# CHAPTER 57

# TECHNOLOGY
# INSTRUMENTATION AND CONTROL ENGINEERING

## Doctoral Theses

01. CHANDRA (Sushil)
**Psychophysiological Assessment of Human Cognition and its Enhancement by Non-Invasive Methods.**
Supervisors: Prof. Alok Prakash Mittal, Dr. Devendra Kumar Jha and Prof. B.K. Dass
Th 23032

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1. Introduction 2. Background and literature review 3. Psychophysiological assessment of cognitive workload 4. A neurophysiological perspective to workload regulation through sudarshan kriya yoga (sky) kriya for mental workload regulation 5. Effect of sudarshan kriya (meditation) on gamma, alpha, and theta rhythm during working memory task 6. Sudarshan kriya yoga as non invasive method for mental stress regulation 7. Emotion regulation by sky technique with the application of frontal brain asymmetry as the recognition index 8. Video game as cognitive enhancer 9. Conclusions and future directions. Bibliography, appendix, list of publication and reprints of publication.

02. JHA (Amar Nath)
**Some Studies on Reduced Order Modeling and Their Application.**
Supervisor: Dr. Yogesh Vijay Hote an Prof. J.R.P. Gupta
Th 23079

*Abstract*
*(Not Verified)*

The model order reduction techniques are important for modeling and controller design. The applications of reduction techniques reduce the order of the system as well as computational cost. Therefore, in this thesis, main thrust is on the reduced order modeling of a system. It is a challenging task to work on different methodologies on model order reduction techniques. However, due to the important role of reduction techniques in control system, an attempt has been made to study different types of model order reduction techniques and various methods have been proposed based on the existing approaches on model order reduction techniques. In the first part of this thesis, a method has been suggested for reduced order model of a system which has as pole at origin. This approach is extension of Krishnamurthy's approach on model order reduction of linear systems. Then, it is pointed out that the Pade method is not a superior method in comparison to other existing methods such as Routh stability method, Stability equation method etc. It is observed that the the superiority of each individual method is based on type of a system. Further, modified Gerschgorin method is proposed for the model order reduction of linear system. Finally, the results have been compared with other existing methods.In second part of the thesis, various methods of model order reduction of interval system have been studied. Further, a simple approach is proposed for model order reduction of lower order interval systems. The main advantage of the proposed approach is that instead of dealing with interval system model and interval arithmetic rules, a reduced order modeling is carried out only on a linear system

model. This approach gives direct formulae for obtaining reduced order models for some class of interval system.

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1. Introduction 2. Model order reduction of linear systems 3. Model order reduction of interval systems 4. Controller design based on model order reduction techniques 5. Application of model order reduction techniques 6. Conclusions and future scope. References, publications related to thesis and about the author.

03. MISHRA (Puneet)
**Some Investigations on Intelligent Controllers for Nonlinear Processes.**
Supervisor: Prof. Vineet Kumar, Prof. K.P.S. Rana and Prof. A.P. Mittal
Th 23075

*Abstract*
*(Verified)*

Many industrial processes exhibit nonlinear and uncertain dynamics. The control schemes must be very effective in dealing with this highly nonlinear and uncertain nature of the process loops. These nonlinearities in the control loops may be linked to mainly three origins. First, inherent nonlinear process dynamics; second, nonlinear final control elements, and thirdly, nonlinear sensor in feedback loop. In this thesis two sources of nonlinearities in the control loop have been considered viz. nonlinear process dynamics and nonlinear final control element. In this thesis, intelligent controllers have been developed for such scenarios. The investigations performed in this thesis are categorized in two broad categories namely, investigations on plant having nonlinear dynamics i.e. binary distillation column and investigations on nonlinear final control element, a pneumatic control valve having stiction nonlinearity. Summary of the work carried out on these two case studies is given below. The interacting, uncertain and disturbance prone nature of the distillation plant makes it a complex process to be controlled. To deal with these issues a fractional order fuzzy logic controller has been proposed for effective control of distillation column product compositions. Further, Pneumatic control valve has been considered which usually possesses the nonlinear behaviour either due to valve characteristics or due to stiction nonlinearity. In this thesis, investigations have been conducted to counteract the commonly found stiction nonlinearity of the pneumatic control valves. Two different controllers, viz. stiction combating intelligent controller (SCIC) and a nonlinear proportional integral controller (NPIC) have been proposed. The SCIC controller is a fuzzy logic controller and NPIC is a nonlinear controller, of which both have been used for the control of a flow process. Both of these controllers were successfully tested in run time on a laboratory scale process control trainer and found to be efficient in achieving their design objectives.

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1. Introduction 2. Literature review 3. Intelligent controllers: nonlinear process-binary distillation column 4. Intelligent controllers: process with a nonlinear final control element 5. Conclusions and future scope. References.

04. SHARMA (Richa)
**Artificial Intelligence Based Control of Robotic Manipulators.**
Supervisor: Dr. O.P. Thakur, Dr. Rachna Manchanda and Dr. R.K. Sharma
Th 23037

*Contents*

1. Introduction 2. Mathematical modelling of robotic manipulators 3. Comparative study of optimization techniques 4. Two-degrees of freedom fractional order pid

controllers 5. Fuzzy logic based control techniques 6. Neural network based control techniques 7. Conclusion and future scope. Bibliography and list of publications.

05. YADAV (Anil Kumar)
**Artificial Intelligence Based Robust and Adaptive Control Techniques for Non-Linear System.**
Supervisor: Dr. Prerna Gaur
Th 23200

*Abstract*
*(Not Verified)*

Almost all physical systems are inherently nonlinear in nature. The design of controller for nonlinear systems is a difficult process; hence the controlling of such nonlinear systems continues to be a challenging task for the researchers in the field of control systems. The objective of this research is to find the control solutions, that can be applied to any of the nonlinear system such as hybrid electric vehicle (HEV), unmanned aerial vehicle (UAV) and heavy duty vehicle (HDV) for speed control applications through the electronic throttle control system (ETCS). A high performance DC and brushless DC servo motor drives are used for the design of ETCS that regulates of desired throttle position rapidly and precisely. However, HEV, UAV and HDVs are normally operated in a dynamic environment of different road grade, weather and load conditions i.e. in the presence of uncertainties and disturbances. Therefore, the design of control algorithm must be robust and adaptive with respect to uncertainties, so the controller should be capable of handling system mismatches under parametric uncertainties, disturbances and noise. The integration of artificial intelligence (AI) techniques such as artificial neural network (ANN), fuzzy logic and adaptive neuro-fuzzy inference system (ANFIS) with both the conventional and modern control techniques such as PID, internal model control (IMC), sliding mode control (SMC), and model reference adaptive system (MRAS) etc. may help to introduced robust and adaptive feature in the controller design. A comparative performance analysis of conventional, modern and AI based controllers for nonlinear systems are presented in order to identify the superior controller among all the controllers designed in this work. The AI based control techniques are developed to achieve the robust performance of the throttle controlled vehicles with the target to achieve a wide range of speed, fuel economy with reduced pollution and improved efficiency.

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