

proof in all cases. The method used in FINPLT is to take each point and compare its coordinates to the point with the next larger value of the  $x$  coordinate. If both the  $x$  and  $y$  coordinates of the next point are close enough to that of the first point, then the point is accepted to be plotted on that line; if it is too far from the first point, it is left to be plotted on another line.

Clearly, the success of this method is dependent on the value of "close enough" used in the process. In FINPLT the value used is three times the maximum minus the minimum coordinate divided by the number of steps of triangular coordinate taken.

#### RESULTS AND COMPUTING TIMES

Examples of the type of results FINPLT produces may be found in [2], [3] where all of the field plots were drawn by FINPLT. Notice that the contour plots are perfectly smooth for well-behaved fields,

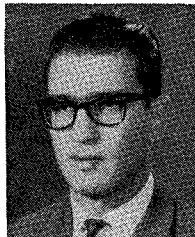
but that discontinuous changes in the derivative can occur in regions where the field changes rapidly. This is not the fault of FINPLT, but indicates that too few finite-element triangles were used to approximate the field in that region.

In order to do a typical plot, say a six fourth-order triangle problem with 30 equipotential lines, FINPLT requires about 30 s of central processing unit (CPU) time on an IBM 360/75 and about 6 min of time on a Calcomp 663 digital plotter.

#### REFERENCES

- [1] Z. Csendes and P. Silvester, "Dielectric loaded waveguide analysis program," *IEEE Trans. Microwave Theory Tech.*, vol. MTT-19, p. 789, Sept. 1971.
- [2] ———, "Numerical solution of dielectric loaded waveguides: I—Finite-element analysis," *IEEE Trans. Microwave Theory Tech. (1970 Symposium Issue)*, vol. MTT-18, pp. 1124-1131, Dec. 1970.
- [3] ———, "Numerical solution of dielectric loaded waveguides: II—Modal approximation technique," *IEEE Trans. Microwave Theory Tech.*, vol. MTT-19, pp. 504-509, June 1971.

## Contributors



**Ali E. Atia** (S'67-M'69) was born in Cairo, United Arab Republic, on August 10, 1941. He received the B.S. degree with honors from Ain Shams University, Cairo, in 1962, and the M.S. and Ph.D. degrees from the University of California, Berkeley, in 1966 and 1969, respectively, all in electrical engineering.

From 1962 to 1964 he was a Lecturer in the Department of Electrical Engineering, Ain Shams University. From 1965 to 1968 he was a Research Assistant in the Electronics Research Laboratory, University of California. From 1968 to 1969 he was a Teaching Fellow and Assistant Professor in the Department of Electrical Engineering and Computer Sciences, University of California. He is presently a Member of the Technical Staff, COMSAT Laboratories, Clarksburg, Md., where he is engaged in the development of various microwave subsystems for communication satellite transponders.

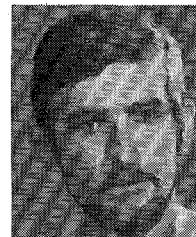


**William J. Ince** was born in London, England, in 1933. He received the B.Sc. degree with honors in physics from the University of Manchester, Manchester, England in 1955, and the S.M. and Ph.D. degrees in electrical engineering from the Massachusetts Institute of Technology, Cambridge, Mass., in 1965 and 1969, respectively.

From 1955 to 1959 he was employed by E.M.I. Electronics Ltd., Hayes, England, where he worked on infrared homing devices for guided weapons and on airborne radar display systems. From 1959 to 1960 he was with the Raytheon Co., Maynard, Mass., where he worked on transistor circuit design. Since December 1960 he has been with the Array Radars Group, M.I.T. Lincoln Laboratory,

Lexington, Mass., where he has been concerned with the design of solid-state receivers and ferrite devices. In 1969 he was appointed Assistant Professor of Electrical Engineering at M.I.T.

Dr. Ince is a fellow of the British Institute of Physics and the Physical Society.



**Jan G. Kretzschmar** was born in Oostende, Belgium, on June 24, 1942. He received the Electrical Engineering degree and the certificate for nuclear physics from the Catholic University of Leuven (K.U.L.), Leuven, Belgium, in 1965 and 1966, respectively. In 1969 he received the Doctor in applied sciences degree from the same University.

In 1970 he worked for two months with Prof. J. B. Davies, University College, London, while from September 1970 to September 1971 he was an ESRO-NASA Postdoctoral Fellow in the Department of Electrical Engineering and Computer Sciences, University of California, Berkeley. He is presently at the Catholic University of Leuven, where he has been a Research Assistant since 1965.

Dr. Kretzschmar is a member of the Koninklijke Vlaamse Ingenieursvereniging (K.V.I.V.).

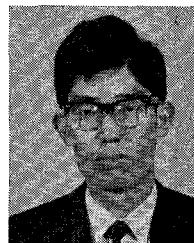


**Raj Mittra** (S'54-M'57-SM'69-F'71), for a photograph and biography please see page 197 of the February 1972 issue of this TRANSACTIONS.



**Tanroku Miyoshi** (S'67) was born in Osaka, Japan, on January 6, 1944. He received the B.S. and M.S. degrees, both in electrical engineering, in 1967 and 1969, respectively, from the University of Tokyo, Tokyo, Japan. He is presently completing the requirements for the Ph.D. degree in electrical engineering at the University of Tokyo.

His research interests are in microwave solid-state devices and microwave circuits.



search Laboratory, Central Research Laboratories. He has been engaged in the research and development of solid-state microwave devices.

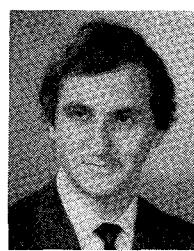
Mr. Takayama is a member of the Institute of Electronics and Communication Engineers of Japan.



**Takanori Okoshi** (S'56-M'60) was born in Tokyo, Japan, on September 16, 1932. He attended the University of Tokyo, Tokyo, Japan, and received the B.S., M.S., and Ph.D. degrees in electrical engineering, all from the University of Tokyo, in 1955, 1957, and 1960, respectively.

In 1960 he was appointed an Instructor in the Department of Electrical Engineering, University of Tokyo, and in 1961 he was transferred to the Department of Electronic Engineering of the same university, becoming an Associate Professor. At the University of Tokyo he has worked primarily in the field of microwave circuits, microwave measurements, and microwave electron devices, specializing in microwave frequency multipliers, noise phenomena in traveling-wave tubes and Gunn oscillators. From 1963 through 1964, while on a leave of absence from the University of Tokyo, he joined Bell Telephone Laboratories, Inc., Murray Hill, N. J., where he was engaged in research on electron guns. Since 1968 he has also been engaged in the research of three-dimensional imaging engineering.

Dr. Okoshi is a member of the Institute of Electronics and Communication Engineers of Japan, the Institute of Electrical Engineers of Japan, and the Japan Society of Applied Physics.



**G. N. Tsandoulas** (S'65-M'67) was born in Preveza, Greece, on August 14, 1939. He received the B.A. and B.S.E.E. degrees from Harvard University, Cambridge, Mass., in 1961 and 1963, respectively, and the Ph.D. degree from the University of Pennsylvania, Philadelphia, Pa., in 1967.

From 1963 to 1964 he was with KEL Corp., Belmont, Mass., working on the implementation of a color television scheme. In September 1967 he joined the Array Radars Group at M.I.T. Lincoln Laboratory, Lexington, Mass. His interests are in the areas of antennas and arrays, diffraction theory, propagation, and electrodynamics.

Dr. Tsandoulas is a member of AAAS.



**Erlind G. Royer** (S'69-M'69) was born in Missoula, Mont., on April 20, 1939. He received the B.S. degree from Montana State University, Bozeman, in 1961, the M.S. degree from Stanford University, Stanford, Calif., in 1962, and the Ph.D. degree from the University of Illinois, Urbana, in 1970.

He was a Tau Beta Pi-Hughes Aircraft Company Fellow from 1961 to 1962. He entered on active duty with the United States Air Force in October 1961, and has worked in the area of ballistic missile telemetry and flight evaluation. He is currently an Assistant Professor of Electrical Engineering and Program Director of the Radio Frequency Systems Laboratory at the U. S. Air Force Academy, Colorado Springs, Colo.

Dr. Royer is a member of Tau Beta Pi, Pi Mu Epsilon, and Phi Kappa Phi.

**Albert E. Williams** (S'66-M'66) was born in Albany, Australia, on March 27, 1940. He received the B.E. degree in electrical engineering from the University of Western Australia, Nedlands, Australia, in 1962, and the Ph.D. degree from University College, London, England, in August, 1966.

In 1966 he was a joint recipient of the IEE (London) Sylvanus P. Thompson Premium award.

From 1966 to 1968 he was a Lecturer in the Department of Electrical Engineering,

University of Western Australia. He is currently a Member of the Technical Staff, COMSAT Laboratories, Clarksburg, Md., where he is actively engaged in the development of mixers and lightweight filters for satellite transponders.



**Frank G. Willwerth** (M'67) was born in Cambridge, Mass., on November 11, 1944. He received the B.S. degree in electrical engineering from Tufts University, Medford, Mass., in 1966.

From 1966 to 1968 he was with Sylvania Electric Company, working in the Antenna and Microwave Laboratory, Waltham, Mass., where he was engaged in microwave integrated circuit development. In November 1968 he joined the Array Radars Group at M.I.T. Lincoln Laboratory, Lexington, Mass.

**Yoichiro Takayama** was born in Kanagawa, Japan, on January 3, 1942. He received the B.E. and M.E. degrees in electronic engineering from Osaka University, Osaka, Japan, in 1965 and 1967, respectively.

He joined the Nippon Electric Company, Ltd., Kawasaki, Japan, in 1967, and is now a Research Engineer of the Electron Device Re-