UNIVERSITY OF DUBLIN

TRINITY COLLEGE

Faculty of Engineering and Systems Sciences

Department of Computer Science

SAMPLE PAPER

CS3081 Computational Mathematics

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Instructions to Candidates:

(i) A total of TWO questions should be attempted.

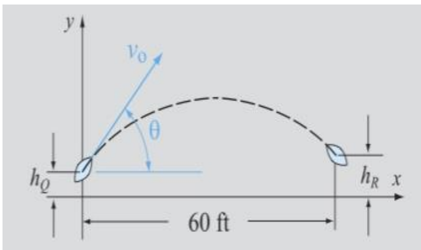
(ii) All questions carry equal marks.

Materials Permitted for this Examination:

(i) Use of non-programmable calculators and log-tables is permitted.
You must note the make and model of your calculator on your answer book.

Question 1.

A quarterback throws a pass to his wide receiver running a route. The quarterback releases the ball at a height of h_Q. The wide receiver is supposed to catch the ball straight down the field 18m away at a height of h_R.



The equation that describes the motion of the football is the familiar equation of projectile motion from physics:

$$y = x \tan\theta - \frac{1}{2}\frac{x^2 g}{v_0^2}\frac{1}{cos^2(\theta)} + h_Q$$

where x and y are the horizontal and vertical distance, respectively, $g = 9.81ms^{-2}$ is the acceleration due to gravity, v_0 is the initial velocity of the football as it leaves the quarterback's hand, and θ is the angle the football makes with the horizontal just as it leaves the quarterback's throwing hand.
For $v_0 = 15ms^{-1}$, $x = 18m$, $h_Q = 2m$, and $h_R = 2.1m$, find the angle θ at which the quarterback must launch the ball.

Write a user-defined function in MATLAB to find the solution(s) using the Bisection Method. Write out the first three iterations. Comment on your results.

[50 Marks]

Question 2.

The power generated by a windmill varies with the wind speed. In an experiment, the following five measurements were obtained:

Wind Speed (Kmph)	14	22	30	38	46
Electric Power (W)	320	490	540	500	480

Derive a general expression for the (n-1)th order Lagrange polynomial passing through n points and use it to calculate the power at a wind speed of 26 Kmph.

[50 Marks]

Question 3.

Using a four-term Taylor series expansion, derive a four-point backward difference formula for evaluating the first derivative of a function given by a set of unequally spaced points. The formula should give the derivative at point $x = x_i$, in terms of $x_i, x_{i-1}, x_{i-2}, x_{i-3}, f(x_i), f(x_{i-1}), f(x_{i-2})$ and $f(x_{i-3})$.

[50 Marks]