Topics for PhD program: Computer Equipment and Technologies

Control Systems

1. Mathematical Modeling of Systems
2. Time-Domain Analysis
3. Frequency-Domain Analysis
4. Stability Analysis
5. Root Locus Technique
6. PID Controllers and Tuning
7. State-Space Representation
8. Compensator Design
9. Digital Control Systems

Recommended Textbooks:

- "Control Systems Engineering" by Norman S. Nise
- "Modern Control Engineering" by Katsuhiko Ogata

Signal Processing

1. Continuous-Time and Discrete-Time Signals
2. Linear Time-Invariant (LTI) Systems
3. Fourier Series and Fourier Transform
4. Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT)
5. Z-Transform and Its Applications
6. Sampling Theorem and Signal Reconstruction
7. Digital Filters (FIR and IIR)
8. Signal Modulation and Demodulation
9. Noise Reduction and Signal Enhancement

Recommended Textbooks:

- "Signals and Systems" by Alan V. Oppenheim, Alan S. Willsky, and S. Hamid Nawab
- "Digital Signal Processing: Principles, Algorithms, and Applications" by John G. Proakis and Dimitris G. Manolakis

Electronics

1. Semiconductor Fundamentals
2. Diodes and Applications (Rectifiers, Clipping Circuits)
3. Bipolar Junction Transistors (BJTs) and Biasing
4. Field-Effect Transistors (MOSFETs, JFETs)
5. Operational Amplifiers (Op-Amps) and Applications
6. Analog and Digital Signal Processing
7. Logic Gates and Digital Circuits
8. Frequency Response and Filters
9. Power Amplifiers and Oscillators

10. Data Converters (ADC/DAC)
11. Communication Electronics Basics
12. Microcontrollers and Embedded Systems
13. PCB Design and Fabrication
14. Sensors and Instrumentation Circuits
15. Noise and Signal Integrity in Electronics

Recommended Textbooks:

- "Electronic Devices and Circuit Theory" by Robert L. Boylestad and Louis Nashelsky
- "Microelectronic Circuits" by Adel S. Sedra and Kenneth C. Smith

Embedded systems

1. Embedded systems

- Definition, characteristics, and applications
- Basic architecture and components

2. Embedded C Programming

- Introduction to C in embedded systems
- Structure, variables, data types, and control structures
- Functions, pointers, and programming techniques

3. Embedded System Components

- Microcontrollers and Microprocessors
- Sensors, Actuators, and I/O devices

4. Memory Organization

- Types of memory: RAM, ROM, EEPROM, Flash
- Memory mapping and management techniques

5. Interrupts

- Concept and importance of interrupts
- Types and handling of interrupts

6. Timers

- Understanding and programming timers
- Application of timers in embedded systems

7. UART/USART

- Basics of serial communication
- UART/USART implementation and programming

8. I2C and SPI

- Introduction to I2C and SPI protocols
- Communication techniques using I2C and SPI

9. FreeRTOS

- Introduction to RTOS
- Core concepts and programming in FreeRTOS

Reading materials:

- Embedded Systems: Introduction to the MSP432 Microcontroller, Jonathan W. Valvano
- Making Embedded Systems: Design Patterns for Great Software, Elecia White
- The Art of Designing Embedded Systems, Jack Ganssle

Microprocessors

1. Introduction to Microprocessors – Evolution, basic concepts, and applications.

2. Microprocessor Architecture – Components, registers, ALU, control unit, and data flow.

3. Instruction Set and Assembly Language Programming – Types of instructions, addressing modes, and programming basics.

4. Memory Organization – Types of memory (RAM, ROM), memory interfacing, and mapping.

5. Input/Output (I/O) Interfacing – Parallel and serial communication, interfacing techniques.

6. Interrupts and Handling Mechanisms – Types of interrupts, interrupt handling, and priorities.

7. Timers and Counters – Operation, applications, and programming.

8. Microprocessor Peripherals – Interfacing with peripherals like ADC, DAC, and sensors.

9. Bus Systems and Communication Protocols – Address, data, control buses, and communication standards (I2C, SPI).

10. Microprocessor Applications and Trends – Real-world applications, embedded systems, and future trends.

Reading materials:

- The 8088 and 8086 Microprocessors: Programming, Interfacing, Software, Hardware, and Applications, Walter A. Triebel

- Microprocessor Architecture, Programming, and Applications with the 8085, Ramesh S. Gaonkar
- Computer Organization and Design: The Hardware/Software Interface, David A. Patterson and John L. Hennessy