



Thesis abstracts

This section presents the abstract of most recent Master or PhD thesis related to aerospace technology and management

ELICERE: The elicitation process for dependability goals in critical computer systems – A case study for space application

Carlos Henrique Netto Lahoz
Institute of Aeronautics and Space
lahoz@iae.cta.br

PhD Thesis in Electric Engineering at the Polytechnic School of the University of São Paulo, São Paulo, São Paulo State, Brazil, 2009.

Advisor: Prof. Dr. João Batista Camargo Júnior

Keywords: Dependability, Goals, Elicitation, Critical computer systems, Space project.

Abstract: The technological advances in electronic and software have been rapidly assimilated by computer systems, demanding new approaches for software and systems engineering to provide reliable products, under well-known quality criteria. In this context, requirements engineering has a strategic role in project development. Problems in the elicitation activity contribute to producing poor, inadequate or even non-existent requirements that can cause mission losses, material or financial disasters, premature project termination or promote an organizational crisis. This thesis introduces the elicitation process for dependability goals, called ELICERE, applied to critical computer systems based on a goal-oriented requirement engineering technique, called i^* , and the safety engineering techniques HAZOP and FMEA, which will be applied for the identification and analysis of operational risks of a system. After creating the system models using i^* diagrams, they are analyzed through guidewords based on HAZOP and FMEA, from which goals related to dependability are extracted. Through this interdisciplinary approach, ELICERE promotes the identification of goals that meet the quality requirements, related to dependability for critical systems, still in the project conception phase. The case study approach is based on a qualitative and descriptive single-case, using a computer system project of a hypothetical launching rocket, called V-ALFA. The ELICERE application in this space project intends to improve the requirement engineering activities in the computer system of the Brazilian Satellite Launch Vehicle, and also a way to explain how the ELICERE process works.

Variability management in software product lines using adaptive object and reflection

Luciana Akemi Burgareli
Institute of Aeronautics and Space
luciana@iae.cta.br

PhD Thesis in Electric Engineering at the Polytechnic School of the University of São Paulo, São Paulo, São Paulo State, Brazil, 2009.

Advisors: Dr. Selma Shin Shimizu Melnikoff and Dr. Mauricio Gonçalves Vieira Ferreira

Keywords: Software product line, Variability, Adaptive object model, Reflection, Brazilian Satellites Launcher

Abstract: The Software Product Line approach offers benefits such as savings, large-scale productivity and increased product quality to the software development because it is based on software architecture reuse, which is more planned and aimed to a specific domain. Variability management is a key and challenging issue, since this activity helps identifying, designing and implementing new products derived from a software product line. This work defines a process for the variability management of a software product line. After modeling the variability, extracting the variants from use case diagrams and features, the next step is to specify the variability that was identified. Finally, the proposed process uses a variability mechanism based on adaptive object model and reflection as support in the creation of variants. The proposed process uses as case study the software system of a hypothetical space vehicle, the Brazilian Satellites Launcher.

Complex permittivity and permeability behaviors, 2-18GHz, of RAM based on carbonyl iron and MnZn ferrite

Adriana Medeiros Gama
Institute of Aeronautics and Space
adriana.gama@iae.cta.br

PhD Thesis in Aeronautics and Mechanics Engineering, Physics and Chemistry in Aerospace Materials at the Technological Institute of Aeronautics, ITA, São José dos Campos, São Paulo State, Brazil, 2009.

Advisor: Prof. Dr. Mirabel Cerqueira Rezende

Keywords: Permittivity, Permeability, Microwave, Radar absorbing material.

Abstract: The main objective of this study is to contribute toward a comprehensive understanding the interaction of magnetic additives with the electromagnetic wave, in the microwave range (2-18 GHz) of radar absorbing materials (RAM). Thus, this work shows the electromagnetic behavior of different RAMs based on MnZn ferrite, carbonyl iron and their mixtures in a silicon rubber matrix. Emphasis is given to the complex permittivity and permeability parameters determination in the frequency range of 2 to 18 GHz and reflection loss measurements between 8-12 GHz. For the complex parameters determination a methodology based on coaxial transmission airline technique was established. The results show that the carbonyl iron interacts with the electric field of the incident wave through the storage component, since the electric field loss component is insignificant. The MnZn ferrite used shows variation of both storage and loss components with the increase of the additive concentration in the RAM and the frequency parameters. Considering the permeability, it is verified that the RAM sample based on carbonyl iron presents the highest values (1.0 to 2.2), in other words, this additive interacts more intensely with the wave magnetic field than with the ferrite (0.7 to 1.8). The measurements of the Reflection losses of RAM processed with the pure additives as well as with their mixtures present good results (70 - 99%). It is also observed that these samples behave as the resonant RAM type. The results also confirm that the microwave attenuation is dependent on the magnetic additive proportion, sample thickness and frequency. In the comparative studies of reflection losses, the experimental measurements and simulations show good agreement, suggesting that the simulation is an adequate support tool for optimizing these materials, diminishing costs and time of RAM processing.

Investigation of the distribution of the film cooling for the liquid rocket engine – LRE with 75 kN thrust

Luis Antonio Silva
Institute of Aeronautics and Space
silva@iae.cta.br

Master's Thesis in Engineering, defended at the Technological Institute of Aeronautics, ITA, São José dos Campos, São Paulo State, Brazil, 2009

Advisor: Prof. Dr. Amilcar Porto Pimenta

Keywords: Investigation, Film cooling, Rocket engine, Liquid propulsion.

Abstract: This work presents a methodology for analyzing a liquid rocket engine cooling system and more specifically an investigation of the film cooling method applied to a 75 kN thrust, kerosene and liquid oxygen rocket engine. In the case study, the engine cooling film is created by the fuel injected by peripheral injectors. Two possibilities were analyzed: in the first it was assumed that 50 per cent of the fuel injected by the peripheral injectors became part of the cooling film; in the second, the cooling film is constituted by only the fuel that flows on the walls. The injection system of an engine under development in IAE (L15) was used in cold tests to validate theoretical and empirical design data obtained by experts from Moscow Aviation Institute (MAI) and to refine some design parameters used in engines under development in IAE.

Adjusting the vertical profile of wind data obtained from anemometric tower and radiosounding in the “Alcântara Launch Center”

Ricardo Costa Leão
Institute of Aeronautics and Space
leão@iae.cta.br

Master's Thesis in Engineering, defended at the Technological Institute of Aeronautics, ITA, São José dos Campos, São Paulo State, Brazil, 2009

Advisors: Prof. Dr. Íria Fernandes Vendrame and Prof. Dr. Gilberto Fernando Fisch

Keywords: Matching, Vertical wind profiles, Cubic splines.

Abstract: This work aims to adjust (“match”) two different vertical wind profiles, one from an anemometric tower with 6 levels (6.0, 10.0, 16.3, 28.5, 43.0 and 70.0 m) obtained by measurements direct from the anemometer, and the other from radiosoundings with wind determination measured by GPS technique up to 500m, in vertical layers of 50m. The result was a single profile obtained using the cubic spline interpolation method, detection of average deviation

(“bias”) between the profiles and adjustment (“matching”) of the profiles, avoiding abrupt changes in the average profile. A real case study was conducted with determination of the trajectory of the rockets launched from the “Alcântara Launch Center” attaining a result that the point of impact strikes the dispersion field with less than 10 per cent error, relative to its radius using the settings profile.

Radar absorbing materials based on thin films processed by physical vapor deposition technique

Viviane Lilian Soethe
Technological Institute of Aeronautics
vivianes@ita.br;viviane.soethe@ig.com.br

Thesis submitted for PhD degree in Physics at Technological Institute of Aeronautics, ITA, São José dos Campos, São Paulo State, Brazil, 2009.

Advisors: Dr. Mirabel Cerqueira Rezende and Dr. Evandro Luis Nohara

Keywords: RAM, Thin films, Radar absorbing materials, PVD.

Abstract: This work shows the study of the production of metal thin films, with nanometric thicknesses, by Physical Vapor Deposition (PVD). Triode magnetron sputtering, electron beam and resistive evaporation techniques were used for the deposition of Al, Ni, Ti, Cu, C, CN_x and Al_xFe_y e Ni_xTi_y alloys. These materials were deposited on polymeric substrates of poly(ethylene terephthalate), with thicknesses of around 0.1 and 0.01 mm. Characterization of the films involved different aspects, such as: thickness, composition and the electromagnetic wave attenuation behavior, in the frequency range of 8–12 GHz. The correlation of the data obtained aimed to evaluate the performance of the nanofilms as Radar Absorbing Materials (RAM). The main result may be cited as the success of the PVD technique used for metal thin film production, being much lighter than the conventional absorbers, and with an excellent RAM behavior in the microwave range. Metal nanofilms are characterized as presenting thickness values below skin depth and dielectric losses. The experimental results show also that the film’s performance in microwave attenuation is affected by different factors, such as the deposition technique used, the metal type and the film thickness. Among the results obtained, we may mention: Al films with attenuation values of 99 per cent at the frequency of 9.5 GHz, Al_xFe_y and Ni_xTi_y films, processed by resistive evaporation technique, with attenuation values

of 70 per cent in broadband (8-12 GHz) and also multilayer structures obtained by adequate combination of nanofilms, with better RAM performance.

Synthesis, doping and characterization of furfuryl alcohol resin and phenol-furfuryl alcohol resin aimed at the optimization of glass-like carbon processing

Silvia Sizuka Oishi
São Paulo State University
silviaoishi@uol.com.br

Thesis submitted for Masters in Mechanical Engineering at São Paulo State University, Guaratinguetá, São Paulo State, Brazil, 2009.

Advisors: Dr. Edson Cocchieri Botelho and Dr. Mirabel Cerqueira Rezende

Keywords: Glassy-like carbon, Doping, Furfuryl alcohol resin, Phenol-furfuryl alcohol resin, Physicochemical properties.

Abstract: Given the growing importance of glassy carbon material in strategic areas, due to its intrinsic characteristics, such as lower density and good thermal and electrical conductivity values, several studies have been observed looking for new polymeric precursors and tighter processing parameters. Similarly, this study aims to establish synthesis routes for furfuryl and phenol-furfuryl alcohol resins and their doping with copper particles, in order to produce reticulated glassy carbon (RGC) electrodes. Within this context different formulations of furfuryl and phenol-furfuryl alcohol resins were synthesized by variation of the monomers – furfuryl alcohol, phenol and formaldehyde, respectively. Confirmation of the success of the synthesis was undertaken using FT-IR spectroscopy, gas chromatography, thermal analyses by differential scanning calorimetry (DSC) and carbon yield content measurements that present results between 27 and 45 per cent of carbon. After this, the specimens were doped with copper colloidal particles. The doped and non doped resins were catalyzed, impregnated in polyurethane (PU) foams and carbonized, in order to obtain the reticulated glassy carbon. Optical and Scanning Electron Microscopy analysis show the homogeneity of PU foams impregnation and uniform texture of RGC specimens. Compression results present the best values for RGC resulting from the carbonization with furfuryl alcohol acid resin (0.55 MPa).

