Annual Report on Pulsed Power Research Colloquium
Grant AFOSR-78-3675

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Pulsed Power Research Colloquium

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A Pulsed Power Lecture Series is being conducted by Texas Tech University for the U.S. Air Force. Modular instructional material for use in this lecture series is being developed. Each module is a self-consistent discussion of some aspect of pulsed power technology. The contents range from the very basic (e.g. basic EM field theory) to advanced, modern topics, such as magnetic switching. The lectures are delivered every two weeks at the Air Force Institute of Technology and the Air Force Weapons Laboratory. The speakers then provide a written text of their lecture, which is edited and published in modular form by Texas Tech University.
Tech University. It is planned to reissue these modules in report or book form at a later date. A total of about 50 modules are planned. Some 30 lecturers have been presented, to date, and about 12 modules have been issued.
ANNUAL REPORT
ON
PULSED POWER RESEARCH COLLOQUIUM

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Submitted by
Plasma and Switching Laboratory
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AIR FORCE OFFICE OF SCIENTIFIC RESEARCH (AFSC)

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M. J. KAUFMAN
Chief, Technical Information Division
SUMMARY

The program objectives of this project are: 1) to offer an up-to-date series of lectures on a fast developing, high technology area of present and future importance to the USAF, and 2) to document the basic information, theory, and technology in this field so as to provide a readily available state-of-the-art report for use by various researchers. The lectures are offered approximately every two weeks at AFIT and at AFWL and are aimed at technically trained AF personnel. A Technical Steering Committee, consisting of A.H. Guenther, AFWL; A.K. Hyder, AFOSR; R.E. Fontana, AFIT, Kip Herron, AFAPL; and M. Kristiansen, Texas Tech University, is responsible for the selection of lecture topics. A general format for the published lecture modules has been established along with an appropriate front cover. These lecture modules will later be published in report form. So far, over 30 lectures have been presented and some 12 lecture modules have been printed. Efforts are presently being made to obtain copyright releases from all the authors, with the intent to publish all or part of the material in book form. An offer has also been received to translate and publish the material in Japanese. The attached reprint of a paper presented at the 3rd IEEE International Pulsed Power Conference in June, 1981 describes the program and lists the various lecture topics and speakers along with some planned lecture topics.
MODULAR INSTRUCTIONAL MATERIAL IN PULSED POWER TECHNOLOGY*

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Abstract

A Pulsed Power Lecture Series is being conducted by Texas Tech University for the U.S. Air Force. Modular instructional material for use in this lecture series is being developed. Each module is a self-consistent discussion of some aspect of pulsed power technology. The contents range from the very basic (e.g., basic EM field theory) to advanced, modern topics, such as magnetic switching. The lectures are delivered every two weeks at the Air Force Institute of Technology and the Air Force Weapons Laboratory. The speakers then provide a written text of their lecture, which is edited and published in modular form by Texas Tech University. It is planned to reissue these modules in report or book form at a later date. A total of about 50 modules are planned. Some 30 lectures have been presented, to date, and about 12 modules have been issued. The structure of the program and the use of these modules for teaching graduate and undergraduate courses in pulsed power engineering is discussed.

Introduction

The recent rapid development of pulsed power technology and education has suffered from the lack of modern educational material, such as text books or even organized reference material. With support from the USAF, we have taken steps to remedy both these shortcomings. The organization of a computerized pulsed power reference source is described in a separate paper at this conference. In this paper we describe the development of modular instructional material in pulsed power technology.

Module Development

The Department of Electrical Engineering at Texas Tech University has, for the last year, organized a pulsed power lecture series for the USAF. The lectures are offered every other week at the Air Force Institute of Technology at Wright-Patterson Air Force Base in Dayton, Ohio and at the Air Force Weapons Laboratory at Kirtland Air Force Base in Albuquerque, New Mexico. Each lecture lasts for approximately 2 1/2 hours and is tutorial in nature. The lecture topics range from the fundamental to the advanced level (e.g., Basic EM Field Theory or Opening Switch Technology). All lectures so far have been unclassified but it is possible that some future lectures may contain classified material. The lecturers are chosen for their expertise in the lecture topic and come from universities, industry, and national laboratories, and in some special cases from foreign laboratories. Each lecturer prepares a written module covering his lecture topic. These modules are edited and published by Texas Tech University. It is intended that suitable collections of these modules will be republished in report or book form. Many of the modules are presently in use in the undergraduate and graduate pulsed power engineering courses at TTU. The main lecture topics and the lecturers to date are listed below. Beyond the current 35 scheduled topics, more than 15 additional topics are envisioned, as shown. Many of the lecture attendees, especially at the AFRL, are receiving Continuing Education Units (CEU) from TTU.

1. "Introduction to Pulsed Power"
   A.H. Guenther - Air Force Weapons Laboratory

2. "Some Basic Concepts and Fundamentals of H.V. Generators"
   M. Kristiansen - Texas Tech University

3. "Basic Electromagnetic Field Theory"
   M. Kristiansen - Texas Tech University

4. "Circuit and Transmission Line Theory"
   M.O. Hagler - Texas Tech University

5. "Electric and Magnetic Properties of Materials"
   E.E. Kunhardt - Texas Tech University

* AFSOR, AFRL, and AFWL supported.
** The only reasonable text material is "Pulse Generators", Edited by G.K. Glasso and J.V. Lebacqz, McGraw Hill Book Co. and Dover Publications, Inc., which is over 30 years old! In addition, Dr. J. Sarjeant of LANL is preparing the collection of a set of notes for a handbook on Pulse Power Conditioning.
Diodes, Electron Beams and Bremstrahlung
R.K. Parker and C.A. Kapetanakos - Naval Research Laboratory

Prime Power
F.C. Brockhurst - Air Force Institute of Technology

Mechanical Energy Storage and Electromechanical Energy
W. Weldon - The University of Texas at Austin

Principal Features in Large Capacitor Banks
E.L. Karp - Los Alamos National Laboratory

Energy Storage Capacitors
W.J. Serjeant - Los Alamos National Laboratory

Marx Generators
T.H. Martin - Sandia National Laboratories

Other Voltage Multiplier Scheme Variants
R. Prestwich - Sandia National Laboratories

Inductive Energy Storage
F. Turchi - R&D Associates

Explosive Generators
W. Cowan - Sandia National Laboratories

Chemical Energy Storage
V.S. Bishop - AF Wright Aeronautical Laboratories

Pulsed MHD Generators
C. Bangerter - STD Research Corporation

Power Conditioning
C.K. Simmons - Raytheon Company

Transformers
J. O'Loughlin - Air Force Weapons Laboratory

Power Flow Through Interfaces
V.P. Vandewater - Sandia National Laboratories

Pulse Forming Networks
R. Butcher - Los Alamos National Laboratory

Gas Breakdown
E.E. Kunhardt - Texas Tech University

Vacuum Switching
A.S. Gilmour - State University of N.Y./Buffalo

Solid State Switching
W.N. Portnoy - Texas Tech University

Thyratrons
D. Turnquist - E G & G

Magnetic Switches and Circuits
W.C. Numnally - Los Alamos National Laboratory

Ignitron Switches
D. Cummings - Physics International Co.

Mechanical Switches
M. Parsons - Los Alamos National Laboratory

Breakdown in Water
R. Miller - Maxwell Laboratories, Inc.

Current Interruption-Explosive and Fuse Switching
Z. Vitekowsky - Naval Research Laboratory

Solid, Liquid, and Gaseous Switches
J.C. Martin - Aldermaston, Reading, England

Gas Insulated Spark Gaps
M.O. Bagier and M. Kristiansen - Texas Tech Univ.

Repetitive Switching
M. Buttram - Sandia National Laboratories

Electro-Magnetic Field Measurements
C. Baum - Air Force Weapons Laboratory

Opening Switches
K.H. Schoenbach and M. Kristiansen - Texas Tech University

Current and Voltage Measurements
R. Hebner - National Bureau of Standards

Some other planned lecture topics are:
1. Foreign Pulsed Power Technology
2. Modeling Techniques
3. Protective Circuits and Grounding Techniques
4. Control Systems
5. Modulator Design
6. Radar Systems
7. Laser Systems
8. Particle Accelerators
9. Particle Beam Fusion
10. Directed Beam Weapons
11. Nuclear Weapons Effects Simulation
12. Electronic Countermeasures
13. High Beta Magnetic Fusion
14. Coherent Radiation from Relativistic Beams
15. Industrial Applications of Pulsed Power Technology

SUMMARY

The series, so far, appear to have been very successful and the modules, although somewhat late in being issued due to author tardiness, are filling an educational need. Countries, such as Japan and West Germany (FRG), have shown considerable interest in the modules. Various methods for making the modules more generally available are being studied. The program is currently being supported until April, 1982. Beyond that time, it may be necessary to continue a limited lecture series to update some of the modules and to add certain new topics.
Program Director's Publication, 1980-81
Journal and Conference Proceedings Papers


* Supported by AFOSR, Physics Directorate


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Interactions

a) Papers Presented


b) Consultative and Advisory Functions

1. Prof. Kristiansen served on the Advisory Committee for the NATO Advanced Study Institute on Breakdown and Discharge in Gases in Les Arcs, France, June 28 - July 10, 1981.

2. Prof. Kristiansen was appointed to the Air Force Scientific Advisory Board.

3. Prof. Kristiansen served as a consultant to NASA on space plasmas on Oct. 8-10, 1980 at Goddard Space Flight Center.

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