Foreword to the Special Issue on Optical Guided Wave Technology

DURING the past decade, optical guided wave technology has progressed from a laboratory endeavor to a commercial activity. With guided wave technology, one can realize greatly improved data handling and passive sensing capabilities with completely new devices such as represented by the family of sensors being developed using fiber-optical components. Building upon the substantial technological base developed in the 1970's, long, very high bandwidth unrepeatered links appear possible and will find application in long intercity links and undersea transmission cables. The componentry base already permits implementation of many practical intracity, intrabuilding, and intraplatform (e.g., aircraft, ships) links. A competitive and healthy market has been developed to service these opportunities. Just evolving is the fiber-sensor area in which magnetic, acoustic, gyro, temperature, acceleration, pressure, fluid level, flow, etc., sensors can be fabricated using optical fibers as sensing elements. While this area has not yet transitioned to commercial production, the capabilities demonstrated recently in several laboratories indicate that previously unachievable levels of sensor performance can now be realized, thus ensuring future commercial involvement.

This and the subsequent (October 1982) Special Issue on Guided Wave Technology are intended to review progress in this field via selected invited papers and to report on recent progress in componentry and subsystems. The papers presented herein provide a good cross section of the current research and development areas in optically guided waves. This Special Issue has been divided into the following five principal subsections: Optical Fiber Properties and Fabrication Techniques, Semiconductor Diode Sources, Optical Fiber Sensors, Planar Waveguides and Devices, and Transmission Links and Optical Fiber Componentry. Most of the subsections include an invited paper highlighting significant aspects of current activity in that section's category.

The invited papers in the fiber fabrication subsection present overviews of two very active areas: fiber fabrication and polarization characteristics in fibers. The first paper describes the modified chemical vapor deposition process (MCVD). Remarkable progress has been achieved in reducing fiber losses, achieving micron level dimensional tolerances, and scaling this process up to production level capacities. This paper also describes the mechanisms involved in the deposition process and gives a brief comparison of MCVD with other fabricational approaches. The second invited paper of this section describes the important principles and parameters affecting the state of polarization of light propagating in a fiber. Polarization considerations represent an important factor in the determination of the performance of coherent fiber communications systems and optical fiber sensors. This subject is also covered in two other papers in this section, thus providing the reader with substantial information in this important area.

The second section is dedicated to semiconductor diode sources. During the 1970's, the principal research activity on these devices was principally in the area of fabrication, characterization, and lifetime improvement. While work continues in these areas, the investigation of the detailed characteristics and limitations of these devices is presently a very active area. The invited paper in this section discusses device noise and distortion characteristics and indicates how they can limit the performance of fiber communication links. Additional discussion on the diode modulation characteristics, signal amplification, and spectral properties induced by optical feedback is presented in three excellent contributed papers in this section. The following Section III discusses the newly developing fiber sensor field. The invited paper on optical sensor technology is the first comprehensive overview of this field. This paper presents the levels of performance published to date and describes trends in the development. Other papers present recent results on thermal, untrasonic, strain, and electric field sensors, describe the effects of coatings on sensor performance, and detail detection and signal demodulation schemes.

The fourth section has two invited papers which illustrate the high level of sophistication achieved by Japanese researchers. The first invited paper describes fiber optical technology for undersea applications, an area of growing interest. This paper illustrates the state of development of undersea cables and repeaters, and presents the capabilities that may be realized using fiber optical technology. An excellent contributed paper on undersea fiber technology further expands on this subject and describes single-mode fiber parameters necessary to ensure optimized undersea cable performance. Several years ago single-mode optical componentry for fiber transmission lines was virtually nonexistent; today most of the componentry needed for systems implementation exist. The second invited paper describes this single-mode componentry and details its use in long-haul transmission field trials. The impressive progress reported indicates that single-mode componentry development is maturing and has practical applications. A unique use of fibers, i.e., long high-bandwidth fiber-optic delay lines is also described in this section.

The final section reports on an area which is more exploratory in nature than the previous section, i.e., planar waveguide technology. Planar guides characteristics as well as fabrication techniques are presented. Fabrication of these guides still represents an active research area as does coupling to planar structures. The advantage of planar guides is that

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they can be fabricated with electrooptically active materials. Two papers illustrating current technology in waveguide modulation are also presented.

While this Special Issue cannot cover all aspects of optical guided wave technology, it does present an accurate snapshot and illustrates well the state of the art and technological trends in guided wave optics. Continued growth with additional applications is expected. The IEEE recognizes this growth and hopes that this and subsequent special issues will provide the reader with a careful collation of works which will help foster this growth.

I would like to extend thanks to those scientists and engineers who have submitted manuscripts to this issue, thus making it possible. The work represented in this issue is truly a credit to all of the authors. I would also like to acknowledge the time and efforts so generously contributed by all of the reviewers. Finally, my deep appreciation to T. Johnson who, in addition to her regular duties, handled all of the correspondence, organized the reviewing processes, and generally performed all administrative duties required in assembling this Special Issue.

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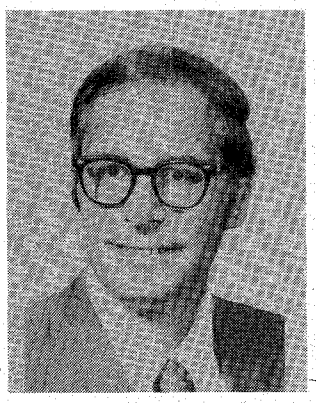
Guest Editor



Thomas G. Giallorenzi (SM'78) was born in New York, NY, on February 28, 1943. He received the B.S. and M.S. degrees in engineering physics and the Ph.D. degree in applied physics from Cornell University, Ithaca, NY, in 1965, 1966, and 1969, respectively. At Cornell University, he worked on theoretical and experimental aspects of optical parametric scattering.

From 1969 to 1970 he was with the General Telephone and Electronics Laboratories, Inc., where his research was on plasma processes in gaseous lasers and arc lamps. In November 1970 he joined the Naval Research Laboratory, Washington, DC. His research has included studies of Raman and parametric scattering, optical parametric oscillators, dye lasers, and fiber and integrated optics. From September 1977 to September 1979 he headed the Optical Techniques Branch. Since July 1979, he has headed the Optical Sciences Division which conducts research in all aspects of optical and electrooptical research. He has authored or coauthored over sixty journal publications and holds over twenty patents.

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