**Question:**

Suppose a reactor normally contains 12 units of dissolved oxygen in a fixed volume of water. Suppose at t=0(min) a quantity of organic waste is introduced, then the oxygen concentration in the reactor can be described by:

C(t) = (12t^2 - 15t +12)/ (t^2+1)

a)Use python to find the value of t at which concentration is minimum. Search minimum concentration in time interval [0,2] with increment 0.01 min.

b) Find the time when the concentration will return back to 12 units. Display time in hours. Use |C(t)-12|<10^-3 as stopping criteria with time step 0.01 min.

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**Subject:**

* Python Programming
* Due in 15 hours 1 minute

**Reminder:** Don't copy and paste from somewhere else. Write original answers and cite sources.

**Answer:**

**The output:**

**(a).**

The minimum concentration is 4.5 at time 1.0min

**(b).**

This concentration do not repeat itself

***PLEASE REFER TO THE EXPLANATION PART FOR THE CODE AND THE DETAILED EXPLANATION.***

**Explanation:**

**(a)**

**Approach:**

* Two lists of **time and concentration** are taken to populate their value with their respective variables.
* **while loop** to populate the list which exits when time is greater than **2.** where the time variable is increasing by **0.01.** Using time variable value, the concentration is calculated using the formula and then inserted into the concentration list.
* Finding the minimum value in the concentration list and then printing the index of the time list.

**CODE: -**

def main():

#taking two list one for time and another for concenteration

time=[]

concentration = []

#intializing the concentration and time variable as one

c = 0.00

t = 0.00

#as for loop cannot iterate over the float numbers

#while loop will help to iterate the time variable till 2

while t <= 2:

#inserting time variable in the list

time.append(t)

#calculating the variable c value using formula

c = (12\*(t\*\*2) - 15\*t + 12)/((t\*\*2)+1)

#adding the concenteration variable to list

concentration.append(c)

#calculating time variable b stepping 0.01 every-time,

#to remove floating-point logical error

#round off is done at every step to decimal place 2

t = round((t + 0.01),2)

#printing time list

#print(time)

#print()

#printing concenteration list

#print(concentration)

#print()

#iterating over the range of 0 to length pf time

for i in range (0,len(time)):

#if the index of any concenteration is equal to minimum concenteration

if(min(concentration) == concentration[i]):

#concenteration of that index is print with the time at that index

print("The minimum concentration is " + str(concentration[i]) + " at time " + str(time[i]) + "min")

"""####verifying the result

print(time.index(1.0),concentration.index(min(concentration)))"""

if \_\_name\_\_ == "\_\_main\_\_":

main()

**(b)**

**Approach**

* Keeping the list and the variables same to populate the values
* This, time loop exits as per the question stopping criteria.
* **To find when the concentration is 12 back again, for that remove the first value of 12 from the concentration list and the time variable at that index.**
* **Now, using for loop to find the value 12 in the concentration list and printing the index value of the time for it. Otherwise, the concentration doesn't repeat itself for 12.**

**CODE:-**

def main():

#taking two list one for time and another for concenteration

concentration = []

time=[]

#intializing the concentration and time variable as 0

c = 0.00

t = 0.00

#running the loop till it meets the breaking condition

while True:

#inserting time variable in the list

time.append(t)

#calculating the variable c value using formula

c = (12\*(t\*\*2) - 15\*t + 12)/((t\*\*2)+1)

#adding the concenteration variable to list

concentration.append(c)

t =((t + 0.01),2)

if (abs(c - 12) < (10\*\*-3)):

break

##now removing the first element as 12 and its time

for i in range (0,len(concentration)):

if (concentration[i] == 12):

concentration.remove(12)

time.pop(i)

break

##dragging the time variable when concenteration is 12

for i in range (0,len(concentration)):

if (concentration[i] == 12):

print("At " +str(time[i]/60)+"hours concentration will be 12 again.")

else:

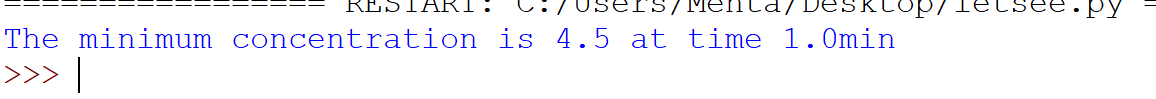
print("This concentration do not repeat itself")

if \_\_name\_\_ == "\_\_main\_\_":

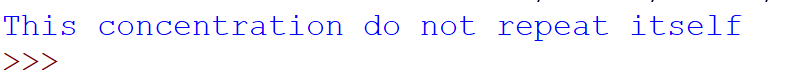
main()

**OUTPUT: -**

**(a)**

****

**(b)**

****

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* 999.PNG

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