Gratitude and "Grattitude"

I came to the United States 50 years ago in 1958 with $50, a passport from my motherland, India, and undergraduate education in my then-technical field of electronics from the Madras Institute of Technology in India. I received my Ph.D. in electrical engineering from the University of Washington and joined what is now the Department of Electrical and Computer Engineering (ECE) at the University of Illinois at Urbana–Champaign (UIUC) in 1965, attracted by the then-department head, Edward C. Jordan, who brought the department to national and international fame as its head for 25 years from 1954 to 1979. After 42 years of tenure in this department, I retired, effective June 1, 2007, as the Edward C. Jordan Professor Emeritus of Electrical and Computer Engineering.

In recent years, I have been engaged in engineering education in India. In December 2005, I got connected to the "Hugging Saint," and "Mother of Compassion," the humanitarian and spiritual leader Amma Mata Amritanandamayi Devi, Chancellor of Amrita Vishwa Vidyapeetham (Amrita University), popularly known as "Amma," meaning "Mother," all over the world. Since then, I have been involved with Amrita University, where I now have the position of Distinguished Amrita Professor of Engineering, offered to me in October 2006. My involvement with Amrita began in a special way, as the first faculty member from the United States teaching from the Amrita campus in Ettimadai, Coimbatore, Tamil Nadu, to students at remote locations on the interactive satellite E-learning Network, under the Indo-U.S. Inter-University Collaborative Initiative in Higher Education and Research, in summer 2006.

I am grateful to many individuals, beginning with my late parents, and for many things. I came with the solid foundation laid at my alma mater in India and acquired more education at my alma mater in the United States and prospered in my profession at Illinois. For all of this, I am grateful to my two Lands, the land of my birth, India, for the foundation, and the land of my work, America, for the prosperity. I am grateful to Amma Mata Amritanandamayi Devi for attracting me to Amrita University, thereby giving me the opportunity for "serving the needs of students of various parts of the world," in the words of former President of India, Bharat Ratna, Dr. A. P. J. Abdul Kalam, with this book, bearing my joint affiliation with Illinois and Amrita.

In the words of the late Gurudeva Sivaya Subramuniyaswami of the Kauai Aadheenam, Kauai, Hawaii: "Gratitude and appreciation are the key virtues for a

better life. They are the spell that is cast to dissolve hatred, hurt and sadness, the medicine which heals the subjective states of mind, restoring self-respect, confidence, and security." I am grateful that I am the author of this book and its predecessor books, over the span of more than 35 years, for introducing electromagnetic theory, commonly known as electromagnetics (EM), to students all over the world. Here, I would like to reconstruct the trail of this gratitude beginning in the 1950s.

One day during the academic year 1957–1958, I had the pleasure of having afternoon refreshments with William L. Everitt in the dining hall of the Madras Institute of Technology (MIT), Chromepet, along with some others in the electronics faculty of MIT. William L. Everitt was then the dean of the College of Engineering at the University of Illinois, Urbana, as it was then known. Dean Everitt was visiting India because the University of Illinois was assisting with the development of IIT (Indian Institute of Technology), Kharagpur, the first of the IITs. Dean Everitt came to Madras (presently Chennai) at the invitation of William Ryland Hill, who was the visiting head of the electronics faculty of MIT during that one year, on leave from the University of Washington in Seattle, Washington.

I happened to be on the staff of the electronics faculty then, having completed my diploma in electronics after three years of study during 1952–1955 and six months of practical training, following my B.Sc. (Physics) from the University of Madras, having attended the Presidency College. One of the subjects I studied at MIT was electromagnetic theory, from the book *Electromagnetic Waves and Radiating Systems*, by Edward C. Jordan, who was then the head of the Department of Electrical Engineering at the University of Illinois. I can only say that my learning of electromagnetic theory at that time was hazy at best, no reflection on Jordan's book.

While I was a student at MIT, one of our great lecturers, by the name of S. D. Mani, was leaving to take a new job in Delhi, for which we gave him a send-off party. After the send-off party, we all went to the Chromepet Railway Station adjacent to the Institute to bid a final goodbye to him on the platform. While on the platform waiting for the electric train to arrive from the neighboring station, Tambaram, he specifically called to me and said, "Narayana Rao, someday you will become the president of a company!"

Contrary to what S. D. Mani said, with his great characteristic style, I did not go on to even work in a company. Instead, William Ryland Hill "took" me to the EE Department at the University of Washington in 1958, then chaired by Austin V. Eastman, a contemporary of Edward Jordan. There, I pursued my graduate study in electrical engineering and received my Ph.D. in 1965, with Howard Myron Swarm as my advisor, in the area of ionospheric physics and propagation, and taking courses from Akira Ishimaru, among others. Eastman gave me the opportunity of teaching courses just like a faculty member, as an instructor, because of my teaching experience at MIT, and the good word of Ryland Hill. That was when I fell in love with the teaching of "transmission lines," from the electromagnetics aspect, which then extended beyond transmission lines and later led to the writing of my books.

Never did I envision during those years that in 1965, after completing my Ph.D. at the University of Washington, I would become a faculty member and be writing my

books in the Jordan-built Department of Electrical and Computer Engineering (as it is now called) in the Everitt-built College of Engineering at the University of Illinois at Urbana-Champaign, as it is now known. Never did I envision that I would spend my entire professional career since 1965 in the hallowed halls of the William L. Everitt Laboratory of Electrical and Computer Engineering, which I call the "Temple of Electrical and Computer Engineering," along with personalities such as distinguished colleagues Nick Holonyak, Jr., and George W. Swenson, Jr. Never did I envision that not only would I be writing books for teaching electromagnetics, following the tradition of Jordan, but also would be holding a professorship, and now an emeritus professorship, bearing his name.

I believe that gratitude is something you can neither express adequately in words nor demonstrate adequately in deeds. Nevertheless, I have tried on certain occasions to express it in words, and demonstrate it in deeds, which I would like to share with you here:

To my alma mater, the Madras Institute of Technology, on the occasion of the Institute Day on February 26, 2004, in the presence of the then-Governor of Tamil Nadu, Sri P. S. Ramamohan Rao, a classmate of mine while in Presidency College, for presenting the sixth edition of my book, *Elements of Engineering Electromagnetics:*

So, Madras Institute of Technology, my dear alma mater
Where I went to school fifty years ago this year
Today I present to you this historic volume
The product of the work of my lifetime
For which fifty years ago you laid the foundation
That I cherished all these years with much appreciation
Please accept this book as a token of my utmost gratitude
Which I offer to you in the spirit of "Revere the preceptor as God"
Hopefully I will be back with Edition No. 7
To express my gratitude to you again in 2007!

And I did go back to my alma mater in January 2007, not to present Edition No. 7, but rather a special Indian Edition of Edition No. 6, which could be considered as Edition No. 7!

At the conclusion of the response speech on the occasion of my investiture as the Edward C. Jordan Professor of Electrical and Computer Engineering, on April 14, 2004:

To Edward C. Jordan, the "father" of my department
Fifty years ago, I may have studied EM from your book with much bewilderment
But today, I offer to you this book on EM which I wrote with much excitement
In appreciation of your profound influence on my professional advancement.

To my alma mater, the EE Department at the University of Washington, giving the keynote speech and presenting the sixth edition of *Elements of Engineering*

Electromagnetics, at the kick-off event for the Centennial Celebration of the Department on April 28, 2006:

> *To the EE Department at the University of Washington*
> *From this grateful alumnus who received from you his graduate education*
> *Not just graduate education but seven years of solid academic foundation*
> *For my successful career at the University of Illinois at Urbana–Champaign*
> *During which I have written six editions of this book on electromagnetics*
> *Besides engaging in the variety of all the other academic activities*
> *I present to you this book with utmost appreciation*
> *On the occasion of your centennial celebration!*

And when you are grateful in life, things continue to happen to you to allow you to be even more grateful. Even as late as November 2005, I did not envision that I would become connected to Amrita University of Amma Mata Amritanandamayi Devi. The opportunity came about as a consequence of the signing of a memorandum of understanding (MOU) in December 2005 between a number of U.S. Universities, including UIUC and the University of Washington, and Amrita University in partnership with the Indian Space Research Organization (ISRO) and the Department of Science and Technology of the Government of India. The MOU had to do with an initiative, known as the Indo-U.S. Inter-University Collaborative Initiative in Higher Education and Research, and allowed for faculty from the United States to offer courses for e-learning on the ISRO's EDUSAT Satellite Network and to pursue collaborative research with India. The Initiative was launched by the then President of India, Bharat Ratna, A. P. J. Abdul Kalam, from New Delhi on the EDUSAT Satellite Network on December 8, 2005.

A delegation from the United States went to India on this occasion, and following the launching ceremony at Ettimadai, Coimbatore, Tamil Nadu, where the main Amrita campus is located, the delegation went to Amritapuri in the state of Kerala to meet with Amma on December 9. That was when I got connected to Amma, and things began to happen. Within the next year, I became the first professor to offer a course on the EDUSAT Satellite Network—a 5-week course in summer 2006, entitled "Electromagnetics for Electrical and Computer Engineering," in memory of Edward C. Jordan, using as the textbook a special Indian Edition of *Elements of Engineering Electromagnetics, Sixth Edition*, published in this connection by Pearson Education and containing a message by former President Abdul Kalam, forewords by UIUC Chancellor Richard Herman, UIUC Provost Linda Katehi, and ECE Professor Nick Holonyak, Jr., and an introductory chapter called "Why Study Electromagnetics?" offering 18 very thoughtful responses to that question, most of them provided by UIUC ECE faculty members.

So, I did not become the "president" of a company, as S. D. Mani proclaimed on the platform of the Chromepet Railway Station. Instead, I went on to become a "resident" of the William L. Everitt Laboratory of Electrical and Computer Engineering, the "Temple of Electrical and Computer Engineering,"—the crown jewel of the campus that provided education to numerous presidents of companies—located at the northeast corner of the intersection of Wright and Green Streets in Urbana, Illinois, on the Campus of the University of Illinois at Urbana–Champaign!

And from the "Temple of Electrical and Computer Engineering" in Urbana, shown above, my gratitude took me to my motherland, halfway around the world, as an "IndiAmerican," a word that I coined implying that the "Indian" and the "American" are inseparable, and which inspired former President Abdul Kalam. There, I reached the destination in my journey at Amma Mata Amritanandamayi Devi's Amrita Vishwa Vidyapeetham, where I got connected to the "young minds" of my motherland, shown in the picture below, along with some staff and my wife and our daughter, taken on August 11, 2006, the last day of the class in front of the beautiful main building of the campus.

I have read somewhere that destination is a journey and not a success in itself. And therefore, the journey began at Amrita and is continuing! As though for this purpose and owing to a combination of circumstances, I became the first Distinguished Amrita Professor of Engineering in October 2006, at which time I decided to write this book, and hence began working on it while at Amrita in Ettimadai. Subsequently, I retired from UIUC effective June 1, 2007, becoming the Edward C. Jordan Professor Emeritus of Electrical and Computer Engineering, so that my journey is now continuing as Jordan Professor Emeritus from Illinois and Distinguished Amrita Professor from Amrita, wherever I am in this global world.

I always believed in the power of education—transcending the boundaries of national origin, race, and religion—to assure the future of the world. Throughout my life, I have been involved in education, as a student, professor, researcher, teacher, author, and administrator. The sheer enjoyment of my work led me to coining the word "grattitude," in 2005, in answer to people wondering if I would ever retire from my job at Illinois. "Grattitude" is a word combining "gratitude" and "attitude," and meaning an "attitude of gratitude." In my journey, I feel grattitude for the opportunity I have been given to help facilitate the education of the wonderful youth from countries all over the world, through my books, teaching, and international activities. I have learned that engaging in an activity with "grattitude" yields immediate enjoyment. I conclude this story of "gratitude and grattitude" with the following poem:

To the students from all around the world
And to the students all over the world
EMpowered by the Jordan name
And inspired by the Amrita name
I offer to you this book on EM
Beginning with this poem which I call PoEM
If you are wondering why you should study EM
Let me tell you about it by means of this PoEM
First you should know that the beauty of EM
Lies in the nature of its compact formalism
Through a set of four wonderful EMantras
Familiarly known as Maxwell's equations
They might be like mere four lines of mathematics to you
But in them lie a wealth of phenomena that surround you
Based on them are numerous devices
That provide you everyday services
Without the principles of Maxwell's equations
Surely we would all have been in the dark ages
Because there would be no such thing as electrical power
Nor would there be electronic communication or computer
Which are typical of the important applications of ECE
And so you see, EM is fundamental to the study of ECE.

So, you are curious about learning EM
Let us proceed further with this PoEM
First you should know that **E** *means electric field*
And furthermore that **B** *stands for magnetic field*
Now, the static **E** *and* **B** *fields may be independent*

But the dynamic **E** *and* **B** *fields are interdependent*
Causing them to be simultaneous
And to coexist in any given space
Which makes EM very illuminating
And modern day life most interesting
For it is the interdependence of **E** *and* **B** *fields*
That is responsible for electromagnetic waves
In your beginning courses you might have learnt circuit theory
It is all an approximation of electromagnetic field theory
So you see they put the cart before the horse
But it is okay to do that and still make sense
Because at low frequencies circuit approximations are fine
But at high frequencies electromagnetic effects are prime
So, whether you are an electrical engineer
Or you happen to be a computer engineer
Whether you are interested in high frequency electronics
Or maybe high-speed computer communication networks
You see, electromagnetic effects are prime
Studying the fundamentals of EM is sublime.

If you still have a ProblEM with EM,
Because it is full of abstract mathematics,
I say, my dear ECE student who dislikes electromagnetics
Because you complain it is full of abstract mathematics
I want you to know that it is the power of mathematics
That enabled Maxwell's prediction through his equations
Of the physical phenomenon of electromagnetic radiation
Even before its finding by Hertz through experimentation
In fact it was this accomplishment
That partly resulted in the entitlement
For the equations to be known after Maxwell
Whereas in reality they are not his laws after all
For example the first one among the four of them
Is Faraday's Law expressed in mathematical form
You see, mathematics is a compact means
For representing the underlying physics
Therefore do not despair when you see mathematical derivations
Throughout your textbook on the Fundamentals of Electromagnetics
Instead look through the derivations to understand the concepts
Realizing that mathematics is only a means to extend the physics
Think of yourself as riding the horse of mathematics
To conquer the new frontier of electromagnetics
Let you and me together go on the ride
As I take you through the steps in stride, with grattitude!

N. NARAYANA RAO