The Genius of Oliver Heaviside

© Malcolm Moore
14-Dec-2003

Introduction

Back in the 1890's a brilliant English mathematician, Oliver Heaviside[1] conceived and developed what he called 'Singularity Functions[2]' and they form of the core of what we use to do computer based modelling and analysis!

On conceiving these time related simple functions, he then associated them to differential calculus and these became the core for the maths relating to "System Feedback and Control Theory" which is core to most military weapons working properly, car suspensions being comfortable, robotic control for automation of today, like the insides of the Hard Disk Drives.

It was only after he died in 1925, when they were cleaning out his house that they discovered volumes of maths notes that described these revolutionary mathematical functions, and an amazing amount more!

(*Aside: Oliver was the nephew of a very famous physicist Sir Charles Wheatstone[3]. Apart from creating these singularity functions, Oliver rewrote Maxwell's 20 electro-magnetic equations and 20 variables into four equations with two variables, so Maxwells' Equations[4] as we know them today are actually Heavisides' Equations!*

Heaviside also corrected William Preece's[5] "Telegraphers Equation[6]" by introducing the fourth (series inductance) component to the equation. This correction then created the workable foundation for mathematically analysing all telecommunication transmission media like wires, coax, stripline, waveguides, radio, optical fibres etc.

Oliver Heaviside[7] was also a brilliant Telegraphy Engineer. He applied the now useful Telegraphers Equation to ocean cables and discovered that the telegraphy signals were being excessively attenuated and distorted with distance because the series resistance component was swamping over the series inductive component.

His solution was to add "Loading" coils at regular distances (for example every 1.6 km) to correct the distortion. Tests in 1881 further upset Preece and proved that Loading worked extremely well. His term "Loading" was a pun on his surname "Heaviside"! It was not until about 1900 in the USA, that Mihajli Pupin[8] put Loading Coils into general practice (and also claimed the patent for his non-original work).

Heaviside also predicted the ionosphere (then called the Heaviside Layer) about the earth, which is extensively used for radio / satellite transmission. His work also was the forerunner foundation for Albert Einstein to develop mathematical physics into further atomic and relativity theory.)

---

[1] http://mysite.du.edu/~jcalvert/math/laplace.htm
[2] http://www.engr.sjsu.edu/kghadiri/EE112/Lecture_Notes/Singularity%20function.pdf
[3] http://highfields-arc.6te.net/biogs/cwheatstone.htm
[4] http://www.scientainment.com/max.pdf
[5] http://en.wikipedia.org/wiki/William_Henry_Preece
[6] http://www.mwjournal-digital.com/mwjournal/adpromo/?pg=112#pg112
[7] http://kom.aau.dk/~heb/kurser/NOTER/OLIVER.PDF
[8] http://en.wikipedia.org/wiki/Loading_coil

The first Heaviside function is an "Impulse Function[9]", which is like a camera flash or lightening bolt. At a specified time there is a sudden infinite pulse – then nothing! In the Stock Market these can be seen when there is a very large trade on one day, and the volume has a huge spike compared to the other small (negligible) trading volumes of the other days. This has almost no use for technical analysis.

The second is a "Step Function[10]" which is just like turning on a light, or stepping onto a stage (with one step). Before a specified time it is ***off*** and at and beyond that specified time it is ***on***. In the Stock Market we often see this when a stock suddenly changes value and stays there. The Moving Average in this case was following one price and then moves up tho the next price and converges on this now "constant price" with zero error. This has tremendous use in technical analysis.

The third is a "Ramp Function[11]" (which is the integral of the step function over time), and that is like driving a toy car along a flat floor then onto a ruler leading to a window ledge (for example). The road suddenly becomes a constant gradient hill. This function is as if the security price steadily ramps at a virtually constant rate over time. So this function also has tremendous value and use in technical analysis.

(More Aside: Each singularity function is an integral over time of the previous function and these functions can be extended / integrated to infinity, and each function can be seen as a particular 'order equation'.

Oliver, with his amazing understanding that he had of mathematics, developed groundbreaking 3D differential calculus and converged this onto algebraic multi-order equations for solving with matrices.

He also introduced the 'p' operator, which he used to solve complex differential equations and extended this into Laplace transforms[12] and Fourier transforms[13] that relate the time and frequency domains – both are used in esoteric technical stock market analysis! Most of this maths stuff is well beyond High School level.

In those days the process for university entrance was to present and read a (University Entrance) paper and if deep enough then university education would be allowed. Needless to say, when Oliver Heaviside started to read his UE (university entrance) paper it utterly confounded the Sitting Professors, and then Oliver quickly progressed / advanced from there, reading his entry paper! Love it!)

Comments and Corrections are welcome

[9] http://en.wikipedia.org/wiki/Dirac_delta_function
[10] http://en.wikipedia.org/wiki/Heaviside_step_function
[11] http://sysdyn.clexchange.org/sdep/Roadmaps/RM3/D-4571.pdf
[12] http://www.stanford.edu/~boyd/ee102/laplace-table.pdf
[13] http://www.cv.nrao.edu/course/astr534/PDFnewfiles/FourierTransforms.pdf