MTH 308: Numerical Analysis & Scientific Computing I
Department of Mathematics and Statistics
Indian Institute of Technology - Kanpur March 2, 2017

Mini Project 1

The following problem is due **Saturday, March 30** at **5:00 PM**.
Steps you should follow :

1. While submitting, all of your programs should be arranged as follows: main directory should be called MP1-ID where ID stands for your roll number. For example, if your roll number is 12345, then the directory name will be MP1-12345; if your roll number is 123456, then the directory name will be MP1-123456.

2. The directory should contain two files, (i) a function file called `orthoProjectionOnCurve.m` that implements the function to solve the problem described below and (ii) a script file named `main.m` that reads as follows:

```
% the script file for testing the code

% the curve
X = @(t) X(t); % function description for X, e.g., X = @(t) 2*cos(2*pi*t)
Y = @(t) Y(t); % function description for Y, e.g., Y = @(t) 3*sin(2*pi*t)
dXdt = @(t) X'(t); % derivative for X(t), e.g., X = @(t) -4*pi*sin(2*pi*t)
dYdt = @(t) Y'(t); % derivative for Y(t), e.g., Y = @(t) 6*pi*cos(2*pi*t)

% point to be projected
x0 = xValue; % the value for x0 goes here
y0 = yValue; % the value for y0 goes here

% desired accuracy
eps = epsValue;  % an epsilon specifying desired absolute error in the
                 % cosine of the angle made by the projection vector
                 % [X(tc)-x0, Y(tc)-yc] with the tangent line to the
                 % curve at tc, i.e., [X'(tc), Y'(tc)]

tic;
tc = orthoProjectionOnCurve(x0, y0, X, Y, dXdt, dYdt, eps);
toc;

[X(tc) Y(tc)]
```

3. Upon completion of the work, once you are ready for submission, go to the directory that contains the directory MP1-ID and compress it using following command at the

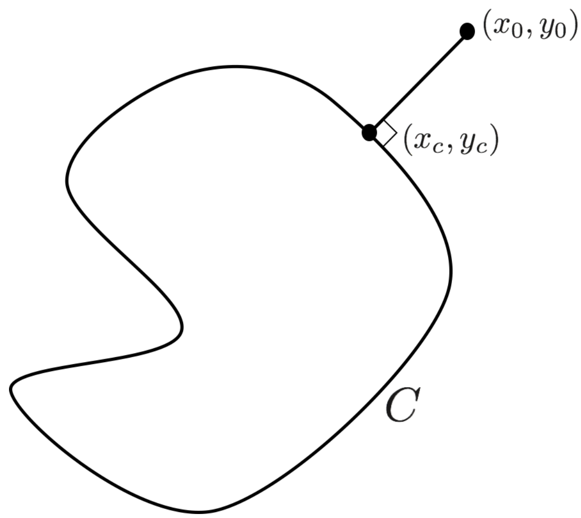
xterm/terminal command prompt

$ tar cvfz MP1-ID.tgz MP1-ID

which will create a file called MP1-ID.tgz .

4. Attach this file in an email with subject MP1-ID and send it to **mth308.iitk@gmail.com** by 5.00 pm on March 18. The supporting short report (not more than two pages) explaining your solution strategy should also be submitted by 5:00 pm in hard or soft-copy. Late submission will not get any credit.

Design and implement (in MATLAB) a numerical scheme that solves the following problem:



Given

- a *simple closed curve* C in $\mathbb{R}^2$ given by $C : [0, 1] \to \mathbb{R}^2$ such that

$$C(t) = (X(t), Y(t)), \quad 0 \le t \le 1,$$

  where $X, Y : \mathbb{R} \to \mathbb{R}$ are infinitely differentiable periodic functions with period 1 (for instance, the ellipse given by $C(t) = (2\cos(2\pi t), 3\sin(2\pi t))$ is one such curve), and

- a point $(x_0, y_0) \in \mathbb{R}^2$,

find the *closest point* (x_c, y_c) on the curve C, that is, find $t_c \in [0, 1)$ such that

$$\sqrt{(X(t_c) - x_0)^2 + (Y(t_c) - y_0)^2} = \min_{t\in[0,1]} \sqrt{(X(t) - x_0)^2 + (Y(t) - y_0)^2}.$$