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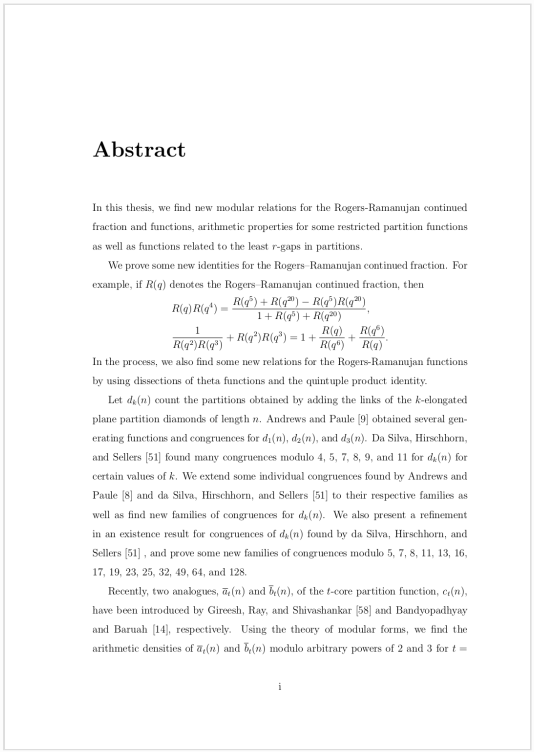

Abstract

In this thesis, we find new modular relations for the Rogers-Ramanujan continued fraction and functions, arithmetic properties for some restricted partition functions as well as functions related to the least r-gaps in partitions.

We prove some new identities for the Rogers–Ramanujan continued fraction. For example, if $R(q)$ denotes the Rogers–Ramanujan continued fraction, then

$$R(q)R(q^4) = \frac{R(q^5) + R(q^{20}) - R(q^5)R(q^{20})}{1 + R(q^5) + R(q^{20})},$$

$$\frac{1}{R(q^2)R(q^3)} + R(q^2)R(q^3) = 1 + \frac{R(q)}{R(q^6)} + \frac{R(q^6)}{R(q)}.$$

In the process, we also find some new relations for the Rogers-Ramanujan functions by using dissections of theta functions and the quintuple product identity.

Let $d_k(n)$ count the partitions obtained by adding the links of the k-elongated plane partition diamonds of length n. Andrews and Paule [9] obtained several generating functions and congruences for $d_1(n)$, $d_2(n)$, and $d_3(n)$. Da Silva, Hirschhorn, and Sellers [51] found many congruences modulo 4, 5, 7, 8, 9, and 11 for $d_k(n)$ for certain values of k. We extend some individual congruences found by Andrews and Paule [8] and da Silva, Hirschhorn, and Sellers [51] to their respective families as well as find new families of congruences for $d_k(n)$. We also present a refinement in an existence result for congruences of $d_k(n)$ found by da Silva, Hirschhorn, and Sellers [51] , and prove some new families of congruences modulo 5, 7, 8, 11, 13, 16, 17, 19, 23, 25, 32, 49, 64, and 128.

Recently, two analogues, $\overline{a}_t(n)$ and $\overline{b}_t(n)$, of the t-core partition function, $c_t(n)$, have been introduced by Gireesh, Ray, and Shivashankar [58] and Bandyopadhyay and Baruah [14], respectively. Using the theory of modular forms, we find the arithmetic densities of $\overline{a}_t(n)$ and $\overline{b}_t(n)$ modulo arbitrary powers of 2 and 3 for $t =$

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CONTRIBUTIONS TO IDENTITIES FOR THE ROGERS-RAMANUJAN CONTINUED FRACTION, ARITHMETIC PROPERTIES OF CERTAIN RESTRICTED PARTITION FUNCTIONS, AND THE LEAST r-GAPS IN PARTITIONS

by PRANJAL TALUKDAR

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