

B.Eng. (Computer Engineering)
Content of Subjects
Applicable to Students Matriculating in 2015 onwards

FIRST YEAR

CE1002 INTRODUCTION TO COMPUTING SYSTEMS

Acad Unit: 3

Pre-requisite: Nil

Introduction; Computer Pioneers and their contributions; Evolution of Computers – Part I; Basic CPU operation and programming language evolution; Evolution of Computers– Part II; CPU Performance Enhancement techniques; Programming Languages; and Programming Paradigms; The internet; Networks and communications; Multi-tasking and Operating Systems; Classifications of Computer Systems; Computing Trends; The Database; e-learning

CE1003 INTRODUCTION TO COMPUTATIONAL THINKING

Acad Unit: 3

Pre-requisite: Nil

Computing and Algorithms; Introduction to Python; Basic syntax and meaning; Variables, Data types, and Operators; More on numbers and built-in functions; Flow control; Program Development Issues (supplementary); Strings and character access; Composite types; User defined functions and modules; File management; Exceptions

CE1004 INVENTIONS AND INNOVATIONS IN COMPUTING

Acad Unit: 2

Pre-requisite: Nil

Binary operations; Von Neumann and Harvard architectures; Invention of semiconductor materials; Examples of simple and complex CPUs; Programming Paradigms and Languages, Compilers and Algorithms; Operating Systems; Internet and distributed computing; Social networks; Numerical methods for the approximate computer solution of otherwise intractable problems; Databases; Data Analytics; Computer graphics and animation; Graphics Processor Unit; Computer and data security; Program Verification, Testing, Reliability and Correctness.

CE1005 DIGITAL LOGIC

Acad Unit: 3

Pre-requisite: Nil

Binary integers and arithmetic; Boolean Variables and Logic; Combinatorial circuits; Implementation technologies; Digital design using hardware description languages; Sequential circuits; Sequential circuits to building blocks; Finite state machines

CE1006 COMPUTER ORGANISATION AND ARCHITECTURE

Acad Unit: 3

Pre-requisite: CE1005 (can be taken concurrently)

Computer Hardware Decomposition; Data Representation, Memory Allocation and Access; Central Processing Unit; Assembly Programming and Instruction Set Architecture; High-level Software to Low-level Instructions; Computer Memory; Data Transfer and Input/Output (I/O) Techniques; Computer Arithmetic; Measuring system performance; Towards higher speed

CE1007 DATA STRUCTURES

Acad Unit: 3
Pre-requisite: CE1003

Basic Constructs in CC program structure, Syntax and semantics; Built-in Data Structures; Recursion; Memory Management in C; Linked Lists; Stacks and Queues; Tree Structures; Implementing other data abstractions

CE1011 Engineering Mathematics I

Acad Unit: 3
Pre-requisite: Nil

Complex Numbers; Vectors; Matrices; Systems of Linear Equations; Descriptive statistics; Probability theory; Probability and sampling distributions; Inferential statistics; Experimental and Numerical Methods.

CE1012 Engineering Mathematics II

Acad Unit: 3
Pre-requisite: CE1011 (can be taken concurrently)

Precalculus; Limits and Continuity; Differentiation; Integration; Ordinary Differential Equations (ODE); Sequences and Series; Function approximation; Numerical differentiation and integration; Fourier Series; Fourier Transform

CE0001 ENGINEERS AND SOCIETY

Acad Unit: 3
Pre-requisite: Nil

This course raises issues pertinent to engineers as professionals as well as members of society. It discusses the requirements and issues of the IT profession, examining the key role professionals play with their contributions to society. Current concerns will be raised of interest to any person living in Singapore.

MH1812 DISCRETE MATHEMATICS

Acad Unit: 3
Pre-requisite: Nil

Elementary number theory; Propositional logic; Predicate logic; Proof techniques; Sets; Linear recurrence relation; Relations; Functions; Graphs; Elementary Combinatorics

SECOND YEAR

CE2001 ALGORITHMS

Acad Unit: 3

Pre-requisite: CE1007, CE1012, MH1812

Introduction to algorithms; Analysis of algorithms; Sorting; Searching; Graphs; Basic Computability and Complexity Theory

CE2002 OBJECT ORIENTED DESIGN AND PROGRAMMING

Acad Unit: 3

Pre-requisite: CE1007

Introduction to Object Orientated Programming; Classes and Objects; C++ Programming Language; Inheritance and polymorphism; Interface and implementation; Object Relationships; Object Collaboration; Designing for Reuse; Java Programming Language; Persistent Objects

CE2003 DIGITAL SYSTEMS DESIGN

Acad Unit: 3

Pre-requisite: CE1005

Review of Verilog and the Digital Design Flow; Verification and Testing; Arithmetic Design; FPGA Architecture and Synthesis; Timing, Pipelining, and Scheduling; Subsystem Design; Busses and Interfacing; Fundamentals of Asynchronous Circuits

CE2004 CIRCUITS AND SIGNAL ANALYSIS

Academic Unit: .3

Pre-requisite: CE1012

DC Signal Analysis; AC Signal Analysis; Signals and Systems; Active Circuit Elements

CE2005 OPERATING SYSTEMS

Acad Unit: 3

Pre-requisite: CE1006, CE1007

Overview of Operating Systems (OS); Processes and Threads; Process Scheduling; Process Synchronization; Deadlock and Starvation; Memory Organization; Virtual Memory Management; File System Organization and Implementation; Input/Output (I/O) Management and Disk Scheduling; Issues in Real-time Operating Systems; Protection and Security

CE2006 SOFTWARE ENGINEERING

Acad Unit: 3

Pre-requisite: CE2002 (can be taken concurrently)

Introduction to Software Engineering; Requirement Specification; Analysis; Project Management; Design; Implementation and Testing; Maintenance

CE2007 MICROPROCESSOR-BASED SYSTEMS DESIGN

Acad Unit: 3

Pre-requisite: CE1006 & CE2004 (can be taken concurrently)

Microprocessor landscape; Microprocessor packages, signals and interfacing – Part 1; Introduction to ARM Cortex-M Architecture and Programming; Peripherals, interfaces and applications – Part 1; Analog signal conditioning and Interfacing; Displays; Signals and interfacing – Part 2; Peripherals, interfaces and applications – Part 2; Semiconductor memory technology and characteristics; Fabrication; System Design Issues; Further integration and programming

THIRD YEAR

CE3001 ADVANCED COMPUTER ARCHITECTURE

Acad Unit: 3

Pre-requisite: CE1006

Introduction and Background: Review of basic computer architecture; Instruction Set Architecture Design; Micro-architecture Design; Memory Systems and I/O Design; Instruction-Level Parallelism; Data-Level Parallelism; Thread-Level Parallelism; Emerging Computing Trends

CE3002 SENSORS, INTERFACING AND CONTROL

Acad Unit: 3

Pre-requisite: CE2004

Overview of electronic instrumentation and control systems; Transducers; Signal Conditioning Circuits; Amplifier circuits; Filter circuits; Op-Amp specifications; Signal conditioning circuit design; Digital Interfaces; Introduction to control system; z-transform; Transfer function; Design of Digital Control; Linear Discrete Data System

CE3003 MICROCONTROLLER PROGRAMMING

Acad Unit: 3

Pre-requisite: CE2005

Integrated Development Environments; Microcontroller Architectures; Efficient Real-time 'C' Programming Techniques; Linking 'C' with Assembler and Libraries; Programming Peripherals and Subsystems; Handling Multiple Tasks in Real-Time; Real-Time Operating Systems; Compiler optimizations

CE3004 MULTIDISCIPLINARY DESIGN PROJECT (MDP)

Acad Unit: 4

Pre-requisite: At least Third Year Standing

The Multidisciplinary Design Project (MDP) is a group-based design project undertaken by a mixed group of students comprising of undergraduates from the CE, CS, BCG and BCE programmes. The project is practical-oriented and multi-disciplinary in nature, requiring system level integration of sub-systems developed by different team members.

The course project will be updated from year to year to remain interesting and relevant. Details of the current year's project will be made known to students at initial MDP briefing.

Microprocessors, Signals and Interfaces; Sensors and Communication; Software engineering; Data structures and Algorithms; Open-source frameworks; Human-computer interaction; System analysis and design

NB: MDP is to be done over one semester by students who have reached at least a year 3 standing. Eligible students will be automatically registered by the school and will be allocated to their respective project group based on a composition of students from different programmes. Students cannot choose to defer the MDP.

Course Schedule: Twelve two-hour weekly slots and five full days during the entire recess week.

The group-based nature of MDP makes it important that the disruptive absence of members is strongly discouraged. Attendance for all scheduled MDP activities is thus compulsory. Students who do not satisfy at least 80% of the overall attendance without valid reasons (e.g. MC) will be deemed to have failed MDP. Students who miss more than 50% of the scheduled MDP sessions will not be deemed to have fulfilled the learning outcomes of MDP and they will be required to re-take MDP in the next available offering. In other words, an "I" will be reflected in the result transcript for MDP.

CE3005 COMPUTER NETWORKS

Acad Unit: 3

Pre-requisite: CE1011 & CE1012

Computer Network Concepts; Network Types and Performances; Data Link Layer; Local Area Networks; Network Layer; Transport Layer; Application Layer

CE3006 DIGITAL COMMUNICATIONS

Acad Unit: 3

Pre-requisite: CE1011 & CE2004

Introduction; Signals and Spectra; Baseband Modulation, Demodulation/Detection; Band-pass Modulation, Demodulation/detection; Source Coding; Channel Coding; Challenges in Communication System Design

CE3007 DIGITAL SIGNAL PROCESSING

Acad Unit: 3

Pre-requisite: CE2004

Discrete-time Signals and Systems; Frequency Analysis of Signals and Systems; The Discrete Fourier Transform; Sampling and Reconstruction; FIR and IIR Filter Design, Digital Filter Structure

FOURTH YEAR

TECHNICAL ELECTIVES

CE/CZ4001 VIRTUAL AND AUGMENTED REALITY

Acad Unit: 3
Pre-requisite: CZ2003

Introduction; Graphical Scene; Animation and Sensing; Light and Sound; Controlling Environment; Programming Scripts; Introduction to Augmented Reality; Displays for Augmented Reality; Tracking, Recognition and Registration; Rendering and Augmentation; Examples of Augmented Reality System

CE/CZ4002 VISUAL MEDIA COMPRESSION AND PROCESSING

Acad Unit: 3
Pre-requisite: Nil

Introduction to media management & processing; Entropy coding; Digital image coding techniques; Motion Estimation; Digital video coding techniques; Advanced topics for visual signal compression; Content Base Image retrieval

CE/CZ4003 COMPUTER VISION

Acad Unit: 3
Pre-requisite: Nil

Introduction to computer vision; Principles of Camera Systems; Image Enhancement in the Spatial domain; Image Enhancement in the Frequency domain; Colour; Edge Processing; Region Processing; Imaging Geometry; 3D Stereo Vision; Object Recognition

CE/CZ4004 3D MODELING AND ANIMATION

Acad Unit: 3
Pre-requisite: CZ2003

Introduction; Computer Graphics Pipeline; Graphics Programming; 3D Shape Representation; Geometric Processing; Rendering; Basic Animation Techniques; Kinematic Animation; Physics Based Simulation; Motion Capture

CE/CZ4005 AUDIO AND SPEECH PROCESSING

Acad Unit: 3
Pre-requisite: Nil

Introduction; Speech Production and Transcription; Audio Signal Analysis; Audio and Speech Signal Classification; Text to Speech Synthesis; Speaker Recognition/Verification

CE/CZ 4011 PARALLEL COMPUTING

Acad Unit: 3
Pre-requisite: CZ/CE2001 & CZ/CE3001

Foundations & Theory; Distributed Memory Programming; Shared Memory Programming; Special E-Learning Topic, Load Balancing; Massively Parallel Programming; Cases Studies

CE/CZ4013 DISTRIBUTED SYSTEMS

Acad Unit: 3

Pre-requisite: CZ/CE2005 & CE3005 or CZ3006

Characteristics of distributed systems and system models; Interprocess communication; Distributed objects and remote invocation; Distributed file systems; Peer-to-peer systems; Name services; Time and global states; Coordination and agreement; Replication and consistency

CE/CZ4015 SIMULATION AND MODELLING

Acad Unit: 3

Pre-requisite: CE/CZ1007 & CE/CZ1011

Introduction; Different Types of Simulation; Simulation World View and Simulation Software; Basic Probability and Statistical Models for Simulation; Random Numbers and Random Variate Generation; Input Modelling; Verification and Validation of Simulation Models; Output Analysis; Comparison of Alternative Designs; Queueing Models

CE/CZ4016 ADVANCED TOPICS IN ALGORITHMS

Acad Unit: 3

Pre-requisite: CE/CZ2001

Analysis Techniques; Dynamic Programming; Search Techniques; Computational Geometry; Min Cut /Max Flow; Lower Bounds and NP-completeness; Approximation Algorithms and Heuristics; Randomized Algorithms

CE/CZ4021 PERVASIVE NETWORKS

Acad Unit: 3

Pre-requisite: CE3005 or CZ3006

Introduction of Pervasive Networks; Medium Access Control (MAC) for Wireless Networks; Routing in Mobile Ad Hoc Networks (MANETs); Mobility Management Services in Cellular Networks; Mobile Internet Protocol (IP)

CE/CZ4022 PERSONAL MOBILE NETWORKS

Acad Unit: 3

Pre-requisite: CE3005 or CZ3006

Fundamentals of Wireless Mobile Communications; Overview of mobile networks, Wireless Personal Area Networks (WPAN); Wireless Local Area Networks (WLAN); Wireless Wide Area Networks (WWAN): cellular communications networks, satellite communications.

CE/CZ4023 ADVANCED COMPUTER NETWORKS

Acad Unit: 3

Pre-requisite: CE3005 or CZ3006

Top-Down View of Computer Networks; Application Layer Protocols; Multimedia Networking; Advanced Network Protocols; QoS and Traffic Management; Network Deployment and Design

CE/CZ4024 CRYPTOGRAPHY AND NETWORK SECURITY

Acad Unit: 3

Pre-requisite: CE3005 or CZ3006

Security Threats and Security Goals; Mathematical Background; Secret-Key Cryptography; Public-Key Cryptography; Hash Functions and MACs; Key Management; Authentication Protocols; Key Establishment Protocols

CE4051 EMBEDDED SYSTEMS DESIGN

Acad Unit: 3

Pre-requisite: CE2003, CE/CZ3001

What is Design; Meeting Design Constraints; Software Design (Modeling); Software Design (Analysis); Hardware Design (Modelling); Hardware Design (Implementation); Sensors and I/O Hardware/Software Co-Design; Hardware/Software Co-Design (Case study)

CE4052 EMBEDDED SYSTEMS DEVELOPMENT

Acad Unit: 3

Pre-requisite: CE/CZ2006 & CE/CZ3001

Introduction to Embedded Systems Programming; The Android Ecosystem; Software Design and Management; Profiling & Optimization; Hardware Acceleration; Multi-Threading; Scheduling & Prioritisation; Advanced Topics

CE4053 EMBEDDED OPERATING SYSTEMS

Acad Unit: 3

Pre-requisite: CE/CZ2005

Embedded OS Introduction; Relevance of Embedded OS; Benchmarking Performance; Single-core Scheduling; Multi-core Scheduling; Resource/Data Sharing; Isolation through Virtualization; RTOS case-studies; Recent Trends

CE4054 PROGRAMMABLE SYSTEMS-ON-CHIP

Acad Unit: 3

Pre-requisite: CE2003

Intro to Programmable SoCs; The SoC Design Flow; SoC Compute Organizations; Communication and I/O Abstractions; Tuning SoCs; Memory Organizations; Advanced Optimization Topics; Design Space Exploration; SoC Project Management and Formulation

CE/CZ4062 COMPUTER SECURITY (SYSTEM SECURITY)

Acad Unit: 3

Pre-requisite: CE/CZ2005

Introduction, Concepts, and Terminology; Identification and Entity Authentication; Access-Control; Security Models; Reference Monitors; Operating System Security; Software Security; Case Studies

CE/CZ4064 SECURITY MANAGEMENT

Acad Unit: 3

Pre-requisite: CE/CZ2006

Introduction; Information Security, Governance, and the Law; Model, Framework, and Approach; Organization and People; Risk Analysis and Assessments; Security Operations; Internal Control, Audit, and Security; Contingency Planning and Management

CE/CZ4065 DIGITAL FORENSICS

Acad Unit: 3

Pre-requisite: CE/CZ1001 or MH1812

Overview of forensic science; Anti-Forensics; Host Forensics; Information Hiding; Non-Standard Storage Mechanisms and Devices; Network Forensics