计算机体系结构 教学大纲

Computer Architecture Subject Syllabus

一、课程信息 Subject Information

课程编号: Subject ID	3100213013	开课学期: Semester	6
课程分类: Category	学科素养 SE	所属课群: Section	专业平台 MT
课程学分: Course Credit	2	总学时/周: Total Hours/Weeks	32/8
理论学时: LECT. Hours	32	实验学时: EXP. Hours	0
PBL 学时: PBL Hours	0	实践学时/周: PRAC. Hours/Weeks	0
开课学院: College	东北大学 悉尼智能科技学院 Sydney Institute of Intelligent Technology Northeastern University	适用专业: Major	计算机科学与技术 CST
课程属性: Pattern	选修 Elective	课程模式: Mode	自建 NEU
中方课程协调人: NEU Coordinator	张冬丽 Zhang Dongli	成绩记载方式: Result Type	百分制 Marks
先修课程: Requisites	计算机组成原理 Principles of Computer Organization、操作系统 Operating Systems、编译原理 Compilation Principle		
英文参考教材: EN Textbooks	无 None		
中文参考教材: CN Textbooks	张晨曦，王志英. 计算机系统结构教程（第 2 版）， 清华大学出版社，2014		
教学资源: Resources	无 None		
课程负责人(撰写人): Subject Director	张冬丽	提交日期: Submitted Date	3/6/2023
任课教师(含负责人): Taught by	张冬丽		
审核人: Checked by	韩鹏	批准人: Approved by	史闻博
		批准日期: Approved Date	3/19/2023

二、教学目标 Subject Learning Objectives (SLOs)

注：毕业要求及指标点可参照悉尼学院本科生培养方案，可根据实际情况增减行数

Note: GA and index can be referred from undergraduate program in SSTC website. Please add/reduce lines based on subject.

整体目标: Overall Objectives	该课程是深入了解计算机结构与组成的核心内容，也是对计算机性能和发展走向影响重大的技术之一。知识内容主要包括计算机体系结构的划分、指令系统设计、流水线技术、向量处理机、存储系统、输入输出系统、多处理机、集群系统等内容，其目的和任务是提高学生从总体结构、系统分析这一层次来研究和分析计算机系统的能力，帮助学生建立整机的概念，使学生掌握计算机系统结构基本的概念、原理、结构、设计和分析方法，并对计算机系统结构的发展历史和现状有所了解，从而使学生能够理解计算机体系结构的核心价值及其对提高自主创新能力，建设创新型国家的重要意义。This subject is the core content of in-depth understanding of computer structure and composition, and is also one of the technologies that have a significant impact on computer performance and development. The knowledge content mainly includes the division of computer architecture, instruction system design, pipeline technology, vector processor, storage system, input/output system, multiprocessor, cluster system, etc. Its purpose and task is to improve students' ability to study and analyze computer systems from the level of overall structure and system analysis, to help students build the concept of complete machine, and enable students to master the basic concept of computer system structure Principles, structures, design and analysis methods, and to understand the development history and current situation of the computer system structure. Therefore, students can understand the core value of computer architecture and its significance for improving independent innovation ability and building an innovative country.	
（1）专业目标: Professional Abilities	1-1	熟悉计算机系统结构基础知识,理解计算机系统的多级层次结构，掌握计算机系统设计的原理及主要方法 Students need to familiar with basic knowledge of computer system architecture, understand the multi-level hierarchical structure of computer systems, and master the principles and main methods of computer system design.
	1-2	理解指令系统结构的分类及寻址方式,掌握指令系统设计的基本原则，以及在设计中缩短指令编码长度的常用方法； Students need to understand the classification and addressing methods of instruction system structures, master the basic principles of instruction system design, and commonly used

		methods to shorten instruction encoding length .
	1-3	理解流水线的原理及性能评价指标,掌握提高流水线性能的方式，以及单功能非线性流水线的最优调度方法； Students need to understand the principles and performance evaluation indicators of pipeline, master the ways to improve pipeline performance, and the optimal scheduling method for single function nonlinear pipelineg.
	1-4	熟悉常用的存储系统层次结构,掌握存储系统中改进平均访存时间的原理以及代表性方法； Students need to familiar with commonly used storage system hierarchies, grasp the principles and representative methods of improving average access time in storage systems.
	1-5	熟悉 I/O 系统中常用的 RAID 分类与特点，掌握评测 I/O 系统的性能参数的方法。Students need to familiar with the commonly used RAID classifications and characteristics in I/O systems, and master the methods of evaluating the performance parameters of I/O systems.
（2）德育目标: The Goals of Moral Education	2-1	通过学习计算机体系结构,学生能够掌握计算机底层框架与发展规律，通晓天下道理，丰富学识，增长见识，塑造品格，努力成为德智体美劳全面发展的社会主义建设者和接班人； By learning the computer architecture, students can master the underlying framework and development laws of computers, understand the truth of the world, enrich their knowledge, increase their knowledge, shape their character, and strive to become socialist builders and successors with all-round development of morality, intelligence, physique, beauty and labor;
	2-2	引导学生明确技术是不断的积累选择与精益求精,认知大国工匠精神的内涵及时代意义,增强专业认同感、民族责任感。 Guide students to clarify that technology is a continuous accumulation of choices and striving for excellence, to recognize the connotation and contemporary significance of the spirit of great craftsmanship, and to enhance their professional identity and sense of national responsibility.
	2-3	认知提升工程科技人才的创新创业能力、责任意识对提高中国在全球发展核心竞争力的作用. The role of enhancing the innovation and entrepreneurship abilities and sense of responsibility of engineering and technology talents in enhancing China's core competitiveness in global development through cognitive enhancement.

课程教学目标与毕业要求的对应关系 Matrix of GA & SLOs

毕业要求 GA	指标点 GA Index	教学目标 SLOs
1、工程知识：能够将数学、自然科学、工程基础和专业	指标点 1-1：掌握数学、自然科学、工程基础和专业知识，并使用其建立正确的	1-1，2-1

知识用于解决复杂工程问题。	数学、物理学等模型以解释复杂工程问题；	
	指标点 1-2：掌握程序设计、数据结构、算法分析与设计、计算机数字系统、操作系统等专业知识，具备计算机程序设计开发能力和计算机与信息系统设计开发与维护能力；	1-2，2-1，2-2
2、问题分析：能够应用数学、自然科学和工程科学的基本原理、方法和手段，识别、表达、并通过文献研究分析复杂工程问题，以获得有效结论。	指标点 2-1：能够应用数学、自然科学和工程科学的基本原理、方法和手段，分析、识别、表达本专业相关的复杂工程问题；	1-2，1-3，2-1
	指标点 2-2：能够应用数学、自然科学和工程科学的基本原理、方法和手段，针对实际复杂工程问题设计针对性的技术方案，并综合运用文献、科学理论和技术手段予以解决。	1-3，1-4，1-5，2-1，2-3
3、设计/开发解决方案：能够设计针对复杂工程问题的解决方案，设计满足特定需求的系统、单元或流程，并能够在设计环节中体现创新意识，考虑社会、健康、安全、法律、文化以及环境等因素。	指标点 3-1：能够设计针对本专业相关复杂工程问题的解决方案，能够设计和开发实现特定功能、满足特定需求的计算机、软件或网络系统。	1-2，1-3，1-4，1-5，2-2，2-3
	指标点 3-2：能够对不同设计方案进行比较和优化，在工作各环节中具有创新意识。	1-2，1-3，2-3
4、研究：能够基于科学原理并采用科学方法对复杂工程问题进行研究，包括设计实验、分析与解释数据、并通过信息综合得到合理有效的结论。	指标点 4-3：能够追踪国际前沿技术动态，掌握本专业涉及的重要技术指标以及达到指标所需的技术途径。	1-1，1-3，2-1
5、使用现代工具：能够针对复杂工程问题，开发、选择与使用恰当的技术、资源、现代工程工具和信息技术工具，包括对复杂工程问题的预测与模拟，并能够理解其局限性。	指标点 5-1：能够对本专业相关复杂工程问题进行建模与分析，理解获取相关信息参数的必要性与基本方法，并理解其局限性。	1-4，1-5，2-1
	指标点 5-3：能够针对本专业相关复杂工程问题，选择与使用恰当的技术、资源、现代工程工具和信息技术工具。	1-3，1-4，1-5，2-2

三、教学内容 Contents (Topics)

注：以中英文填写，各部分内容的表格可根据实际知识单元数量进行复制、扩展或缩减

Note: Filled in both CN and EN, extend or reduce based on the actual numbers of knowledge unit

(1) 理论教学 Lecture

知识单元序号: Knowledge Unit No.	1	支撑教学目标: SLOs Supported	1-1，2-3
知识单元名称 Unit Title		计算机系统结构的基本知识 Basic knowledge of computer system architecture	

知识点: Knowledge Points	计算机系统结构的概念 The concept of computer system architecture； 计算机系统结构的发展； The development of computer system architecture； 影响计算机系统结构的成本和价格因素； The factors of cost and price affect computer system architecture；
	定量分析技术基础 Fundamentals of quantitative analysis technology； 计算机系统结构中并行性的发展（并行性概念，提高并行性的技术途径） The Development of Parallelism in Computer System Architecture (Concept of Parallelism, Technical Approaches to Improving Parallelism)

学习目标: Learning Objectives	了解: Recognize	计算机体系结构的发展史、计算机体系结构的研究对象和内容以及学习本课程的目的、意义和要求。 The development history of computer architecture, the research object and content of computer architecture, and the purpose, significance and requirements of learning this course.
	理解: Understand	计算机体系结构的发展与分类 Development and classification of computer architecture
	掌握: Master	计算机系统的多级层次结构及计算机体系结构的概念 Hierarchical Structure of Computer System and the Concept of computer architecture

德育目标 Moral Objectives	认知当前全球，特别是我国计算机基础理论创新的发展对提升中国工程关键技术及核心竞争力的重要意义。 The significance in understanding the current global, especially the development of computer basic theory innovation in China, in enhancing the key technologies and core competitiveness of Chinese engineering.
重点: Key Points	基本概念、计算机体系结构中的定量分析技术 Basic concepts, quantitative analysis techniques in computer architecture

难点: Difficult Points	Amdahl 定理 Amdahl's theorem

知识单元序号: Knowledge Unit No.	2	支撑教学目标: SLOs Supported	1-2，2-2
知识单元名称 Unit Title	指令系统的设计 Design of instruction system		

知识点: Knowledge Points	指令集结构的分类；寻址技术；指令集结构的功能设计；操作数的类型和表示； Classification of instruction set structures; Addressing technology; Functional design of instruction set structure; The type and representation of operands;
	指令集系统的发展与改进 Development and Improvement of Instruction Set Systems

学习目标: Learning Objectives	了解: Recognize	指令系统结构的分类 Classification of instruction system structures
	理解: Understand	指令操作码的优化 Optimization of instruction opcodes
	掌握: Master	指令系统的基本要求 Basic requirements for instruction systems

德育目标 Moral Objectives	引导学生明确技术是不断的积累选择与精益求精，认知大国工匠精神的内涵及时代意义，增强专业认同感、民族责任感。 Guide students to clarify that technology is a continuous accumulation of choices and striving for excellence, to recognize the connotation and contemporary significance of the spirit of great craftsmanship, and to enhance their professional identity and sense of national responsibility.
重点: Key Points	指令集结构分类、寻址技术、指令设计技术 Classification of instruction set structure, addressing technology, and instruction design technology.
难点: Difficult Points	指令操作码最短码长编码方式与优化的计算 The shortest code length encoding method and optimization calculation for instruction operation codes.

知识单元序号: Knowledge Unit No.	3	支撑教学目标: SLOs Supported	1-3，2-2
知识单元名称 Unit Title	**流水线技术** Pipeline technology		

知识点: Knowledge Points	流水线的基本概念及分类；流水线性能分析（时空图，吞吐率，加速比，效率，消除流水线瓶颈段的方法）； The basic concept and classification of assembly lines; Pipeline performance analysis (spatiotemporal graph, throughput, acceleration ratio, efficiency, methods for eliminating pipeline bottleneck segments);
	流水线中的相关、冲突及解决方法（结构相关，数据相关，控制相

		关，定向技术，指令调度，分支预测，延迟分支等）
		Correlation, conflict, and resolution methods in pipeline (structure related, data related, control related, directional technology, instruction scheduling, branch prediction, delayed branches, etc.);
学习目标: Learning Objectives	了解: Recognize	MIPS R4000 流水线计算机简介 Introduction to MIPS R4000 Pipeline Computer
	理解: Understand	流水线的基本概念及分类 Basic concepts and classification of assembly lines
	掌握: Master	流水线相关的概念，流水线性能分析方法，避免冲突的常用技术和方法 The concept of pipeline hazards, pipeline performance analysis methods, and commonly used techniques and methods to avoid conflicts
德育目标 Moral Objectives		引导学生明确技术是不断的积累选择与精益求精，认知大国工匠精神的内涵及时代意义，增强专业认同感、民族责任感。 Guide students to clarify that technology is a continuous accumulation of choices and striving for excellence, to recognize the connotation and contemporary significance of the spirit of great craftsmanship, and to enhance their professional identity and sense of national responsibility.
重点: Key Points		流水线概念与流水线性能分析 Pipeline Concept and Pipeline Performance Analysis
难点: Difficult Points		流水线中相关与冲突的概念及解决方法 The Concept and Solution of Pipeline hazards and Conflict

知识单元序号: Knowledge Unit No.	4	支撑教学目标: SLOs Supported	1-1，2-1

知识单元名称 Unit Title	向量处理机 Vector processor		
知识点: Knowledge Points	向量的处理方式（横向处理方式，纵向处理方式）；Vector processing methods (horizontal processing, vertical processing) 向量处理机的结构（"存储器-存储器"结构，"寄存器-寄存器"结构）The structure of vector processors ("memory-memory" structure, "register- register" structure)		
	提高向量处理机性能的常用技术 Common Techniques for Improving the Performance of Vector Processors		
学习目标: Learning Objectives	了解: Recognize	向量处理机的结构 The Structure of Vector Processors	
	理解: Understand	非向量处理机的概念与功能 The Concept and Function of Non Vector Processors	
	掌握: Master	向量的两种处理方式，提高向量处理机性能的常用技术 Two processing methods for vectors, and commonly used techniques to improve the performance of vector processors	

德育目标 Moral Objectives	让学生通过学习，掌握事物发展规律，通晓天下道理，丰富学识，增长见识，塑造品格，努力成为德智体美劳全面发展的社会主义建设者和接班人 Through learning, students can master the laws of development, understand the principles of the world, enrich their knowledge, broaden their horizons, shape their character, and strive to become socialist builders and successors with comprehensive development of morality, intelligence, physical fitness, aesthetics, and labor.
重点: Key Points	向量的处理方式，提高向量处理机性能的常用技术 Processing mode for vectors, and commonly used techniques to improve the performance of vector processors
难点: Difficult Points	向量处理机的结构，向量处理机性能的度量方法 The structure of vector processors and methods for measuring their performance.

知识单元序号: Knowledge Unit No.	5		支撑教学目标: SLOs Supported	1-4，2-1
知识单元名称 Unit Title	存储器层次结构 Memory hierarchy			
知识点: Knowledge Points	存储器的层次结构 The hierarchical structure of storage； Cache 基本知识 Basic knowledge of Cache； Cache 性能分析 Cache performance analysis； 降低 Cache 失效率的方法 Methods to Reduce Cache Failure Rate			
	减少 Cache 失效开销的方法 Methods to reduce cache failure costs； 减少命中时间的方法 Methods to reduce hit time			
	虚拟存储器 Virtual storage			
学习目标: Learning Objectives	了解: Recognize	存储器层次结构 Memory hierarchy； 提高命中率的方法 Methods to improve hit rate		
	理解: Understand	Cache 结构和的工作原理 Cache structure and working principle		
	掌握: Master	Cache 的命中率计算 Calculation of cache hit rate		
德育目标 Moral Objectives	让学生通过学习，掌握事物发展规律，通晓天下道理，丰富学识，增长见识，塑造品格，努力成为德智体美劳全面发展的社会主义建设者和接班人 Through learning, students can master the laws of development, understand the principles of the world, enrich their knowledge, broaden their horizons, shape their character, and strive to become socialist builders and successors with comprehensive development of morality, intelligence, physical fitness, aesthetics, and labor			
重点: Key Points	存储器的层次结构 The hierarchical structure of storage Cache 结构 Cache structure 提高命中率技术 Techniques for improving hit rates			

难点: Difficult Points	改进平均访存时间的方法 Method for improving average memory access time

知识单元序号: Knowledge Unit No.	6	支撑教学目标: SLOs Supported	1-1，1-5，2-2
知识单元名称 Unit Title	输入输出系统 Input /output system		
知识点: Knowledge Points	I/O 系统与外部存储设备 I/O system and external storage devices； 可靠性、可用性和可信性 Reliability, availability, and credibility； 廉价磁盘冗余阵列(RAID) Redundant array of inexpensive disks (RAID)		
	I/O 系统性能分析 I/O system performance analysis		
	I/O 与操作系统　I/O and operating system		

学习目标: Learning Objectives	了解: Recognize	I/O 系统设备与 CPU 的连接方法 Connection method between I/O system equipment and CPU
	理解: Understand	I/O 系统的发展　Development of I/O systems
	掌握: Master	廉价磁盘冗余阵列(RAID)概念与各级特点 The concept and characteristics of redundant array　of inexpensive disks(RAID)

德育目标 Moral Objectives	寓价值观引导于知识传授和能力培养之中，帮助学生塑造正确的世界观、人生观、价值观 Integrating values into knowledge impartation and ability development, helping students shape correct outlooks on worldviews, life, and values.
重点: Key Points	I/O 设备与 CPU/存储器的连接方法及性能分析 The connection method and performance analysis between I/O devices and CPU/memory
难点: Difficult Points	主流 RAID 的分类与各自特点 Classification and characteristics of main current RAID

知识单元序号: Knowledge Unit No.	7	支撑教学目标: SLOs Supported	1-1，2-3
知识单元名称 Unit Title	多处理机 Multiprocessor		
知识点: Knowledge Points	并行计算机系统结构的分类 Classification of Parallel Computer System Architecture		
	互连网 Interconnection network 同步 Synchronization		

学习目标: Learning Objectives	了解: Recognize	并行计算机系统结构的分类 Classification of Parallel Computer System Architecture
	理解: Understand	多处理机的概念、出现与发展 The Concept, Generation, and Development of Multiprocessors

	掌握: Master	多处理机结构和共享存储器系统结构 Multiprocessor Architecture and Shared Memory System Architecture
德育目标 Moral Objectives		认知提升工程科技人才的创新创业能力、责任意识对提高中国在全球发展核心竞争力的作用 The role of enhancing the innovation and entrepreneurship abilities and sense of responsibility of engineering and technology talents in enhancing China's core competitiveness in global development through cognitive enhancement
重点: Key Points		多处理机结构 Multiprocessor Architecture; 共享存储器系统结构 Shared Memory System Architecture
难点: Difficult Points		并行计算机系统结构的分类 Classification of Parallel Computer System Architecture; 对称共享存储器系统结构 Symmetrical Shared Memory System Architecture

四、教学安排 Teaching Schedule

注：可根据实际情况增减行数

Note: Please add/reduce lines based on subject.

教学内容 Teaching Contents	学时(周)Hour(Week)			
	理论 LECT.	实验 EXP.	实践 PRAC.	PBL
计算机系统结构的基本知识 Basic knowledge of computer system architecture	4	0	0	0
指令系统的设计 Design of instruction system	4	0	0	0
流水线技术 Pipeline technology	6	0	0	0
向量处理机 Vector processor	4	0	0	0
存储器层次结构 Memory hierarchy	6	0	0	0
输入输出系统 Input and output system	4	0	0	0
多处理机 Multiprocessor	4	0	0	0
总计 Total	32	0	0	0

五、教学方法 Teaching Methodology

注：可根据实际情况增减行数或修改内容

Note: Please add/reduce lines or revise content based on subject.

勾选 Check	教学方法与特色 Teaching Methodology & Characters
☑	多媒体教学：基于信息化设备的课堂教学 Multi-media-based lecturing
☑	实践能力传授：理论与行业、实际案例相结合 Combining theory with industrial practical problems
☑	课程思政建设：知识讲授与德育相结合 Knowledge delivery with ethic education
☐	PBL 教学：问题驱动的分组学习与交流 Problem-based learning
☐	其他: Other:

六、成绩评定 Assessment

注：可根据实际情况增减行数或修改内容

Note: Please add/reduce lines or revise content based on subject.

考核环节: Assessment Content	平时 Behavior	环节负责人: Director	张冬丽
给分形式: Result Type	百分制 Marks	课程总成绩比重(%): Percentage (%)	50
考核方式: Measures	平时成绩以学生出勤和学生作业完成情况综合评定，其中，学生出勤占平时成绩的 60%，学生作业完成情况占平时成绩的 40%。 According to attendance and assignments performance of the students, the mark is evaluated, where attendance accounts for 60%, assignments performance accounts for 40%.		

考核环节: Assessment Content	期末 Final	环节负责人: Director	张冬丽
给分形式: Result Type	百分制 Marks	课程总成绩比重(%): Percentage (%)	50
考核方式: Measures	考试，2 小时答题。 Examination, two hours.		

七、改进机制 Improvement Mechanism

注：未尽事宜以教学团队以及学院教学指导委员会商定为准。

Note: Matters not covered in this file shall be determined by TAB of SSTC, NEU.

教学大纲改进机制 Subject Syllabus Improvement Mechanism			
考核周期(年): Check Period (YR)	4	修订周期(年): Revise Period (YR)	4
改进措施 Improvement Measures	课程负责人根据课程教学内容与人才培养目标组织课程团队讨论并修改教学大纲，报分管教学工作副院长审核后由执行院长批准。 The subject coordinator shall be responsible for the syllabus discussion and improvement, and the revised version shall be submitted to deputy dean (teaching affairs) for reviewing then to executive dean for improvement.		
成绩评定改进机制 Assessment Improvement Mechanism			
考核周期(年): Check Period (YR)	1	修订周期(年): Revise Period (YR)	1
改进措施: Improvement Measures	课程负责人根据课程教学内容、课堂教学效果以及成绩分布，对课程教学方法和成绩评定环节进行改进，并同步优化评定办法。 The subject coordinator shall revise the syllabus based on the teaching content, effect and result distribution while optimize the assessment measures.		