

Math 782: Analytic Number Theory (Instructor's Notes)*

Analytic Versus Elementary:

- **Terminology** (Analytic Number Theory makes use of Complex Analysis and Elementary Number Theory does not; but it isn't so simple to distinguish.)

- Writing an integer as a sum of two squares. This is the first of a few examples of how Complex Analysis can be used to answer a question seemingly unrelated to it: if a and b are sums of 2 squares, why must ab be also?

- Coverings. A covering of the integers is a system of congruences $x \equiv a_j \pmod{m_j}$ such that every integer satisfies at least one of these congruences. A *perfect covering* is one in which each integer satisfies exactly one of the congruences. Suppose we have a *finite* perfect covering of the integers with each modulus $m_j > 1$. Show that the largest modulus occurs twice. Use that

$$\frac{1}{1-z} = \sum_{j=1}^r \frac{z^{a_j}}{1-z^{m_j}} \quad \text{for } |z| < 1,$$

where $1 < m_1 \leq m_2 \leq \dots \leq m_r$ and $0 \leq a_j < m_j$. Suppose that $m_{r-1} \neq m_r$. Then the right-hand side, and not the left-hand side, gets large (in absolute value) as z approaches $\exp(2\pi i/m_r)$. The contradiction implies $m_{r-1} = m_r$.

- Preliminaries on exponentials. The following are useful formulas:

$$\sum_{j=0}^{n-1} e^{i(2\pi k/n)j} = \begin{cases} 0 & \text{if } k \neq 0 \\ n & \text{if } k = 0, \end{cases}$$

$$\int_0^1 e^{i2\pi k\theta} d\theta = \frac{1}{2\pi} \int_0^{2\pi} e^{ik\theta} d\theta = \begin{cases} 0 & \text{if } k \neq 0 \\ 1 & \text{if } k = 0. \end{cases}$$

- Putnam Problem A-6, 1985. If $p(x) = a_0 + a_1x + \dots + a_nx^n$ is a polynomial with real coefficients a_j , then set $\Gamma(p(x)) = a_0^2 + a_1^2 + \dots + a_n^2$. Let $f(x) = 3x^2 + 7x + 2$. Find, with proof, a polynomial $g(x)$ with real coefficients such that (i) $g(0) = 1$, and (ii) $\Gamma(f(x)^n) = \Gamma(g(x)^n)$ for all positive integers n .

There are perhaps better ways to do this problem, but we use what we just learned to establish

$$\Gamma(p(x)) = \int_0^1 p(e^{2\pi i\theta}) p(e^{-2\pi i\theta}) d\theta.$$

Note that $f(x) = (3x+1)(x+2)$. That $g(x) = 6x^2 + 5x + 1 = (3x+1)(2x+1)$ provides a solution follows from

$$\Gamma(f(x)^n) = \int_0^1 f(e^{2\pi i\theta})^n f(e^{-2\pi i\theta})^n d\theta$$

*These notes are from a course taught by Michael Filaseta in the Fall of 1996.

Abstract Analytic Number Theory

G Psacharopoulos



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the basic substructuring idea is to consider a substructure a part of the model separately and eliminate all but the degrees of freedom needed to connect this part to the rest of the model so that the substructure appears in the model as a substructure a collection of finite elements whose response is defined by the stiffness and mass o

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limitations of structural elements membrane elements cannot be used to overlay a substructure that consists of second order three dimensional brick elements of type c3d20 r h if the substructure will be used as a slave surface normally abaqus standard automatically converts c3d20 r h brick elements to elements with midface nodes c3d27 r h because this

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in abaqus standard the response within a substructure once it has been reduced to a substructure is considered to be a linear perturbation about the state of the substructure at the time it is made into a substructure

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set this parameter equal to yes default if the substructure eigenproblem needs to be solved during substructure generation in abaqus substructure eigenvectors can be used to define substructure modal damping for a given substructure abaqus standard will evaluate the stiffness associated with frequency dependent springs and dashpots at

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the purpose of this example is to provide basic demonstration and verification of the substructuring capabilities in abaqus problem description the example is a frame consisting of two columns connected by a beam figure 1 16 1 1 the columns and the beam are each modeled with 10 elements of type b21 once a substructure has been

