



**UTM**  
UNIVERSITI TEKNOLOGI MALAYSIA

Faculty of  
Electrical  
Engineering



**Short Course on  
Variable Structure and Sliding Mode Control – Concept, Theory and  
Applications  
By  
Prof. B. Bandyopadhyay**

**Synopsis**

Robustness has been an important issue in control systems design ever since 1769 when James Watt developed his flyball governor. A successfully designed control system should be always able to maintain stability and performance level inspite of uncertainties in system dynamics and/or in the working environment to a certain degree. A large part of today's fervor on robust control research is focused on those techniques which utilize the Variable Structure Control method and Sliding Mode Control. As well known, the two methods are closely related but, strangely enough, their respective research areas are quite separated. Sliding mode control is a particular type of Variable structure control. The Variable structure control systems are characterized by a suite of feedback control laws and a decision rule, which may be regarded as a combination of subsystems where each subsystem has a fixed control structure and is valid for specified regions of system behavior. Furthermore, the system may be designed to possess new properties not present in any of the composite structures alone. In sliding mode control, variable structure control systems are designed to drive and then constrain the system states to lie in a predefined manifold. During sliding mode, the system dynamics is governed by the chosen manifold which results in a well celebrated invariant property towards certain class of disturbances and model mismatches and thus clearly makes this methodology an appropriate candidate for robust control.

**Professor Bijnan Bandyopadhyay** received his B.E. degree in Electronics and Telecommunication Engineering from the University of Calcutta, Calcutta, India in 1978, and Ph.D. in Electrical Engineering from the Indian Institute of Technology, Delhi, India in 1986. In 1987, he joined the Interdisciplinary Programme in Systems and Control Engineering, Indian Institute of Technology Bombay, India, as a faculty member, where he is currently a Professor. In 1996, he was with the Lehrstuhl für Elektrische Steuerung und Regelung, Ruhr Universität Bochum, Bochum, Germany, as an Alexander von Humboldt Fellow. He has been a visiting Professor at Okayama University, Japan, Korea Advance Institute Science and Technology (KAIST) S.Korea and Chiba National University in 2007. He visited University of Western Australia, Australia as a Gledden Visiting Senior Fellow in 2007. Professor Bandyopadhyay is recipient of UKIERI(UK India Education and Research Initiative) Major Award in 2007, 'Distinguished Visiting Fellowship' award in 2009 and 2012 from "The Royal Academy of Engineering", London. Professor Bandyopadhyay is a Fellow of Indian National Academy of Engineering (INAE), Senior member of IEEE and a Fellow of IETE (India). He has published 10 books and monographs, 9 book chapters and more than 330 journal articles and conference papers. He has guided 26 Ph.d. thesis at IIT Bombay. His research interests include the areas of higher order sliding mode control, multirate output feedback control, discrete-time sliding mode control, large-scale systems, model order reduction, nuclear reactor control and smart structure control. Prof. Bandyopadhyay served as Co-Chairman of the International Organization Committee and as Chairman of the Local Arrangements Committee for the IEEE International Conference in Industrial Technology, held in Goa, India, in Jan. 2000. He also served as one of the General Chairs of IEEE ICIT conference held in Mumbai, India in December 2006. Prof. Bandyopadhyay has served as General Chair for IEEE International Workshop on Variable Structure Systems held in Mumbai in January 2012. Prof. Bandyopadhyay is currently Technical Editor of IEEE/ASME Transaction on Mechatronics

**Objective**

The main objective of this course is to lay a foundation in the theory of sliding mode control covering a large spectrum of recent research in this area including continuous-time, discrete-time, higher order sliding modes, sliding mode observers and differentiator as well as the various applications of this powerful design technique. The course will also introduce the most innovative ideas in this field which will benefit the researchers and academicians.

**Course Topics:**

1. Introduction To Variable Structure Control/Sliding Mode Control
2. Continuous Time Sliding Mode Control. Filippov Solution, Sliding Surface Design And Several Reaching Laws.
3. Discrete-Time Sliding Mode Control, State Feedback And Multi-rate Feedback Based Sliding Mode Control
4. Observer And Sliding Mode Observer
5. Integral Sliding Mode Control, Composite Nonlinear Feedback Control(CNF), Integral Sliding Mode With CNF Technique
6. Chattering Problem; Drawback Of One Sliding Mode Control, Second Order Sliding Mode Control, Twisting And Super Twisting Sliding Mode Control
7. Integral Sliding Mode Control With Super Twisting Sliding Mode, How To Implement Super Twisting Sliding Mode
8. Application Of Sliding Mode Control: SLOSH Container Under Actuated System, Spatial Control Of A Large Nuclear Reactor, Aerospace Problem, Industrial Emulator System Etc.

**Important Dates**

Last date for receipt of registration:  
**10 December 2014**  
Course dates :  
**16 and 17 December 2014**

**Venue**

Tutorial Room 5  
Level 5  
FKE Building  
P19a

**Fee**

**RM 600**  
per person  
**\*Discount RM 300**  
for UTM staff and student

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