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Tangent formulation for the band structure of one-dimensional N-period layered photonic crystals FRANK SZMULOWICZ[1], Air Force Research Laboratory — At symmetry points of the Brillouin zone, the two-layer Kronig-Penney (KP) problem has even and odd parity solutions that are expressible with tangents and cotangents. Similar solutions are derived here for an arbitrary number of layers. Namely, the eigenvalue-eigenvector problem for the energy spectra and wave functions of arbitrary, one-dimensional, N-period layered systems is formulated in terms of tangents only. The resulting equations are compact, algorithmically simple, numerically stable, and physically appealing. The derived secular equation is Hermitian and only of order N×N, i.e., half the size of the KP secular equation. The eigenfrequency condition has physically attractive geometric representation in terms of N-sided figures such as triangles and tetrahedrons for N=3. The analytic power of the formalism is demonstrated by diagonalizing the secular equation for N=3, finding a factored form of the KP equation, and deriving analytic eigenfrequency conditions and analytic wave functions for the three layer problem. The analyticity of the formalism should aid the band gap engineering of the band structure and wave functions of multilayer structures. The numerical ease of implementation is demonstrated by calculating the eigenfrequencies and wave functions for a three-layer photonic crystal.

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