



Uva Wellassa University of Sri Lanka
Faculty of Science & Technology
Department of Computer Science & Technology
IIT Degree Programme
Year IV Semester I



End Semester Examination – February/March 2012

CST474-3 Scientific Problem Solving with Computer Models

Instructions

Answer all questions. Each question carries equal mark.

No. of questions: Eight (08)

No. of pages: Three (03)

Time: Three hours (3 hr)

Total marks allocated: 40%

Index No:

Solve the following problems using Maxima.

1. Solve the simultaneous equations:

$$\frac{x}{8} + \frac{5}{2} = y$$

$$11 + \frac{y}{3} = 3x$$

2. You received the following experimental data

0	90
10	101
20	105
30	109
40	110
50	125
60	145
70	149
80	160
90	181
100	210

Find a mathematical formula that best describes the data.

3. The decay of voltage, V volts, across a capacitor at time t seconds is given by $V=250*\exp(-t/3)$.
- Find the voltage after 3.4s.
 - Find the time when the voltage is 150V.
 - Draw a graph showing the natural decay curve over the first 6 seconds.

4. Show that the differential equation

$$\frac{d^2y}{dx^2} - 4\frac{dy}{dx} + 4y = 0$$

is satisfied when

$$y = x e^{2x}$$

Solve the following problems using R.

5. The following ten observations, taken during the years 1970-79, are on October snow cover for Eurasia. (Snow cover is in millions of square kilometers):

year	snow.cover
1970	6.5
1971	12.0
1972	14.9
1973	10.0
1974	10.7
1975	7.9
1976	21.9
1977	12.5
1978	14.5
1979	9.2

- Enter the data into R (for example, by using "`read.table`").
 - Plot `snow.cover` versus `year`.
 - Use the `hist()` command to plot a histogram of the snow cover values.
 - Repeat (ii) and (iii) after taking logarithms of snow cover.
6. Consider the dataset `mtcars` built-in in R that contains measurements on 11 aspects of automobile design and performance for 32 automobiles (1973-74 models). Load it with the command

data(mtcars)

You can check the help file using the command **help(mtcars)**. To see all the data in the dataset, type

mtcars

To access a column from the dataset, use the syntax: **mtcars\$column_name**

- (i) Calculate the mean fuel consumption for cars with different number of cylinders (first, calculate the mean fuel consumption for cars that have 4 cylinders, then the mean fuel consumption for cars that have 6 cylinders, and then the mean fuel consumption for cars that have 8 cylinders)
 - (ii) Is there correlation between the fuel consumption and the weight of the car? Explain your answer.
7. For each of the following probability distributions, generate 100 pseudo-random variables, and plot them (each distribution on a separate graph):
- (i) The uniform distribution
 - (ii) The normal distribution
 - (iii) The Poisson distribution

(Tip: check **help(stats)**)

8. Monte Carlo integration method approximates the integral

$$I = \int_a^b g(x) dx$$

with the formula

$$\hat{I} = (b-a) \mu(g(X_i))$$

where μ – is the mean, and X_i – random variables uniformly distributed in the interval $[a,b]$.

Take $g(x) = 3x^2$, $a = 0$, $b = 10$. The integral in this case will be equal to

$$I = \int_0^{10} 3x^2 dx = 1000$$

Calculate Monte Carlo approximations for this integral, taking the number of random variables, $n = 10, 100, 1000, \dots, 10000000$, successively incrementing n ten times. Plot the graph showing the results of the approximations at different n versus n .