is in H whenever $a, b \in H$, and $x(yH) = (xy)H$ for every $x, y \in Q$. Under these circumstances Q has an expansion in left cosets of H, and the system Q/H of left cosets is made into a left loop under a suitable definition of multiplication. The group $\mathfrak{L}$ spanned by the left multiplications (that is, the permutations $L_x(a) = ax$) of Q is introduced, and an isomorphism of Q with $\mathfrak{L}/\mathfrak{L}_0$ (where $\mathfrak{L}_0$ is the subgroup of $\mathfrak{L}$ consisting of all permutations keeping the identity E fixed) is established. It is shown that the admissible left subloops of Q are in 1:1 correspondence with the subgroups $\mathfrak{M} \supset \mathfrak{L}_0$ of $\mathfrak{L}$, and isomorphisms $H \cong \mathfrak{M}/\mathfrak{L}_0$, $Q/H \cong \mathfrak{L}/\mathfrak{M}$ are established. An extension theory is developed: given left loops H and K, a construction is given for all left loops Q such that $Q/H = K$. Necessary and sufficient conditions are given (when H is a group) that Q shall be a group, and specialization of H to be normal yields the Schreier extension theory. (Received October 20, 1944.)

12. Seymour Sherman: *Complex polynomials and polygonal domains.*

Theorems of Sturm, Routh, and Hurwitz have been generalized so as to provide a finite numerical algorithm for finding the number of such roots of a polynomial with complex coefficients as lie on a generalized polygon or linear transformation thereof. By this means a finite procedure is given for determining the number of roots of a polynomial lying in a quadrant, half-plane, circle, or circular sector. Such problems have proved of interest recently in connection with airplane flutter (S. Sherman, Jane DiPaola, and H. Frissel, *Routh's discriminant, flutter, and ground resonance*, abstract 50-7-190) and econometric business cycle analysis (P. A. Samuelson, *Conditions that the roots of a polynomial be less than unity in absolute value*, Annals of Mathematical Statistics vol. 12 (1941)). (Received October 17, 1944.)

Analysis

13. E. F. Beckenbach: *A Looman-Menchoff theorem for Newtonian vectors.*

It is shown that if the vector function $X(x, y, z)$ is continuous in the finite domain D, if except at most at the points of a denumerable set of points in D, $X(x, y, z)$ is totally differentiable in the planes parallel to the coordinate planes, and if the curl and divergence of $X(x, y, z)$ vanish almost everywhere in D, the $X(x, y, z)$ has continuous partial derivatives of all orders. (Received October 28, 1944.)

14. R. E. Fullerton: *Linear operators with range in a space of differentiable functions.*

The Banach space $C^n(0, 1)$ is defined to be the space of functions possessing n continuous derivations over the interval (0, 1) with norm $\|f\| = \text{l.u.b.}_{0 \leq t \leq 1} \text{l.u.b.}_{k \leq n} |f^{(k)}(t)|$. If $Tx = f$ is a bounded linear operator from a Banach space X to $C^n(0, 1)$, Tx is representable in the form $\bar{x}_t x$ where $\bar{x}_t$ is a function defined from (0, 1) to the space $\bar{x}$ conjugate to X. In this paper, necessary and sufficient conditions that $\bar{x}_t$ represent such an operator are found. Both bounded and completely continuous operators are investigated. Particular attention is devoted to representations of operators from sequence spaces and Lebesgue spaces to the space $C^n(0, 1)$. In all cases the expression for the norm of the operator is obtained in terms of the function $\bar{x}_t$. (Received October 20, 1944.)