculate the squared index checksum.

```
- No, no, no, my brain in my head.
- It will have to come out.
- Out? Of my head?
- Yes! All the bits of it. Nurse! Nurse! Nurse!
```

15. Take-off roll simulation of an aircraft

For an aircraft the following data are given:

Lift coefficient	C_L	= 1.45
Zero-lift drag coefficient	C_{D0}	= 0.035
Drag polar	πAe	= 23.8761
Air Density	rho	= 1.225 kg/m^3
Wing area	S	= 102 m^2
Gravity acceleration	g	= 9.80665 m/s^2
Aircraft mass	m	= 41467 kg
Take-off speed	$V_{take\text{-}off}$	= 67.00 m/s (results from mass and C_L)
Total thrust(both engines)	T	= 180 kN (2 x 90,000 N).
Friction coefficient	μ	= 0.030

We start the counter after the static friction has been overcome. So for the rolling phase, the friction coefficient is constant and given as 0.03. This means that the wheel friction drag force will be 3% of the normal force on the wheels.

Initially the normal force will be equal to the weight, but during take-off the lift increases so the weight minus the lift will be the normal force, which will get less.

So the model will consist of the following equations:

$$L = C_L \frac{1}{2} \rho V^2 S$$

$$C_D = C_{D0} + \frac{C_L^2}{\pi A e} = C_{D0} + \frac{C_L^2}{23.8761}$$

$$D_{aero} = C_D \frac{1}{2} \rho V^2 S$$

$$N = W - L$$

$$D_f = \mu N$$

$$D = D_{aero} + D_f$$

Use a time step of 1 millisecond ($dt = 0.001$) to simulate the take-off roll. Calculate the time and way travelled.

Check your simulation: It should reach 30 m/s after 7.48 seconds.

How long will it take before the aircraft takes off and what is the required runway length for that?

Give the take-off time in seconds in 4 significant digits.
Give the use runway length in meters in 3 significant digits.