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Numerical Computations for F.M, W&WWT Technology and Surveying using Open Source Platform

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***Abstract*—Numerical computation is essential to solve complex mathematical equations in engineering. Its application in solving real time problems in Civil Engineering and also in other branches of engineering and technology. Complex numerical calculations can be easily calculated using open source platform known as Scilab (Simlar to MAT Lab). To encourageOpen Source Education at all levelsby making use of the open source platform like Scilab.The present paper accomplishes to create awareness about the application of worldwide freely available software "Scilab (similar to MATLAB)" in numerical computation of topicslike fluid mechanics,water and sewage treatment and surveying. Scilab codes are written for three examples influid mechanics, water and sewage treatment, and surveying. These Scilab codes are executed in Scilab Cloud. Codesrewritten for certain examples in scilab. These codes can be executed in Scilab cloud.The result of the Scilab Code will be displayed instantaneously in Scilab Cloud.**

***Index Terms*— Water and Wastewater treatment (W&WWT), Fluid Mechanics (F.M), Open Source software, Numerical Calculations and Surveying.**

I. INTRODUCTION

The complex mathematical equations and design problems in different subjects of engineering involves lengthy equations and lot of calculations. This is cumbersome and time consuming. Many professional software's and free software's are available in the present era.Scilab is free and open source software used to solve complex mathematical equations. Scilab is a tool used to solve the numerical computations thus providing a powerful and favorable environment for computing engineering design and scientific applications.
Hundreds of mathematical functions are included in Scilab. The high level programming language of Scilab facilitates access to advanced data structures, 2-D and 3-D graphical functionsare.
Scilab includes following big list of functionalities:

*Maths & Simulation:*Mathematical operations and data analysis is essential in the field of engineering and science applications. Scilab provides about 1700 mathematical functions for usual engineering and science applications. It also includes mathematical operations and data analysis.

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*2-D & 3-D Visualization:*Scilab provides graphics functions to visualizing, interpretingand exportingof data is done using the graphic functions provided by Scilab and offers many ways to various types of plots and charts are created and customized in many ways offered by Scilab.

Optimization: ***C****onstrained and unconstrained continuous and discrete optimization problems are solved by the Algorithms provided by Scilab . large-scale optimization issues are fixed by Scilab*

Statistics: Tools to perform data analysis and modeling.

Control System Design & Analysis: Control system study is possible using the standard algorithms and tools provided by Scilab

Signal Processing:Visualizing, analyzing and filtering the signals in time and frequency domains tools are available in Scilab

*Application Development:*Scilab enables managing the data exchanges and native functionalities with external tools.

*Xcos - Models and simulations using hybrid dynamic systems:*Modeling mechanical systems, hydraulic circuits, control systems.Hybrid dynamical systems models are designed using the Xcos which is a graphical editor.Xcos is usefulfor designing, loading, saving, compiling and simulation of models.… (**www.scilab.org**)

Scilab Cloud (www.cloud.scilab.in)
Codes for particular example(s) written and executed online in Scilab on Cloud. After execution the outputgenerated by Scilab in Cloud can then be verified with the solved example(s) from the standard textbook. It enables to change the values of the variables and in fact, the code itself, and execute it. In addition to the given examples, one can write the codes for any problem and get the output. It facilitates copy and pasteoption. Defining new data types and operations on these data types by using awesome results from an open system designed in scilab.The National Mission on Education under the banner Information and Communication Technology (ICT) started a project known as FOSSEE. Free and Open Source Software for Science and Engineering Education (FOSSEE) with the knockarea being "open source simulation packages replace equivalent proprietary software" by mobilizing the funds from Ministry of Human Resources Development (MHRD).Indian Institute of Technology, Bombay (IITB) is the pioneer institution to start the FOSSEE Project aiming to promote open source education at all levels. Another activity supported by the FOSSEE team is the Scilab Textbook Companion (TBC). The aim of the TBC activity is solving the examples from the standard textbooks and port them to Scilab, which is useful for UG, PG and faculty of science and engineering stream.Students and faculty from various institutions of India created code in Scilab. Fossee Team of IIT Bombay developed Scilab code and port to Scilab cloud and executed solved examples of all units from standard text books written by well-known authors. Examples of 14 different units from the standard book written by G. M. Fair, J.C. Geyer, and Okun 's (1956) both for fresh water and sewage treatment, 14 different units from the book written by R. K. Bansal (2017) for study fluid mechanics and hydraulic machines and 14 different units from the book written by N.N. Basak (2014) for surveying. Codes are written for all solved examples from standard textbooks of engineering using an open source platform system such as Scilab. (http://www.scilab.in/Textbook_Companion_Project)

II. Literature Review

The SeTS (Sewage Treatment Simulation) runs under Scilab, a free commercial program from the University of Karlsruhe. SeTS is a GNU-licensed wastewater simulator. It has models for ASM1–ASM3 (Activated Sludge Models) and ADM 1 (Anaerobic Digestion Model #1). (David L. Russell, PE (2006).Bansal R. K. (2017) have addressed behavior of the fluids and consideration of pressure forces on fluids.G. M. Fair and J.C. Geyer (1956) have addressed themselves to the presentation of principles rather than practice, of methodology rather than method, and of rationality rather than rule of thumb. During the design of treatment units, they have given more impotence to structural rather than a functional part.Mark J. Hammer and Mark J. Hammer Jr. (2008) have explained the superfluous principles and contemplating practices in water treating, water distribution system, wastewater collection, water purification, sludge processing and disposal methods, advanced wastewater treatment, andrecycle water and reuse.Soli J.Arceivala and Shyam R. Asolekar (2009) have described the design of Municipal sewage plant (MSTP).wastewater reuse for irrigation and the design of effluent treatment plants. Treatment of industrial wastewater and its application for land use. Metcalf and

Eddy (2003) have given the guide lines for interpretation of irrigation water quality standards. Detailed study of sewage treatment and industrial wastewater treatment load on treatment units. (Water Reuse Association:https://wateruse.org). N. N. Basak (2014) Explained the horizontal and vertical measurements on above and below the earth surface. The topics such as chain surveying. plane table survey, Compass surveying, and determination of area of irregular shapes and boundaries. Find the quantity of earth work involved in cutting and filling for highways and railway embankments.J. O. Smith and Pete Smith (2011) have described the Decision Support Systems for environmental modelling. They have also explained the uncertainty analysis in environmental modelling. Another book in which Scilab codes for solved examples are written is on methods of Irrigation and Hydel Power Engineering (Dr.B.C. Punmia, 2009). The design irrigation methods based on United States Soil Conservation service (SCS) is described (Glenn Schwab, Delmar D. Fangmeier, et.al,1993). 3.0

III. Codes are Interpreted for Three Examples usng SCILAB with Results After Execution in SCILAB Cloud

Scilab codes are written for three examples for finding the viscus property of fluids in Fluid Mechanics, the design of sewers for water supply,swage and wastewater disposal and to determine the area between the baseline and an irregular boundary in surveying for different data, of solved and unsolvedexamples given in the standard text books. The codes are rewritten to have more clarity and to understand the methodology how to write the code for different data. The codes written in scilab executed in Scilab Cloud and the results are verified.

Example 1: Two vertical cylinders have a height of 35 cm. A smaller one rotates concentrically inside another larger cylinder. The diameter of smaller and larger cylinderis 20 cm and 20.20 respectively. A liquid of unknown viscosity is filled in the space between the two vertically placed cylinders. If atorque of 12 Nm isrequired to rotate the inner cylinder at 100 r.p.m. Compute the fluidviscosity?

// The Scilab code for the above problem is clearly mentioned below.

```
 // Chapter 1-Properties of Fluid
 // Problem 1
 //Given Data Set in the Problem (SI Units)
d=20/100
 d_outer=20.20/100
 l=35/100
T=15
N=100
 // Calculations
 u_tang=%pi*d*N/60
Area_surface=%pi*d*l
 Du=u_tang-0
 dy=(d_outer-d)/
 // We know, Shear stress=Force/Area=viscosity*(Velocity Gradient)
 // also, Torque=Force*Diameter/2.......or... Force=(Torque*2)/Diameter
 // hence, 2*Torque/(diameter*area) =Viscosity*(Vel. gradient)
visc=2*T/(d*Area_surface*du/dy)
mprintf ("The liquid Viscosity is %f poise", visc*10)
```

The result of the above Scilab Code in Scilab Cloud is below.

d = 0.2, d_outer = 0.202, l = 0.35, T = 15, N =100, u_tang =1.0471976,
Area_surface =0.2199115, du =1.0471976, dy = 0.001, visc =0.6513505

The liquid **Viscosity**is **6.513505 poise**

Example 2: Design a filtration plant to supply 230 MLD (159800 lpm) of water to a city having population of 400000 people.

//The Scilab codefor the above problem is clearly mentioned below.

```
//initialization of variables
//provide two circular mixing basins of 3m deep
P1=230 // Quantity of water to be treated in the filtration plant in million liters per day (MLD)
```

```
P2=159800 // Quantity of water to be treated in the filtration plant in liters per minutes (lpm)
W= 400000 // Total population of the city
d= 2 // detention period in minutes
V= d*P2/2 // Volume of each mixing basin in litres
V1= 26.63// Surface area of each mixing basin in sq metres
D= sqrt(V1*4/%pi)// Diameter of circular mixing basin in metres
//Provide two flocculating and reaction basins of each 3 m deep
q= 30 // detention period in minutes
q1= q*P2/2 // Volume of each basin in litres
q2= q1/1000 // Volume of each basin cubic metres
a= q2/3 // Surface area of each basin Square. Metres
    // provide two settling basins of 3 m deep, allowing 0.6 m sludge
t= 120// detention period in minutes
S1=t*P2/2 // Volume of each of settling basin in   litres
S2=S1/1000 // Volume of each of settling basin in cubic metres
S3= S2/2.4 //surface area of each of settling basin with actual depth2.4m
 // depth of settling basin(3m) minus depth of sludge (0.6)
S= P2/S3 // Rate of filtration in lpm /Sq metre
//Provide 10 filters facilitating rapid filteration
r= 80 // Assumed Rate of filtration in lpm/ Square metre
r1= 10// Rapid sand filters
    // Calculations
A= P2/(r1*r) // Surface area of each rapid sand filter in Square metre
  // Results
Printf('the dimensions of the components filtration plant with rapid filtration process and the media of filtration as sand =    % f Sq metre', A)
```

The result of the above Scilab Code in Scilab Cloud is below.

P1 =230, P2 = 159800, W =400000, d =2, V = 159800, V1 =26.63, D =5.8229176, q =30,
q1 =2397000, q2 = 2397, a =799, t = 120, S1 = 9588000, S2 =9588, S3 =3995, S =40,
r =80, r1 =10, A =199.75

the dimensionsof the components of the filtration plant with rapid filtration process and the media of filtration as sand = **199.750000** Sq. metre

Example 3: The following readings were observed from a chain line to the boundary line of an irregular shape at an interval of 10m:

Offsets at 10 m interval are: 0m, 5m,7m, 10m, 9.2m,6.4m, and 0m
find the area between the base line, the boundary line of an irregular shape and the end offsets by:
1) the mid ordinate formula, 2) Average ordinate formula, 3) Trapezoidal formula, and
4) Simpson's formula.
// The Scilab code for the above problem is clearly mentioned below.

```
clear; // Remove clear, clc from code if you want to access existing stored variable from the memory
//GIVEN
dis=10, a=0, g=0, b=5, c=7, d=10, e=9.2, f=6.4
printf("\n Mid ordinate formula")
//FINDING MID ORDINATES
h1=(a+b)/2
h2=(b+c)/2
h3=(c+d)/2
h4=(d+e)/2
h5=(e+f)/2
h6=(f+g)/2
//find area
area=dis*(h1+h2+h3+h4+h5+h6)
printf("\n required area is %0.3f square meters',area)
printf("\n average ordinate formula')
dis=10//m
```

```
p=6//no of divs
bl=dis*p//base length
no=7//no of ordinates
area2=bl*(a+b+c+d+e+f+g)/no
printf("\n required area is %0.3f square meters',area2)
printf("\n trapezoidal formula')
area3=(dis/2) *(2*(a+b+c+d+e+f+g))
printf("\n required area is  %0.3f square meters',area3)
printf("\n simpsons formula')
area4=(dis/3) *(4*(b+d+f) +2*(c+e))
printf("\n required area is  %0.3f square meters',area4)
```

The result of the above Scilab Code in Scilab Cloud is below.

dis =10, a =0, g =0, b =5, c =7, d =10, e =9.2, f =6.4

Mid ordinate formula

h1 =2.5, h2 =6, h3 =8.5, h4 =9.6, h5 =7.8, h6 =3.2

area =376.

required area is 376.000 square meters

average ordinate formula

dis = 10, p =6, bl = 60, no = 7

area2 =322.28571

required area is 322.286 square meters

trapezoidal formula

area3 = 376.

required area is 376.000 square meters

simpsons formula

area4 = 393.33333

required area is 393.333 square meters

REFERENCES

[1] http://www.uni-karlsruhe.de/~gh31/SeTS

[2] David L. Russell, PE (2006). "Practical Wastewater Treatment", Willy-Future Science Publicatio

[3] G.M.Fair, J.C. Geyer, and Okun's (1956). "Water and Wastewater Engineering", John Wiley & Sons.

[4] G. M. Fair and J.C. Geyer (1956). "Water Supply and Wastewater Disposal", John Wiley & Sons.

[5] Mark J. Hammer, Mark J. Hammer Jr (2008). "water and Wastewater Technology "PHI Learning Pvt. Ltd-.New Delhi

[6] Metcalf & Eddy (2003). "Wastewater Engineering Treatment and Reuse" Tata McGraw Hill Edtion

[7] Water Reuse Association: https://watereuse.org

[8] WCL Reports No. 17, US Water Conservation Lab, Phoenix, Arizona. "SRFR; A Computer Program for Simulating Flow in Surface Irrigation – Furrows – Basins and Borders"

[9] Free open source Software for Science and Engineering Education:(FOSSEE) (http://fossee.in)

[10] http://www.scilab.in/TextbookCompanion_Project: The Text Book Companion project (TBC).

[11] Soli J. Arceivala & Shyam R. Asolekar(2009)."Wastewater Treatment for Pollution Control and Reuse", Tata McGraw Hill Publication.

[12] J. O. Smith & Pete Smith (2011). "An Introduction to Environmental Modelling", Oxford University Press.

[13] N. Basak "Surveying and leveling"

[14] A K Arora "Surveying Volume-III"

[15] B C Punmia, A K Jain and A K Jain "Suyveying Volume-III"

[16] R K Bansal "A Text of Fluid Mechanicsand Hydraulic Machines (in S I Units)"

[17] Dr. B. C. Punmia (2009). "Irrigation and Water Power Engineering", Laxmi Publications (P) LTD.

[18] Glenn O. Schwab, Delmar D. Fangmeier, et.al(1993). "Soil and Water Conservation Engineering", JohnWiley & sons.

[19] www.scilab.org.

[20] www.cloud.scilab.in