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**Title:** An extension of the sine addition formula on groups and semigroups

**Author(s):** Bruce Ebanks

The functional equation  $f(xy) = f(x)g(y) + g(x)f(y)$  is called the sine addition formula, and in a very general setting it is known that  $g$  must be the average of two multiplicative functions. Here we consider the case in which the two multiplicative functions coincide, but we generalize that case to a functional equation with four unknown functions. That is, assuming that  $M$  is a nonzero multiplicative function, we solve  $f(xy) = k(x)M(y) + g(x)h(y)$  for the four unknown functions  $f, g, h, k$  on groups and certain semigroups under the additional assumption that the unknown functions are at least central.

**Address:**

Bruce Ebanks  
Department of Mathematics  
University of Louisville  
Louisville, Kentucky 40292  
USA