

"GHEORGHE ASACHI" TECHNICAL UNIVERSITY OF IAȘI
Faculty of Automatic Control and Computer Engineering
Department of Computer Engineering
Competition for academic position of professor: no. 5
Courses: Fault Tolerant Systems, Input-Output Systems

Thematic area
related to the the lecture from the thematic area
for the competition for the academic position of professor: no. 5
from the posts of the staff of the Department of Computer Engineering
for the academic year 2023-2024

Course title: **Fault tolerant systems**

- Fault tolerance – definition
 - The utility of fault tolerance evaluation
 - Applications of fault tolerance
- Dependability – definition, fundamental elements, attributes
 - Reliability, maintainability, availability,
 - Safety, integrity,
 - Credibility
- Dependability methods and threats
 - Predicting, preventing, and eliminating faults
 - Dependability evaluation
 - Threats: fault, error, and failure
- Reliability indicators
 - Failure rate
 - The operation probability
 - Methods for reliability measurement
 - Dispersion of operation periods
- Reliability models
 - Series, parallel and mixed models
- Hardware redundancy
 - Active reserves and passive reserves
 - Hybrid redundancy
 - Improving reliability indicators through redundancy
- Redundant systems
 - Methods for implementation of redundancy
 - Redundancy based on majority logic
 - Example: Triple modular redundancy (TMR) and TMR/Simplex
- Markov models for reliability and availability evaluation,,
 - Reconfigurable systems with or without reserves
 - Repairable systems
- Hybrid redundant structures
 - TMR with active reserves
 - TMR with passive reserves
- Self-testable systems
 - The general structure and the possible states
 - Determining dependability attributes based on states
 - Types of self-testable structures
 - Self-testable TMR structure
- Testing systems using test vectors (TV)

- Activation and propagation of defects
- Types of faults
- Exemplification of TV testing of logic circuits
- Reliability assessment of electrical equipment
 - Data acquisition and preprocessing
 - Evaluation method, sampling parameters
 - Data processing
- Redundancy of information
 - Codes: Hamming, cyclic, arithmetic
 - Hamming codes for error detection and correction
 - Encoding and decoding techniques
 - Redundant systems using coding
- Cyclic codes for detection of errors
 - Encoding and decoding using Cyclic Redundancy Check (CRC)
 - Properties of the generator polynomial
 - Error detection: detectable errors and undetectable errors
 - Example of implementation for CRC

References

- 1) D. Patterson, J. Hennessy, "Computer Organization and Design MIPS Edition: The Hardware/Software Interface", 6th edition, Morgan Kaufmann, ISBN: 978-0124077263 , 2020.
- 2) O. Stan, M. Misaroş, S. Enyedi, M. Misaros, L. Miclea, "Introduction to the dependability of systems (in Romanian)", Cluj - Napoca, Publisher: UTPress, ISBN 978-606-737-597-8, 2022.
- 3) I. Koren, CM Krishna, "Fault-Tolerant Systems - Second Edition", Publisher: Elsevier, ISBN 978-0-12-818105-8, 2020.
- 4) E. Dubrova, "Fault-Tolerant Design", Publisher: Springer, ISBN 978-1-4614-2113-9, 2013.
- 5) "Energy-Efficient Fault-Tolerant Systems", Editors: J. Mathew, R. Shafik, D. Pradhan (Eds.), ISBN 978-1-4614-4193-9, 2014.
- 6) E. Burlacu, et.al, "Introduction to the study of system reliability (in Romanian)", Scientific Ed. Bucharest, ISBN: 973-44-0158-0 , 1995.

Course title: **Input-output systems**

- I/O systems
 - Structure, modules, I/O types (programmed and interrupts),
 - I/O processors
- Direct memory access (DMA)
 - Performance and benefits
 - Structures of systems with DMA
- Computer buses
 - Electrical considerations, synchronization, arbitration,
 - The PCI parallel bus and its variants,
 - The VME bus and the VXS standard.
- I2C and SPI serial buses
 - The used signals
 - Communication protocols
 - Advantages of each communication protocol and applications
- Universal Serial Bus (USB)
 - Structure, pipelines, registers
 - Descriptors – overview

- Example of the USB descriptors for the computer mouse
- Peripherals for embedded systems:
 - Types of devices and their interfaces
 - External storage devices for data
- Liquid crystal displays
 - Twisted Nematic (TN),
 - Vertical Alignment (VA),
 - In-Plane Switching (IPS)
- Organic LED (OLED) displays :
 - Operation modes
 - Types of displays and advantages
- Other types of displays
 - LED-based displays
 - Electronic paper
- Graphics cards
 - Video RAM,
 - Graphics and 3D accelerators,
 - Graphics processing units
- Digital interfaces: HDMI, DVI
- Speech recognition systems
 - General structure and applications
 - Voice signal preprocessing
- Speaker-dependent speech recognition:
 - Dynamic time warping ,
 - The autocorrelation function
- Speaker-independent speech recognition
 - Applying the FFT to the voice signal,
 - Formant extraction,
 - Vowel and word recognition.

References:

- 7) ZF Baruch, " Input/Output Systems", MEGA Publishing House, Cluj-Napoca, ISBN 978-606-020-242-4, 2020.
- 8) R. Radescu, " Peripheral equipment (in Romanian)", Electra Publishing House, ISBN: 978-9-7378-3877-3, 2006.
- 9) V. Pulkki, M. Karjalainen, "Communication Acoustics - An Introduction to Speech, Audio and Psychoacoustics", ISBN 978-1-1198-2544-9 , 2015.
- 10) "Springer Handbook of Speech Processing", Editors: J. Benesty, MM Sondhi, YA Huang, ISBN: 978-3-540-49125-5, 2008.

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