Lab Questions.

ASSIGNMENT - 01

LATEX 2_ε Exercises

Reproduce each example as shown. Don't worry about exact font size unless explicitly specified.

Text Exercises

Easy

1. A simple test sentence: the quick brown fox jumps over the lazy dog.
2. **Bold** and *italic* fonts may be used to add emphasis to the text. It is also possible to use sans-serif and `typewriter-style` fonts.
3. The LATEX language uses some special characters that must be preceded by a \ or they will not be printed. These include: $ & % # _ { } ~ ^
4. Leaving a blank line between sentences marks a break between paragraphs.

   A new paragraph should contain a new idea, of course.
5. It's possible
   to break the lines
   wherever you like. You can move the text
   horizontally using the \hspace* command. (The gap is 3 cm in this case.)

   You can also move the text vertically using the \vspace* command (Now the gap is 1.5cm). This only works between paragraphs.
6. Font size can be varied from tiny up to the normalsize and then up to Huge. *This is an example in which font size matters.*

Medium

1. LATEX 2_ε uses environments to perform useful functions; for example,

   center (note US spelling) environment,

   flushleft environment,

   and flushright environment.

2. Environments can also be used to make lists:
   - itemize does not number list entries
   - bullet points are used

   1. enumerate does number the entries
   2. in fact, enumerate was used to generate the example numbers on this sheet.
3. `In the verbatim environment, text will be printed directly \emph{latex commands will not be excuted}          and spaces are important.`
4. Tables can also be generated easily using environments

1.0	One
2.0	Two
3.0	Three

Tricky stuff

1. Quite tricky tables can be constructed

Famous Dead Mathematicians		
Name	Fields of Study	`Survives as`
Archimedes	Geometry, Bath water, Ways of killing Romans	A Principle, An Axiom
Euler	You name it, he studied it	An equation, A constant, A formula, A method
Gauss	integration, integers	A distribution, A theorem

2. You   can also   make beautiful patterns
   with text
   but then again

   Why ?

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Mathematics Exercises

Easy

1. Any equation can be directly inserted into text, $x^2 + 1 = 0$.
2. Longer (or taller) equations are best inserted using the equation environment

$$\int \frac{x^2+3x+1}{2x+7}\,dx. \tag{1}$$

An advantage is that your equations will be automatically numbered.

3. Traditional mathematical typesetting demands that variables are italicised and this is the default in math-mode. The \mbox or \text (part of the amsmath package) commands must be used to generate normal text. Compare

$$a = b + c \quad if b > c, \tag{2}$$

to

$$a = b + c \quad \text{if } b > c. \tag{3}$$

4. There are some special commands function names

$$\sin^2 x + \cos^2 x = 1, \quad f''(x) = \ln x.$$

5. Lots of mathematical symbols are easily accessible

$$\Upsilon \notin [1,\infty), \quad R \propto C^{\frac{1}{2}}, \text{ as } C \to \infty, \quad \sum_{k=1}^{\infty} (-1)^{k+1} \frac{1}{k^2} = \frac{\pi^2}{12}.$$

6. Vectors may be denoted using the \boldmath command; i.e. the vector, $\boldsymbol{x}$. Boldmath remains on until turned off with the \unboldmath command. Check this now $a^2 + b^k = c^k$.
7. Brackets change size automatically

$$(A+B), \text{ is smaller than } \left[\frac{A+B}{C+D}\right].$$

Medium

1. Matrices are written by combining the array environment and brackets

$$\begin{pmatrix} a & b & c \\ d & e & f \\ g & h & i \end{pmatrix}.$$

2. This structure can also be used in the following example

$$y = \begin{cases} 0 & \text{if } x > 0, \\ 1 & \text{if } x < 0, \\ \infty & \text{if x} = 0. \end{cases}$$

3. There are no automatic line breaks in equations, you must specif

$$f_{il}^{(F)} = \int\!\!\int\!\!\int \frac{\mathrm{Bo}}{\mathrm{Ca}} k_i \psi_i^{(F)}\, \mathrm{d}V + \int\!\!\int\!\!\int \left[p\frac{\partial \psi_i^{(F)}}{\partial x_i} - \left(\frac{\partial u_i}{\partial x_j} + \frac{\partial u_j}{\partial x_i}\right) \right.$$

$$- \frac{1}{\mathrm{Ca}} \oint \psi_i^{(F)} m_i \,\mathrm{ds},$$

4. It's not obvious how to generate boldsymbols in formulæ

$$\int\!\!\int\!\!\int_V \boldsymbol{\nabla . u}\, \mathrm{d}V = \int\!\!\int_\Gamma \boldsymbol{u.n}\, \mathrm{d}S,$$

but the amsmath package includes a useful command to help \bo

Tricky Stuff

1. There are some custom maths fonts, which must be included in bbm font, $x \in \mathbb{R}$. Another useful font is the caligraphic font x = people like the Fraktur font $\mathfrak{K}$.
2. Splitting brackets across lines can break the automatic sizing. Tr

$$f_{il}^{(F)} = \int\!\!\int\!\!\int \frac{\mathrm{Bo}}{\mathrm{Ca}} k_i \psi_i^{(F)}\, \mathrm{d}V - \frac{1}{\mathrm{Ca}} \oint \psi_i^{(F)} m_i \,\mathrm{ds} - \int\!\!\int p_b \psi$$

$$\frac{\partial \psi_i^{(F)}}{\partial x_i} - \left(\frac{\partial u_i}{\partial x_j} + \frac{\partial u_j}{\partial x_i}\right) \frac{\partial \psi_i^{(F)}}{\partial x_i} \Bigg] \,\mathrm{d}V$$

3. The theorem environment can be useful, but needs to be defined

Theorem 1 (The LaTeX 2_ε Law) *Backslash is the most overus*

Theorem 2 (The Computer's Law) *The* `delete` *key will be u put together.*

Assignment -3

Fourth year B. S. Honours, Session: 2019-2020

Course Title: Math Lab IV, Course No.: AMTH 450

Department of Applied Mathematics, University of Dhaka

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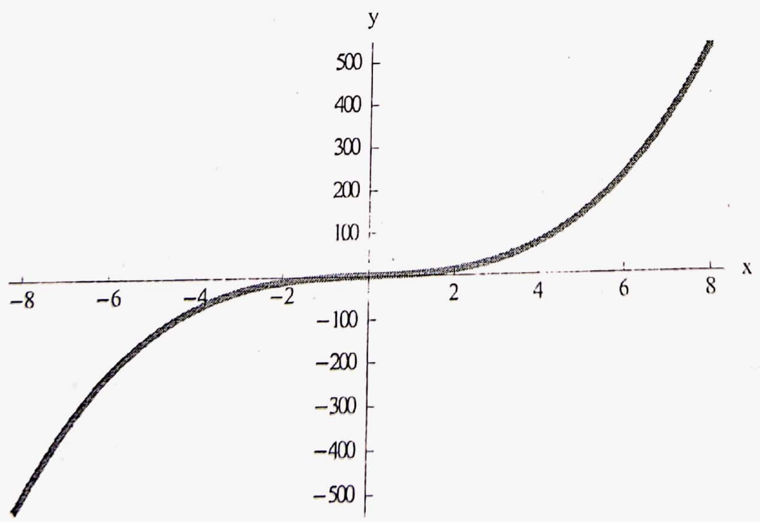
Drawing graphs using Tecplot

Instructions:

1. Generate two column data and save it in a data file.
2. Use the data file generated in Step *1* to draw the graph by *Tecplot*.
3. Try to make the plot in the desired style and shape.

Hints: Generate data for the function $f(x) = x^3 + 2x + 1$ on $[-8, 8]$ taking $\Delta x = 0.1$.

The graph of the function should have the following shape.



Date: 01/09/2019

Assignment 03

Fourth Year BS (Honors) 2018-2019

Course Title: Math Lab IV, Course Code: AMTH 450

Department of Applied Mathematics, University of Dhaka

Name: Md. Nirab Hossain **Roll No:** FH-23

No.	Problem
1.	The circular helix shown in figure-1 is represented by the parametric equations $$x = 2\cos t, \quad y = 2\sin t, \quad z = \frac{t}{2}, \quad 0 \le t \le 15.$$ Generate necessary data taking $\Delta t = .1$ and then use Tecplot to produce a 3D plot like figure-1 as exactly as possible.

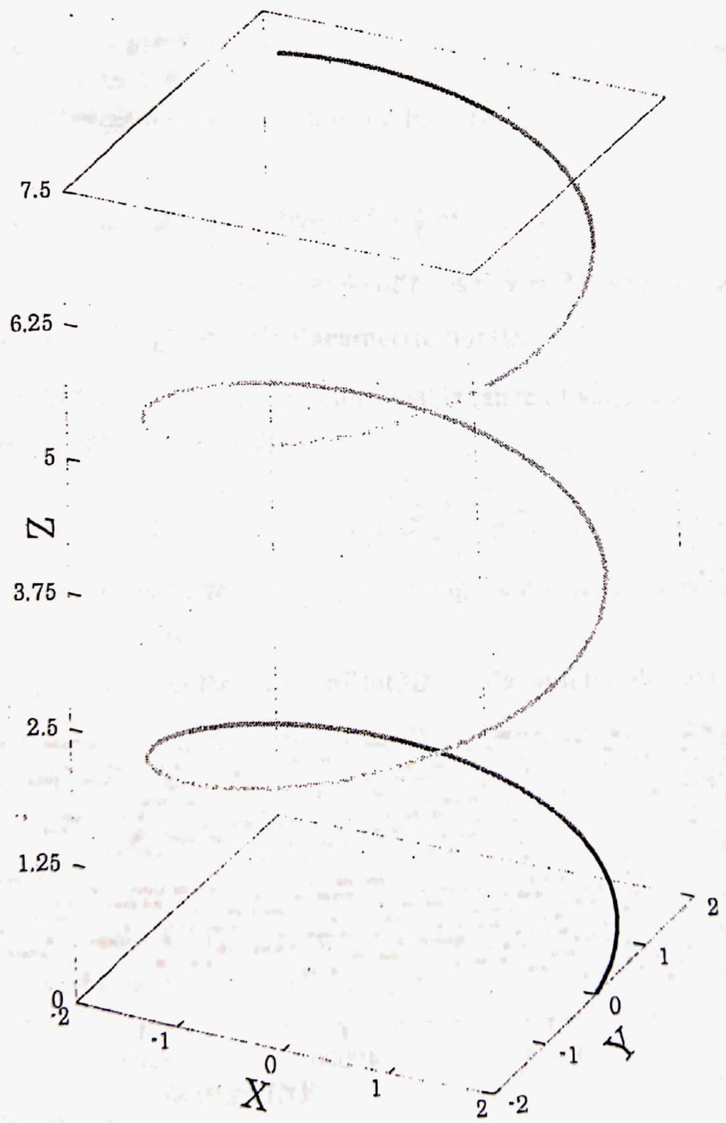


Figure-1: Circular Helix.

Date: 01/09/2019

2. For any positive integer n, the 'Halistone Sequence', denoted by $\{h_i\}$, is defined as

$$h_i = \begin{cases} n & for\ i = 0 \\ f(h_{i-1}) & for\ i > 0 \end{cases}$$

where $f(n) = \begin{cases} \frac{n}{2} & if\ \ n\ is\ even \\ 3n+1 & if\ \ n\ is\ odd. \end{cases}$

The famous 'Collatz Conjecture' states that for every positive integer n, the hailstone sequence will eventually reach 1 and the smallest is i for which $h_i = 1$ is called the *total stopping time* of n. For example, if you start with $n = 10$, the hailstone sequence is $\{10, 5, 16, 8, 4, 2, 1\}$ and the total stopping time of 10 is 6.

Generate a data file containing all the positive integers up to 100000 with their corresponding total stopping time and then use Tecplot to draw a scatter plot like figure-2 as exactly as possible. Also use the same data file to produce a **lin-log** plot.

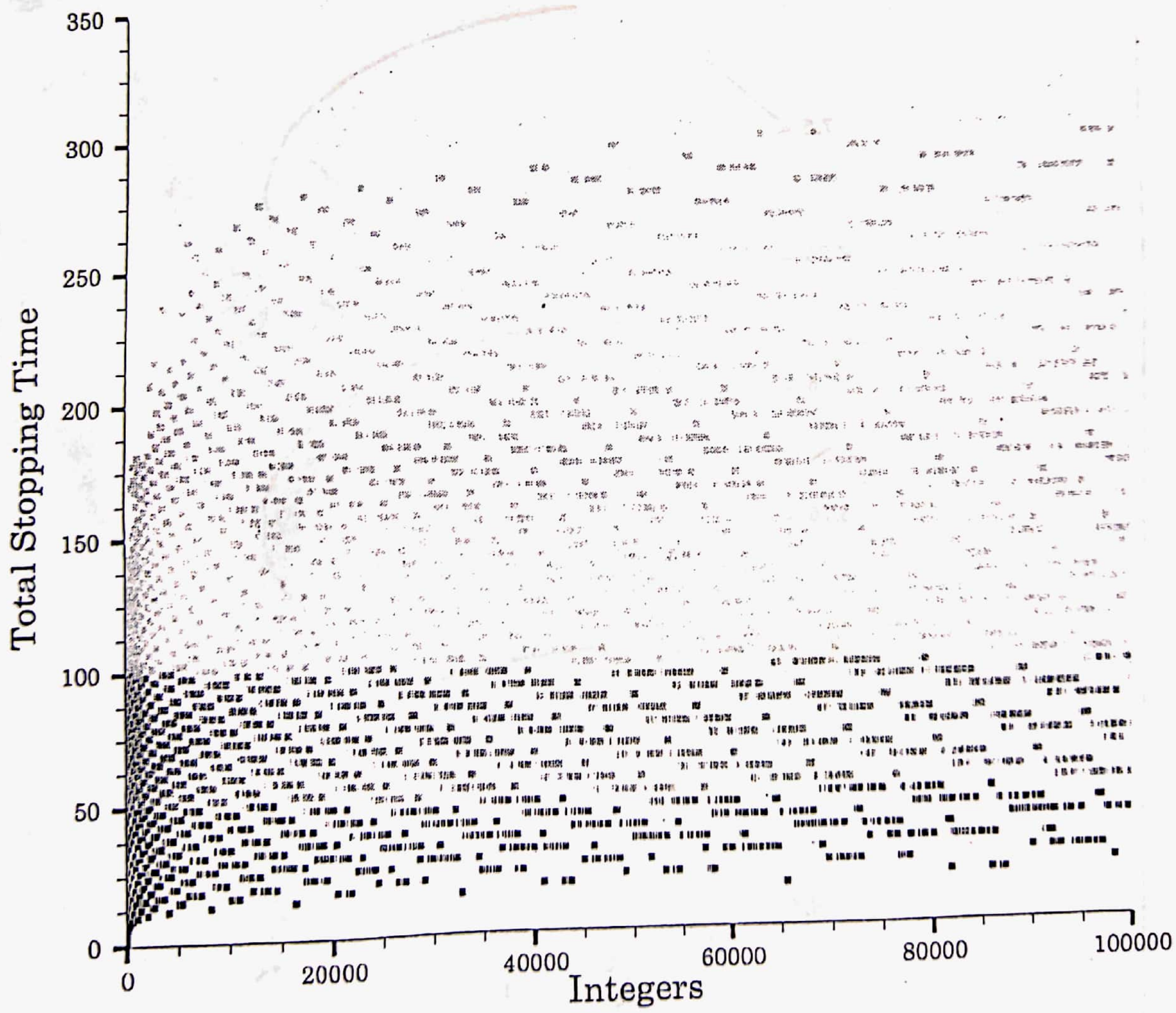


Figure-2: Scatter plot of Integers vs Total Stopping Time.

09/2019

Assignment 04

Fourth Year BS (Honors) 2018-2019

Course Title: Math Lab IV, Course Code: AMTH 450

Department of Applied Mathematics, University of Dhaka.

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1. Use **PolarPlot** and **ParametricPlot** to sketch the curve: $r = e^{\cos\theta} - 2\cos 4\theta + \sin^5\frac{\theta}{12}$, $0 \le \theta \le 24\pi$, which is known as 'butterfly'.

2. Consider the function $f(x,y) = \frac{x^2y}{x^4+4y^2}$. Draw the three dimensional figure and the level curves using **Plot3D, ContourPlot, DensityPlot** in the neighbourhood of the origin. Also try to use **Axes, PlotPoints, PlotStyle, Contours, ColorFunction** options to get a better graph.

3. The normal-form equation of the plane through P(x_0 , y_0 , z_0) with the normal vector **n** = **ai** + **bj** + **ck** is given by $\boldsymbol{n}.(\boldsymbol{r}-\boldsymbol{r}_0) = 0$, where $\boldsymbol{r} = (x,y,z), \boldsymbol{r}_0 = (x_0,y_0,z_0)$. Plot the surface passing through the point P(-2,1,3) with normal vector **n** = 3**i** + **j** + 5**k** using **Plot3D.**

4. The equation of a particular ellipsoid is given by $\frac{1}{16}x^2 + \frac{1}{4}y^2 + z^2 = 1$.
   (i) If the parametrization is given by $x = 4\cos t\cos r, y = 2\cos t\sin r, z = \sin t, -\frac{\pi}{2} \le t \le \frac{\pi}{2}, -\pi \le r \le \pi$, then draw the graph with **ParametricPlot3D.**
   (ii) Also use **ContourPlot3D** to plot the graph with suitable range of variables. Use **BoxRatios, Axes, AxesLabel, Mesh** to generate better graph.

5. Plot the function $f(x) = e^{-(x-2)^2} + e^{-(x-4)^2}$ for $0 \le x \le 6$.
   (ii) Approximate the volume of solid obtained by revolving the region bounded by the graphs $y = f(x), x = 1, x = 5$ and the x-axis.
   (iii) Plot the solid of revolution using **RevolutionPlot3D**and **ParametricPlot3D.**
   (iv) Approximate the volume of solid obtained by revolving the region bounded by the graphs $y = f(x), x = 1, x = 5$ and the y-axis.
   (v) Use **ParametricPlot3D** to generate the figure of the solid described in part (iv).

6. Calculate the volume of the solid bounded between the surfaces $z = 4x^2 + 4y^2$ and $z = 16 - 4x^2 - 4y^2$ on the rectangular domain $[-1,1] \times [-1,1]$.

7. Calculate the volume of the solid region bounded by the paraboloid $f(x,y) = 4 - x^2 - y^2$ and the xy-plane using polar coordinates.

8. Calculate the mass of the solid region W bounded between the planes $z = 1 - x - y$ and $z = 1 + x + y$ and situated over the triangular domain D bounded by $x = 0, y = 0$, and $y = 1 - x$. Assume the density of W is given by $\rho(x,y,z) = 1 + x^2 + y^2$.

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9. Let, $f(x,y) = 4(x^2 + y^2 + 1)^{-1}$. Find equations of the tangent plane and normal line to $f(x,y)$ at $\left(\frac{1}{2}, 1, f\left(\frac{1}{2}, 1\right)\right)$. Confirm your results graphically.

10. Use **Module** to define a function named '$LessPrimes(n)$' that finds all the prime numbers less than a positive integer n.

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15/09/2019

Assignment 05

Fourth Year BS (Honors) 2018-2019
Course Title: Math Lab IV, Course Code: AMTH 450
Department of Applied Mathematics, University of Dhaka.

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1.	Use **DSolve** to solve the linear first-order ODE $y'(x) = -\cos x\ y(x)$. If $C[1]$ is the constant of integration, then produce a list of particular solutions where $C[1] = i, \{i, -5, 5\}$. Plot these particular solutions on the interval $0 < x < 4\pi$. Place ticks at the points $\{0, \pi, 2\pi, 3\pi, 4\pi\}$.
2.	Solve the following nonlinear ODE for violin string $$x''(t) + \left\{\frac{1}{3}[x'(t)]^2 - 1\right\}x'(t) + x(t) = 0$$ using **DSolve** and **NDSolve.** Get some particular solutions using the following initial conditions: (i) $x(0) = 0.1, x'(0) = 0$ (ii) $x(0) = 1.0, x'(0) = 0$ (iii) $x(0) = 1.9, x'(0) = 0$ Plot the above solutions in the same figure using different colors on the interval $0 < t < 15$. Try to use the option **codecolor** as well.
3.	Suppose an oscillator has an equation of motion as $mx''(t) + kx'(t) + ax^3(t) = 0$. Set $m = 1, k = 0.3, a = 0.04, x(0) = 0$ and $x'(0) = 1,2,3,4,5$. Plot the solutions in the same figure with different colors on the interval $0 < t < 15$.
4.	Solve the Lorenz system $$x'(t) = \sigma(y - x),$$ $$y'(t) = \rho x - y - xz,$$ $$z'(t) = xy - \beta z.$$ With $\sigma = 10, \beta = \frac{8}{3}, \rho = 28$. Plot the solution for $0 < t < 50$ using a suitable initial condition.
5.	Solve the following standard predator-prey model $$x'(t) = x(\alpha - \beta y),$$ $$y'(t) = y(\delta x - \gamma),$$ Where x is the number of prey and y is the number of predator. Solve the nonlinear system with $\alpha = \frac{2}{3}, \beta = \frac{4}{3}, \gamma = 1,\ \delta = 1$. Plot the solutions with $x(0) = y(0) = 0.9\ to\ 1.5$, with stepsize 0.1. Place dots on the initial points of each solution curve.
6.	Solve the PDE: $u_{xx} = u_{tt}, t > 0, -\infty < x < \infty, u(x, 0) = 3x, u_t(x, 0) = \sin 2x$ using Laplace transform.

Assignment-6

Fourth Year BS (Honors) 2018-19

Course Title: Math Lab IV, Course No.: AMTH 450

Department of Applied Mathematics, University of Dhaka

Name: Md. Nirab Hossain **Roll No:** FH-020-023

1. Find the value of the game using MathLab Code:

$$\begin{bmatrix} -2 & 0 & 0 & 5 & 3 \\ 3 & 2 & 1 & 2 & 2 \\ -4 & -3 & 0 & -2 & 6 \\ 5 & 3 & -4 & 2 & 6 \end{bmatrix}$$

2. The transportation costs (in Tk.) are given below.

	Destination				
Source	D1	D2	D3	D4	Supply
S1	2	4	4	1 150	150
S2	10	3 100	7 100	7	200
S3	6 50	7	20 50	5 50	150
Demand	50	100	150	200	

Write a MathLab Code to find the initial basic feasible solution using

i) North West Corner Rule

ii) Least Cost Method.

3. Write a MathLab Code to find the optimal solution of the Transportation problem in Q. (2) using U-V method (MODI - Method).

4. Write a MathLab Code to solve the following Assignment Problem:

$$\begin{bmatrix} 20 & 28 & 19 & 13 \\ 15 & 30 & 31 & 28 \\ 40 & 21 & 20 & 17 \\ 21 & 28 & 26 & 12 \end{bmatrix}$$

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FH - 23

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Session: 2018 - 2019

AMTH 450 : Math Lab

Assignment : Financial Mathematics

Write programming code using MatLab/Mathematica/FORTRAN/ to get the output of the following problems:

1. A stock price is currently \$50. It is known that at the end of 6 months it will be either \$60 or \$42. The risk-free rate of interest with continuous compounding is 12% per annum. Calculate the value of a 6-month European call option on the stock with an exercise price of \$48. Verify that no-arbitrage arguments and risk-neutral valuation arguments give the same answers.
   6.2639

2. A stock price is currently \$30. During each 2-month period for the next 4 months it will increase by 8% or reduce by 10%. The risk-free interest rate is 5%. Use a two-step tree to calculate the value of a derivative that pays off $[\max(30 - S_T, 0)]^2$, where S_T is the stock price in 4 months. If the derivative is American-style, should it be exercised early?
   5.3928

3. Consider a European call option on a non-dividend-paying stock where the stock price is \$40, the strike price is \$40, the risk-free rate is 4% per annum, the volatility is 30% per annum, and the time to maturity is 6 months. $e^{\sigma\sqrt{\Delta t}}$
   (a) Calculate u, d, and p for a three-step tree.
   (b) Value the option using a three-step tree.
   (c) Finally value the option with 10, 50, 100 and 500 time steps.

4. Suppose that observations on a stock price (in dollars) at the end of each of 15 consecutive weeks are as follows:

   30.2, 32.0, 31.1, 30.1, 30.2, 30.3, 30.6, 33.0, 32.9, 33.0, 33.5, 33.5, 33.7, 33.5, 33.2

   (a) Estimate the stock price volatility.
   (b) What is the standard error of your estimate?

5. Consider the equation for geometric Brownian motion, as used to model the path of an underlying asset:

$$dS = \mu S dt + \sigma S dX \tag{1}$$

where dX is the increment of a Wiener process (drawn from a Normal distribution with mean zero and standard deviation $\sqrt{dt}$); we may then write that

$$dX \approx \phi\sqrt{dt} \tag{2}$$

where ϕ is a random variable drawn from a normalised Normal distribution. Utilising (2) and risk neutrality, (1) can be integrated exactly over a timescale δt (NOT necessarily small) to yield (see also your lecture notes)

$$S(t+\delta t) = S(t)\exp\left((r - \frac{1}{2}\sigma^2)\delta t + \sigma\phi\sqrt{\delta t}\right) \tag{3}$$

Equation (3) then generates a random path. Since δt need not be small, in the case of European options, it is possible to generate a (random) value of S at expiry ($t = T$) in just one step (i.e. $\delta t = T$). From this value (say $S(T)$), the payoff can then be easily calculated ($\max(K - S(T), 0)$ in the case of a call option). If this payoff is denoted as $\mathbf{Payoff}_i$ (for the ith simulation), then the value of this payoff at $t = 0$ is

$$P_i(t=0) = \mathbf{Payoff}_i e^{-rT} = \max\left(K - S(T), 0\right) e^{-rT} \tag{4}$$

If N simulations are performed, then we merely average out the $P_i(t=0)$ to yield an approximation for the value of the call, i.e.

$$P = \frac{\sum_{i=1}^{N} P_i(t=0)}{N} \tag{5}$$

- Use the method above to calculate the value of a European put option, with

$$S(t=0) = 5, K = 5, r = 0.04, \sigma = 0.2, T = 0.5$$

- Plot out the value of the option, with increasing N ($N = 1000, 5000, 10000, 50000$, or more!).
- Compare the values you obtain with the exact values.
- Determine how accurately the values of your call and put options satisfy the put-call parity relationship

$$P + Ke^{-rT} = C + S_0$$

  with increasing N ($N = 1000, 5000, 10000, 50000$, or more).

[*Last updated: October 31, 2019*]