SPEECH OF SPONSOR, LUIS MARTÍNEZ SALAMERO

Rector, authorities, academic colleagues, Dr. Vadim Utkin, ladies and gentlemen,

It is a great honour for all of us that Dr. Utkin is here today to receive an honorary degree from the Rovira i Virgili University. It is a great cause for celebration—particularly for the Department of Electronic, Electric and Automatic Engineering and the School of Engineering—that he has accepted this nomination. When the idea of nominating Dr. Utkin was first discussed in the School and the Department, the enthusiasm was unanimous since his work has deep roots in engineering, it is interdisciplinary and it can be used in a wide variety of specialities.

Vadim Ivanovich Utkin was born in Moscow in 1937 into a Russian family originally from Siberia. As a young man he combined his love for ice hockey with his university studies and he graduated in Engineering in 1960 at the Institute of Power Systems in Moscow. In the same year he joined the group of researchers at the Institute of Control Sciences in the same city where he was awarded his university and state doctorates in 1964 and 1971, respectively, and where he directed the Laboratory of Discontinuous Control Systems between 1973 and 1994.

It was during this period that he made considerable theoretical contributions to the field of Automatic Control in conjunction with other colleagues such as Emilianov and Filipov, which made it possible to lay the foundations of variable structure systems and sliding mode control.

At that time a scientific community made up of engineers, physicists and mathematicians was searching for how non-linear systems could best adapt to servomechanisms. In 1956, the International Federation of Automatic Control (IFAC)

was founded. It functioned as a catalyst, a sanctioning body and judge of the scientific contributions that scientists regularly submitted for review or debate to the emerging periodicals and the international congresses that brought them together every four years and thus broke down the rigid barriers of a world that had been divided into blocks since the end of the Second World War.

It was during the War that servomechanisms burst onto the scene. They were based on an extremely powerful body of theory which, in turn, was based on the behaviour of the frequency of linear systems and feedback theory, which Black, Nyquist and Bode had been helping to consolidate since the 1920s. However, the non-linear elements presented what seemed to be an insurmountable difficulty: they could not be part of a General Theory and had to be analyzed individually. The rapid spread of controller design in the linear system frequency domain led to the development of methods for analyzing non-linear systems that would enable linear techniques to be applied with identical or similar criteria, particularly with regard to the prediction of the stability of servomechanisms. The results obtained were approximations, when the treatment was analytical, or accurate descriptions that required a complex background of numerical calculations. They were applied in a variety of industrial processes, largely actuator control in mechanical systems. Many of these cases represented a well-known paradox in engineering: the simplicity of their production was inversely proportional to the complexity of their mathematical description. One denominator that was common to them all was the appearance of two or more types of dynamic description—that is to say, of differential equations—which depended on the mode or region of operation in which the feedback system is found. This behaviour led the group of researchers headed by Emilianov and Utkin to formulate the notion of the variable structure system and initiate its systematic study. Thus began a fascinating chapter in the intersection of

Applied Mathematics and Automatic Control Theory which would soon bear fruit in the fields of robotics, the regulation of electric machines, process control and, years later, power electronics. In 1964 Filipov published his theory of differential equations with discontinuous right-hand sides in English, which prompted Utkin to formulate the notion of equivalent control and the associated method for studying sliding modes in variable structure systems. The path had been cleared for systematic study, and in 1977 Vadim Utkin published an article in *Transactions on Automatic Control* of the Institute of Electrical and Electronics Engineers. It was given an extraordinary reception by the scientific community because it provided a detailed presentation of the theoretical foundations of sliding mode control in variable structure systems. This paper was followed by five books and over 300 scientific articles, which mean that Vadim Utkin has now accumulated more than 4000 citations in the leading engineering journals. Dr. Utkin's work has helped to develop mathematical methods for describing variable structure and sliding mode control systems; to draw up design principles based on decomposition and invariance through control algorithms; and to apply these systems to the automation of processes, the regulation of electric motors, the control of electric and hybrid vehicles and the control of robotic manipulators. His theoretical results have been implemented in metallurgy, the petrochemical industry, the fishing industry, metal cutting tool machines, turbo-diesel engine control, car air-conditioning and control of the air/fuel ratio in hybrid vehicles.

Before gaining international respect and admiration, he was recognized by his own country: in 1972 he was awarded the Lenin Prize, the highest scientific distinction of the former USSR. And between 1975 and 1978 he was often taken to Sarajevo because of his involvement as head scientist in an international project between the Moscow Institute of Cybernetics and the Yugoslavian company Energoinvest on the application

of sliding mode control to electric induction motors. It was in Sarajevo that he was awarded an honorary degree in 1978.

In 1994 he travelled to the United States where he occupied the Ford Chair for distinguished visiting professors at the Ohio State University in Columbus. During his stay there he was involved in intense research activity on automotion systems in collaboration with such representative companies of the sector as Ford's Scientific Research Laboratory or DELPHY, developing techniques for controlling and estimating variables in alternators, for the sensorless control of asynchronous electric motors and for the variable geometry control of turbo-diesel engines. Since 2002 he has been a full professor of the Departments of Mechanical Engineering and Electrical Engineering at the same university.

His research in America increased his international recognition. In 2003 he was awarded the Oldenburger medal of the American Society of Mechanical Engineers (ASME). In 2004 he was appointed Fellow of the Institute of Electrical and Electronics Engineers (IEEE) and in 2005 he was awarded the Humboldt Prize of the German Government. And in 2008 he was elected foreign member of the Academy of Sciences and Arts of Bosnia-Herzegovina.

Vadim Utkin has never taken any great delight in receiving all these awards. He has never ceased to work or to take an interest in new fields in which to apply the theory of variable structure systems. Having been a visiting researcher for more than 40 years at prestigious centres in the United States, Japan, Germany, and Italy, in 2009 he accepted an invitation from the Department of Electronic, Electric and Automatic Engineering of the URV to come for a visit of several months. During his time he taught a weekly seminar on sliding mode control and he worked in conjunction with a research group to

find the analytical justification for the behaviour of some interleaved power converters in a ring configuration with hysteresis control. The results of this research in conjunction with other previous work have opened up the way to consolidate sliding mode control in power electronics as a robust, reliable and easy-to-design tool that can naturally adapt to the intrinsic characteristic of variable structure systems used by power electronic converters.

A teacher of teachers, Dr. Utkin has for more than 20 years been the driving force behind a school of control theory for variable structure systems which is structured biennially around an international congress of the same name attended by researchers from all over the world who are working in the field of sliding mode control. Many of his former students at the Institute of Control Sciences are continuing his legacy as leading researchers of variable structure systems, and ensuring the continuity of a school of research based on mathematical rigour and the permanent search for applications in engineering. Among others, in Mexico there are Leonid Fridman, a lecturer at the Autonomous National University, Alexander Poznyak, a head of department at the Centre for Research and Advanced Studies of the National Technical Institute and Yuri Orlov, head of research at the Centre for Scientific Research and Higher Education in Ensenada; in Canada, Igor Boiko, is a lecturer at the University of Calgary; and in Russia, Segey Ryvkin, is a researcher at the Institute of Control Sciences in Moscow.

Professor Utkin has investigated the application of the theory of variable structure systems to many engineering fields, although perhaps his specialist area is electromechanical systems. I would like to finish by highlighting one aspect of his work that I regard as fundamental: the precision and elegance of his writing, completely free of clutter, which links up with the best of the Spanish *conceptista* tradition.

Rector, insofar as I have been able, I have described the life and work of Mr. Vadim Ivanovich Utkin. I believe that I have said enough for his merits to be recognized by your authority. Therefore, I request that you award Vadim Ivanovich Utkin an honorary degree and allow him to become a member of our university.