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Fourier series representations of new classes of eta quotients

The Dedekind eta function $\eta(z)$ is the holomorphic function defined on the upper half plane $\{z \in \mathbb{C} \mid \ \mathrm{Im}(z) > 0\}$ by the product formula

$$\eta(z) = e^{\pi i z/12} \prod_{n=1}^{\infty} (1 - e^{2\pi i n z}).$$

We determine Fourier series representations of new classes of etaquotients of weight 2. For example we show that

$$\frac{\eta^3(2z)\eta(4z)\eta^2(8z)}{\eta^2(z)} = \sum_{n=1}^{\infty} \Big(\sum_{m|n} \Big(\frac{8}{m}\Big) m \Big) e^{2\pi i n z},$$

where $\left(\frac{8}{m}\right)$ is the Kronecker-Jacobi symbol. We prove our results using the theory of modular forms. This is a joint work with Ayse Alaca and Saban Alaca