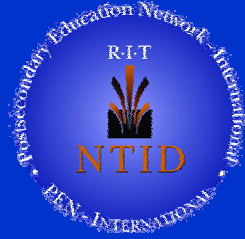


# Teaching Mathematics to Deaf College Students: The NTID Model



A PEN-International Workshop  
For PEN-International Partners in China

By  
Professors Daniele & Carr  
June 22-23, 2004  
Changchun, China

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聋哑大学生数学教育: NTID模式

PEN-International 研讨会

针对PEN-International 的中国合作伙伴

Daniele & Carr 教授

2004年六月22-23日

长春, 中国

PEN-International 是日本Nippon财团赞助



## Teaching Mathematics to Deaf College Students: The NTID Model

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Rochester Institute of Technology

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聋哑大学生数学教育: NTID模式


教授和系主任: Vincent A. Daniele 博士

副教授: Joan A. Carr 小姐

罗切斯特理工大学

国家聋哑工业学院

科学数学系



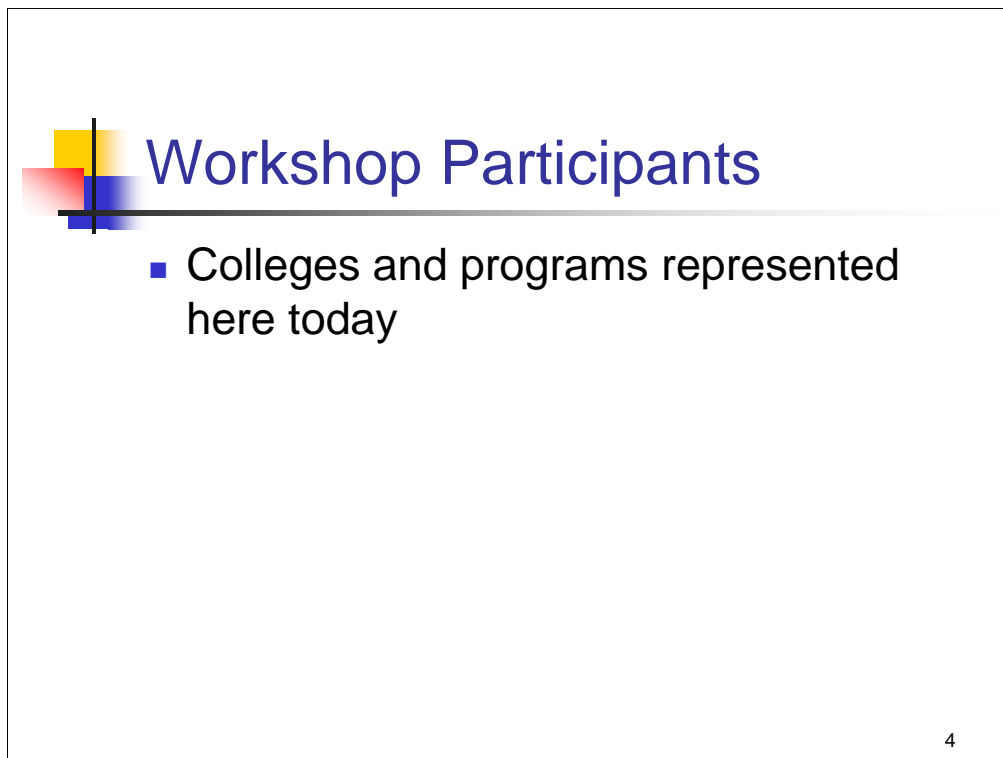
## Communication

- Thank you to our translator
- We welcome your questions and comments at any time during the presentation

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### 信息交流

- 感谢翻译
- 我们欢迎大家在研讨会中任何时候进行提问发言

A presentation slide titled "Workshop Participants". The title is in a large, blue, sans-serif font. To the left of the title is a graphic consisting of overlapping colored squares (yellow, red, blue) and a black crosshair. Below the title is a horizontal line. Underneath the line is a single bullet point in a blue square, followed by the text "Colleges and programs represented here today". In the bottom right corner of the slide, there is a small number "4".

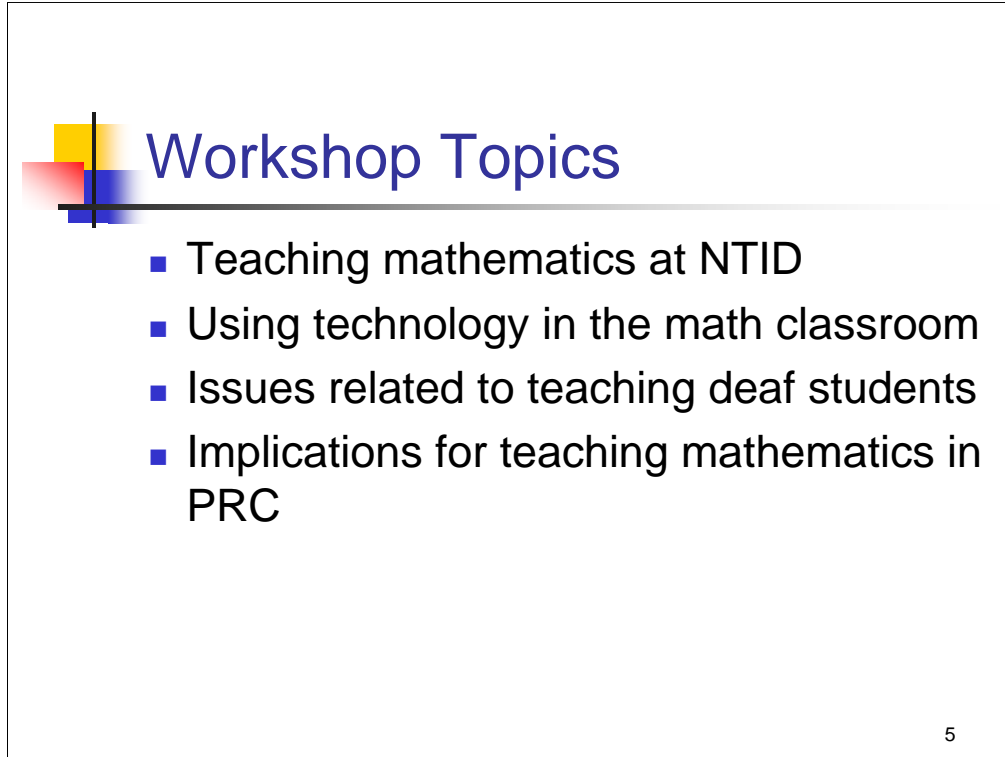
## Workshop Participants

- Colleges and programs represented here today

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研讨会参与者

- 今天提及的学院和项目

A presentation slide titled "Workshop Topics" with a decorative graphic of overlapping colored squares (yellow, red, blue) and a black crosshair. The slide lists four bullet points: "Teaching mathematics at NTID", "Using technology in the math classroom", "Issues related to teaching deaf students", and "Implications for teaching mathematics in PRC". A small number "5" is in the bottom right corner.


## Workshop Topics

- Teaching mathematics at NTID
- Using technology in the math classroom
- Issues related to teaching deaf students
- Implications for teaching mathematics in PRC

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### 研讨会主题

- 在NTID教育数学
- 数学课使用的技术
- 教育聋哑学生的问题
- 在中国教育聋哑学生的含意




## Mathematics for Deaf Students at NTID/RIT

- 35 years of experience with deaf students
- Two mathematics departments serve our deaf students
  - NTID
  - RIT College of Science

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在NTID/RIT教育聋哑学生数学

- 35年聋哑学生的教学经验
- 2个数学系为聋哑学生服务
  - NTID
  - RIT科学系




## Number of Students

- Total RIT: 14,000-15,000
- Total Deaf: 1000-1100
  - Bachelors level: 400 plus
  - Associates level: 600 plus
- Math students:
  - NTID: 150-250 per academic term
  - Bachelors level math: 50 per term

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### 学生数量

- RIT总学生数: 14000-15000
- 聋哑学生: 1000-1100
  - 学士: 400多
  - 大专: 600多
- 数学专业学生
  - NTID: 每学期150-250人
  - 学士水平数学: 每学期50人



## Mathematics for Deaf Students at NTID

- NTID Mathematics Courses:
  - Serve NTID technical programs
  - Satisfy minimum NTID graduation requirement
  - Prepare students to enter Associate degree programs
  - Prepare students for other colleges of RIT
  - May carry credit for Baccalaureate programs


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在NTID教育聋哑学生数学

•NTID的数学课:

- 适合NTID的技术项目
- 满足NTID最低毕业要求
- 帮助学生预备大专学历的课程
- 帮助学生预备RIT其它院校
- 学分可能带入学士课程






## RIT College of Science Mathematics

- Serve the other 7 colleges of RIT
- Traditional college courses
- Deaf students mainstreamed with their hearing peers in large classes
- Interpreting, note taking
- Full-time NTID support faculty
  - Tutoring and advising

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### RIT数学科学学院

- 服务RIT其它7个学院
- 传统学院课程
- 聋哑学生和听力正常学生一起上大班课程
- 手语翻译, 笔记
- 专职支持NTID的教职工
  - 辅导和建议




## Diversity of Deaf Students

- There is great diversity among our deaf students
- Not all of our deaf students are the same in terms of:
  - Academic ability
  - Learning style
  - Communication style/ability
- We have learned to address the needs of the students we get

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### 聋哑学生的多元化

- 我们的聋哑学生多元化
- 不是所有聋哑学生在这些方面都一样:
  - 学习能力
  - 学习方式
  - 交流方式\能力
- 通过学习我们已经能够满足各种学生的要求



## NTID Mathematics Course Map

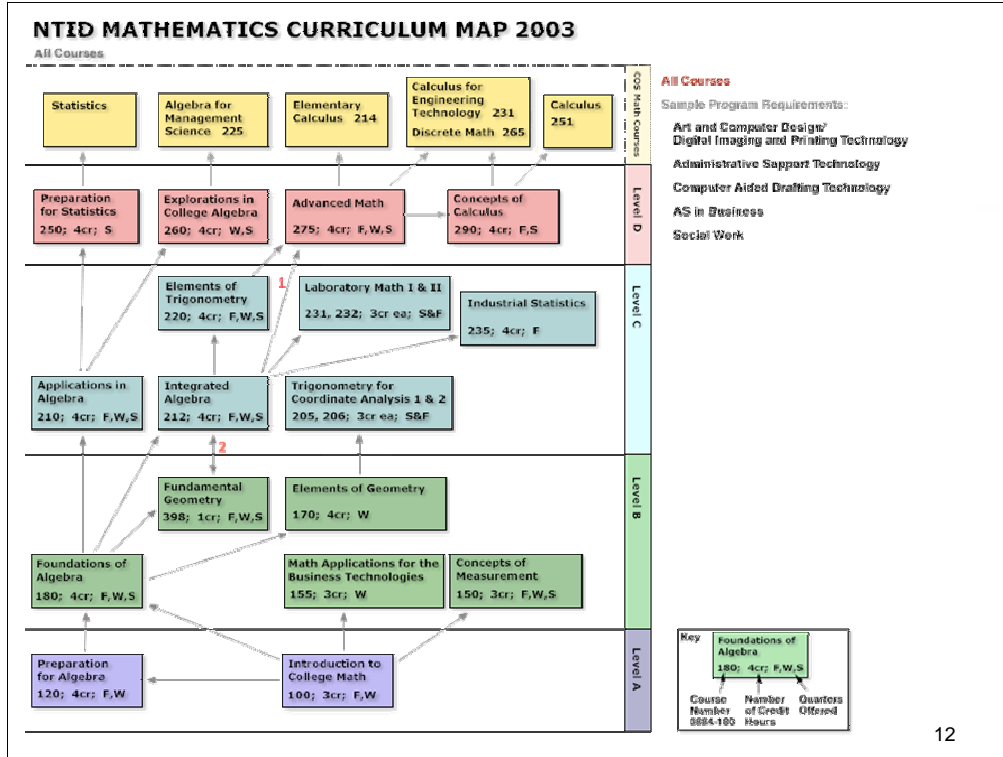
- The map shows our math curriculum
- The map guides students and advisors

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### NTID 数学课程表

- 下表是数学课程表
- 学生和辅导员将遵循该表

Teaching Mathematics to Deaf College Students: The NTID Model



2003年NTID数学课程表

统计学 管理科学的代数225 初级微积分214 工程技术的微积分231 离散数学265 微积分251 --- COS数学课程  
所有课程 专业基础课: 艺术和电脑设计/电子影像和印刷技术

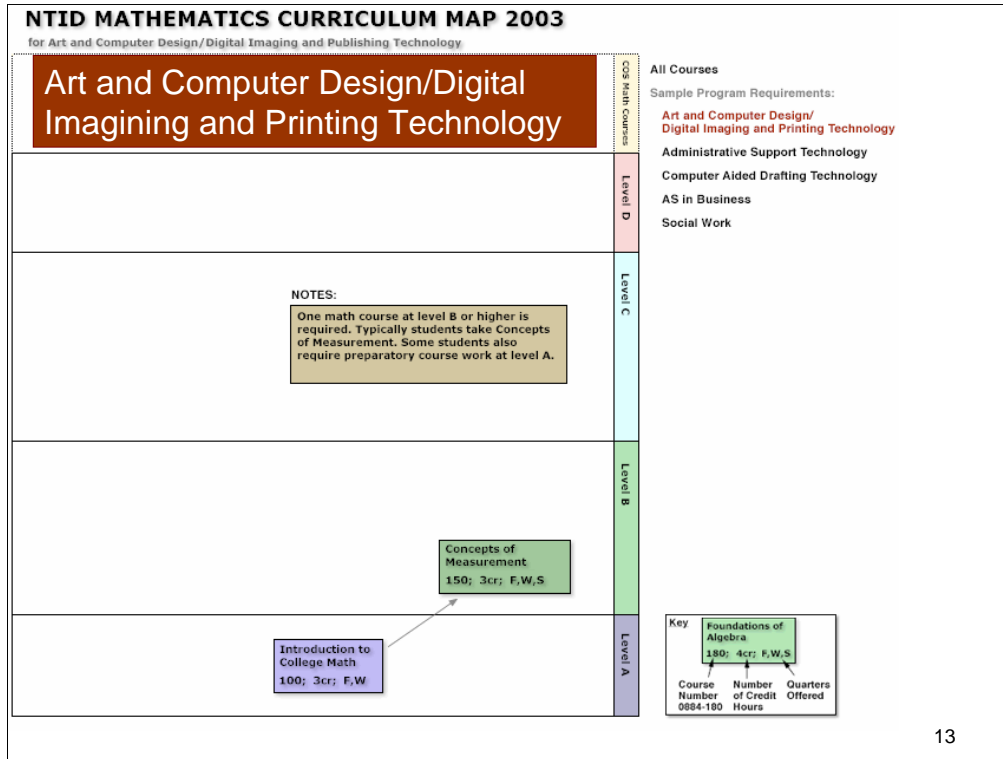
统计预备课程250 大学代数入门 260 高等数学275 微积分概念290 --- D 级别  
管理支持技术 电脑辅助制图技术 商业AS 社会工作

三角元素220 实验数学I&II231,232 工业统计学235 --- C 级别  
应用代数210 合成代数212 三角坐标分析205,206

基础几何398 几何元素170 --- B 级别  
基础代数180 数学在商业技术上的应用155 测量概念150

代数入门120 大学数学介绍100 --- A 级别

图案说明 基础几何  
课程号0884-180 学分学时 授课学期



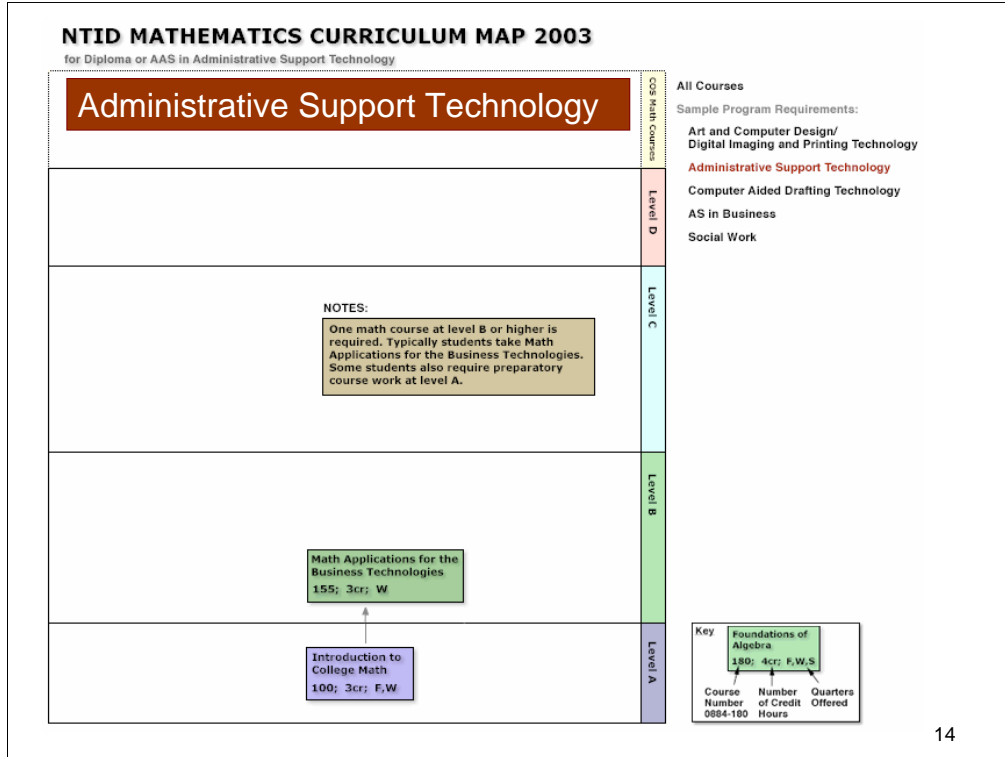
2003年NTID数学课程表  
文学和计算机设计/数码影像和打印技术

文学和计算机设计/数码影像和打印技术 COS数学课程  
所有课程 专业基础课: 艺术和电脑设计/电子影像和印刷技术

D级别 管理支持技术 电脑辅助作图技术 商业AS 社会工作  
备注: B级以上需修一门数学课程, 通常学生会选修测量概念. 有些学生会被要求准备A级别的课程 C级别

测量概念150 B级别  
大学数学入门100 A级别

图案说明 基础几何  
课程号0884-180 学分学时 授课学期



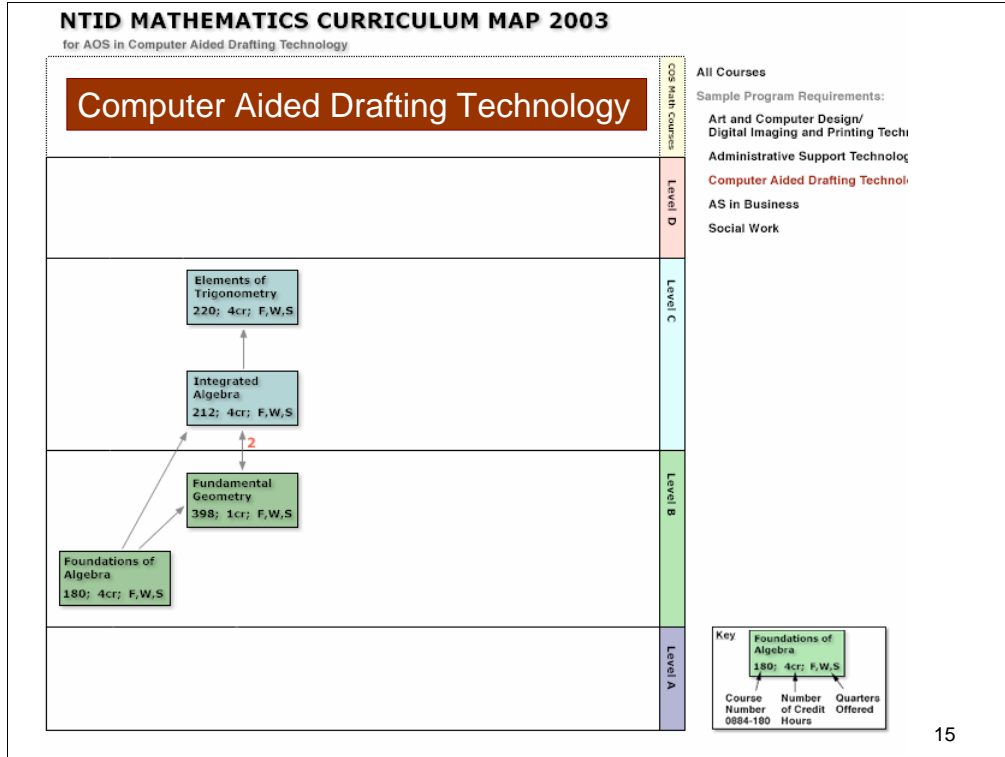
2003年NTID数学课程表  
管理支持技术专业

管理支持技术 COS数学课程  
所有课程 专业基础课: 艺术和电脑设计/电子影像和印刷技术

**D级别** 管理支持技术 电脑辅助作图技术 商业AS 社会工作  
备注:B级以上需修一门数学课程,通常学生会选修数学在商业技术上的应用. 有些学生会被要求准备A级别的课程 C级别

数学在商业技术上的应用155 **B级别**  
大学数学入门100 **A级别**

图案说明 基础几何  
课程号0884-180 学分学时 授课学期

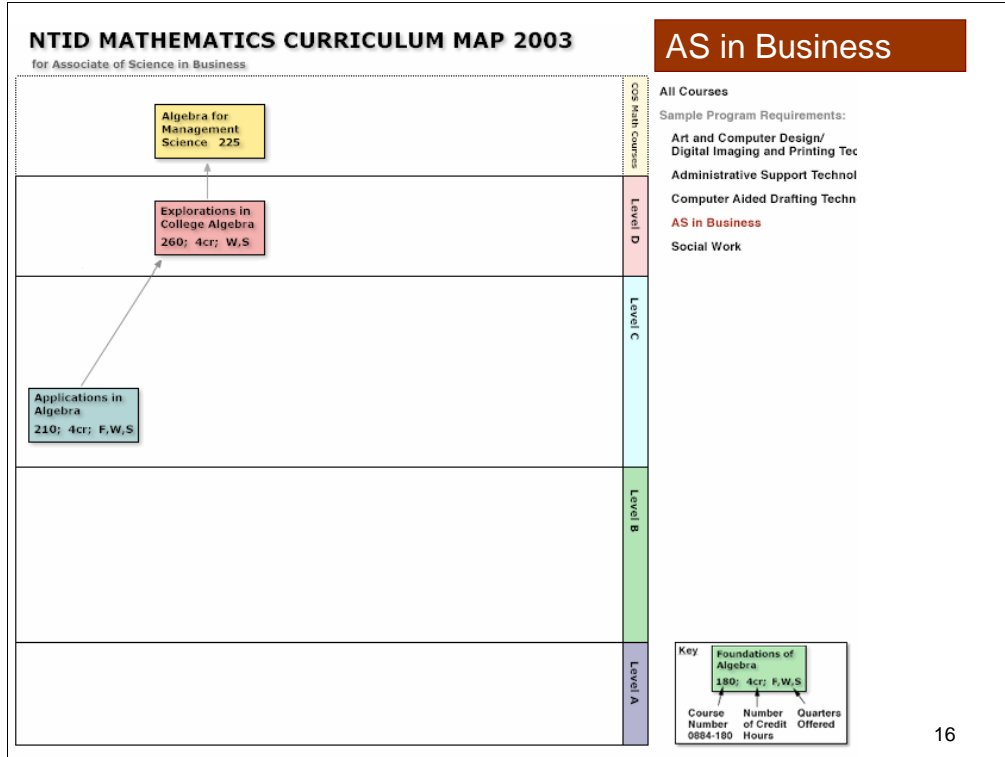


2003年NTID数学课程表  
电脑辅助作图技术专业

电脑辅助作图技术 COS数学课程  
所有课程 专业基础课: 艺术和电脑设计/电子影像和印刷技术

**D级别** 管理支持技术 电脑辅助作图技术 商业AS 社会工作  
三角元素220 合成代数212 **C级别**  
基础几何398  
基础代数180 **B级别**  
**A级别**

图案说明 基础几何  
课程号0884-180 学分学时 授课学期



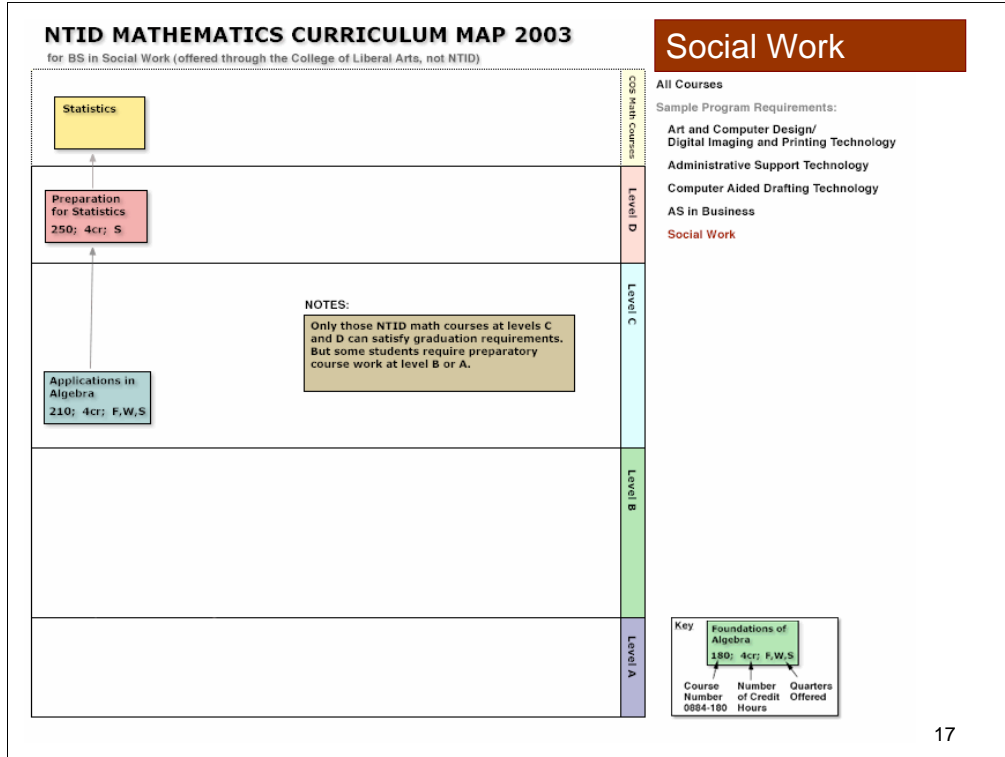
2003年NTID数学课程表 商业专业大专  
商业专业大专 (AS)

管理科学代数225 COS数学课程  
所有课程 专业基础课: 艺术和电脑设计/电子影像和印刷技术

大学代数入门 260 **D级别** 管理支持技术 电脑辅助作图技术 商业专业大专 社会工作  
应用代数210 **C级别**  
**B级别**  
**A级别**

图案说明 基础几何  
课程号0884-180 学分学时 授课学期





### 2003年NTID数学课程表

社会工作本科专业(本专业由文科学院提供, 不是NTID)

#### 统计学 COS数学课程

所有课程 专业基础课: 艺术和电脑设计/电子影像和印刷技术

统计学准备250 D级别 管理支持技术 电脑辅助作图技术 商业AS 社会工作  
应用代数210 备注: 只有NTID的C级和D级的数学课程才能满足毕业要求. 但有些学生会被要求准备A级或B级的课程 C级别

B级别

A级别

图案说明 基础几何  
课程号0884-180 学分学时 授课学期




## Criteria for NTID Mathematics Placement

- Standard college entrance test
  - Not useful at lower levels
- NTID Mathematics placement test
- Previous coursework
- Choice of Technical Program
- Interview with student

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### NTID数学课程定位标准

- 标准大学入学考试
  - 不适合低级别
- NTID数学定位考试
- 先前的课程
- 选择技术项目
- 学生面试



## Mathematics Facilities

- Three General Purpose Classrooms
  - Small class size (8-15)


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### 数学教学设施

- 三间普通用途的教室
  - 小班 (8-15人)

## Mathematics Facilities


- Hearing and deaf instructors



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数学教学设施

•听力正常教师和聋哑教师




## Mathematics Facilities

- NLC (NTID Learning Center)
  - Daytime and evening tutoring
  - Tutors are full-time and adjunct faculty

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### 数学教学设施

- NLC (NTID 学习中心)
  - 白天和夜晚辅导
  - 辅导员是全职和教师助手




## Math Lab

- Computers, Printers
- Overhead projection
- Software
  - Excel, TI-Connect, Geometer's Sketchpad,
  - Word Processing (for lab reports)
- Photos of the Math Lab

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### 数学实验室

- 计算机, 打印机
- 幻灯投影仪
- 软件:
  - EXCEL电子表格, TI-Connect, Geometer's Sketchpad,
  - Word电子文档 (实验报表)
- 数学实验室照片




## Technology in All Classrooms

- TI-83 Plus Graphing Calculator
  - TI-83 Overhead ViewScreen™
  - TI-Presenter™
- TI-30X IIS for lower level courses
- Document camera
- Overhead projectors
- LCD projector

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### 所有教室的技术

- TI-83Plus图形计算器
  - TI-83 Overhead ViewScreen™
  - TI-Presenter™
- IT-30X IIS 用于较低级别课程
- 相机记录
- 幻灯投影仪
- 雷射投影仪



## Texas Instruments

- Texas Instruments educators home page (China)  
<http://education.ti.com/china/>
- TI-30X IIB  
<http://education.ti.com/china/product/calculators/30xiib.html>
- TI-83Plus  
<http://education.ti.com/china/product/calculators/83p.html>

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### 德州仪器

- 德州仪器教育世界主页 (中国)

<http://education.ti.com/china/>


- TI-30X IIB

<http://education.ti.com/china/product/calculators/30xiib.html>

- TI-83Plus

<http://education.ti.com/china/product/calculators/83p.html>






## Capabilites of TI-83 Plus

- Storing variables and evaluating algebraic expressions
- Graphing functions (rectangular, polar, parametric)
- Finding roots, maximum, minimum
- Solving equations graphically
- Plotting statistical data and determining regression equations
- Computing numerical derivatives and integrals

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### TI-83 Plus的能力

- 储存变量和评估代数表达式
- 绘图功能 (长方形的, 极坐标的, 参数的)
- 寻找平方根, 最大值, 最小值
- 利用图形解决方程式
- 对统计数据绘图, 判断回归方程
- 计算微分和积分




## Why We Use Calculators

- To motivate students
- To develop and reinforce concepts
- To introduce advanced concepts to students with learning gaps
- To investigate a hypothesis using trial and error
- They make us better mathematicians and teachers

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为什么使用计算器

- 激励学生
- 培养和加强概念理解
- 帮助后进学生学习先进技术
- 通过实验和误差来调查假设
- 计算器使我们成为更好的数学家和老师




## Why We Use Calculators

- Graphing calculators link to computers
  - Download programs
  - Download data
  - Write lab reports that include calculator screen captures
  - Transfer calculator data to computer applications
- Graphing calculators link with data gathering devices (science applications)

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### 为什么使用计算器

- 图形计算器可连到计算机
  - 下载程序
  - 下载数据
  - 书写实验报告可包括计算器屏幕桌图
  - 数据从计算器传递到计算机
- 图形计算器可连到数据采集设备(科学应用软件)



## Effective use of Technology and Visual Materials

- Use of technology and visuals not sufficient to guarantee access to deaf students
- A story about use of technology with deaf professionals

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有效利用技术和可视材料

- 使用技术和可视材料不能保证有利于聋哑学生
- 举例聋哑专业人士使用技术



## Effective use of Technology and Visual Materials

- Wait time and eye gaze
- Taking notes
- Visibility of writing surfaces
- Acoustical distractions minimized
- Visual distractions minimized; deaf students may be more easily distracted
- Furniture arranged for visibility
- New technologies may not always be accessible to the deaf (telephone)

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有效利用技术和可视材料

- 等候时间和眼睛注视
- 记笔记
- 书写表面的可视性
- 尽量减小噪音
- 尽量减小视觉干扰; 聋哑学生可能易受干扰
- 安排教室设备提高可见性
- 聋哑学生不能利用某些新技术 (如电话)




## Issues: Teaching and Learning Mathematics

- Mathematics is not generally an area of strength for our entering deaf students
  - As a group, deaf students have not performed as well as their hearing peers
- Many students prefer the computational aspects of mathematics
- Problem solving and conceptual understanding is more difficult

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问题:教育和学习数学

- 通常数学不是聋哑学生的强项
  - 小组学习中,聋哑学生比不上听力正常学生
- 大部分学生更喜欢数学计算
- 解决问题和概念理解比较困难




## Issues (continued)

- Student's educational backgrounds are varied:
  - Former teachers may not be trained mathematicians
  - Former teachers may not be able to communicate well
  - Emphasis often given to computation and manipulation
  - Academic advising and encouragement is often missing

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### 问题 (继续)

- 学生的教育背景不同:
  - 先前的教师可能不是受过培训的数学家
  - 先前的教师可能无法交流得很好
  - 重点都在计算和操作上
  - 没有学习上的建议和鼓励



## Issues (continued)


- Math instruction may be given lower priority than English
- Spoken and written language can be barriers to mathematics learning

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问题 (继续)

- 数学教育不如英语教育重要
- 口语和书面语可能成为学习数学的障碍






## Issues (continued)

- Incidental learning and interaction with others may be lacking
- Experiential diversity critical for learning may be lacking
- Students may lack persistence and resilience, especially related to problem solving

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问题 (继续)

- 没有同学间的相互学习
- 没有学习经验多元化
- 学生缺乏持久性和顺应性,特别在解决问题方面




## Learning Style

- There is some question as to whether using a “general to specific” or “specific to general” approach is more effective
  - Many of our deaf students prefer a specific to general approach
  - Other students simply want “the rule”
- A teaching example:  $10^0=1$

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### 学习方式

- 难于判断“一般到特殊”还是“特殊到一般”的有效性
  - 大多数聋哑学生倾向于从“特殊到一般”的方式
  - 其他学生则需要“标准”
- 教学举例:  $10^0=1$




## Research Results

- Deaf students may not be skilled at:
  - Metacognition (thinking about thinking)
  - Monitoring their own understanding
  - Recognizing what they do not know
  - Understanding the whole instead of individual parts
  - Understanding the purpose of a task
  - Relating new material to existing knowledge

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### 研究成果

- 聋哑学生弱点:
  - 思维方式
  - 追踪自己的理解方式
  - 认识到自己的不懂的方面
  - 总体理解,而不是片面理解
  - 理解任务的目的
  - 知识的相关性



## Research Results

- Students may have difficulty:
  - Making inferences
  - Transferring and applying what they know
  - Sorting important from unimportant information
  - Knowing when to ask for help and what questions to ask

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### 研究成果

- 学生可能在以下几点会遇到困难:
  - 推论
  - 已学知识的转移和应用
  - 信息重要性的判别
  - 判断什么时候需要帮助,提出什么问题



## Language in the Mathematics Classroom

- Teaching mathematical concepts requires emphasizing language
  - Writing to learn mathematics
  - Writing to improve English
- Language should be developed, expanded and practiced
- The language of instruction may not be the student's first language

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### 数学教室里的语言

- 教育数学概念需要强调语言的重要性
  - 书写以学习数学
  - 书写以提高英语
- 所用语言要精炼, 详细, 熟练
- 教学中使用的语言不一定是学生的母语



## Language in the Mathematics Classroom

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- At NTID the languages of instruction are English and American Sign Language
- Symbols of mathematics and technology have their own syntax and meaning
- Connections between language of mathematics and the languages of instruction must be made
- Not all humor is effective with deaf students

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### 数学教室里的语言

- NTID 使用的教学语言是英语和美式手语
- 数学和技术符号有自己的语法和含义
- 数学语言和教学语言必须联系起来
- 不是所有的笑话聋哑学生都能理解



## Language in the Mathematics Classroom

- In English many words have multiple meanings
- Sign for a word may be different based on context
- It is helpful to discuss the choice of technical signs used
- Some mathematical words have multiple forms, but only one sign
- Sometimes non-technical vocabulary causes trouble

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### 数学教室里的语言

- 许多英语单词具有多义性
- 某个手势根据上下文可能意思不同
- 讨论选择技术方面的手语很有帮助
- 一些数学用语方式不同但手势一样
- 有时非技术用语也会引起问题



## Language in the Mathematics Classroom


- Students should communicate what they are doing and why they are doing it.
- Workshop participants: In what ways is our experience with the relationship between language and mathematics similar to yours or different from yours?
- Are there Chinese characters which have multiple meanings, depending on context?

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### 数学教室里的语言

- 学生要互相交流做什么,为什么这样做
- 研讨会参与者: 你对语言和数学的关系的经验和其他人有何相同之处和不同之处
- 中文是否也有多义性? 根据上下文意思不同






## Classroom Assessment

- Assessment of student work can be difficult because of language factors
  - Students may not be able to communicate all they know
  - We might assume students know more than they do

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### 课堂评定

- 由于语言关系造成对学生作业评定的困难性
  - 学生可能没法完全表达他们所知道的
  - 老师可能认为学生知道的比看起来更多




## Classroom Assessment

- Our assessment of student work reflects established standards of mathematics education in the USA
  - Tests, quizzes
  - Lab reports
  - Group work
  - Presentations
  - Homework assignments

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### 课堂评定

- 我们对学生作业的评定是依照美国数学教育标准
  - 考试,小测试
  - 实验报表
  - 小组作业
  - 演讲
  - 家庭作业



## Our Curriculum Model

- In the USA, we are guided by standards set by professional organizations
- At NTID, we work closely with technical programs to determine necessary mathematics
- We offer more than an algebra to calculus sequence

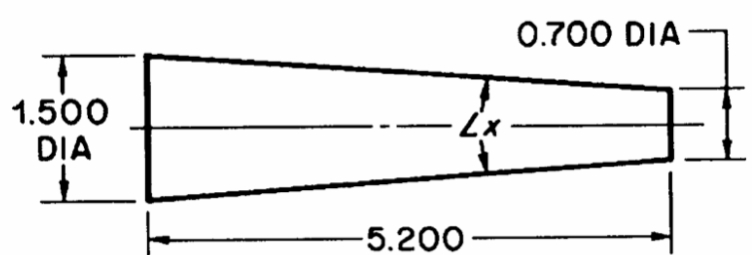
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### 我们的课程模式

- 在美国,我们依照专业组织的标准
- 在NTID,我们和技术项目紧密合作来决定数学教育
- 我们提供从代数到微积分教育顺序以及更多

## Trigonometry for Machining

3. Find the included taper  $\angle x$ .  
All dimensions are in inches.



The diagram shows a tapered shaft with a length of 5.200 inches. The diameter at the left end is 1.500 DIA and at the right end is 0.700 DIA. The included angle is labeled as  $\angle x$ .

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加工的三角法

3. 找出 LX 的角度. 尺寸单位是英寸

## Trigonometry for Machining


6. Find diameter  $x$ .  
All dimensions are in inches.

The diagram shows a technical drawing of a tapered shaft. The base diameter is labeled as 2.125 DIA. The height of the tapered section is 0.785 inches. The angle of the taper is given as  $42^{\circ}50'$ . The top diameter is labeled as  $x$ . A dimension of 0.250 inches is shown for the thickness of the base. The drawing is a cross-section of the shaft.

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加工的三角法

6. 找出X的尺寸.尺寸单位是英寸




## Curriculum Model (continued)

- We strive to maintain standards without causing student failure
- There is a thin line between enabling and preventing
- Most of our students do not pursue careers in mathematics

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### 课程模式(继续)

- 我们在不使学生不及格的基础上尽力保持教学标准
- 使能和预防之间的距离很小
- 大部分学生不会选择数学作为职业




## Instructional Emphases

- Problem solving
- Reasoning, divergent thinking
- Technology, calculators
- Reasonableness of results
- Models, diagrams, sketching
- Symbol use and meaning
- Lab activities and reports
- Language and communication
- Study skills, persistence, and use of a text

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### 教学重点

- 解决问题
- 推理,分散思维
- 答案的合理性
- 模式,图解,草图
- 使用和理解符号
- 实验作业和报告
- 语言和交流
- 学习技能,持久力, 使用课本



## Curriculum Considerations


- What mathematics do deaf students need?
  - What are the needs of the technical programs?
  - Where does each student start?
  - How far must each student progress?
  - How can students move through the curriculum?
  - What are the time constraints?
  - What can technologies can be used?
  - Will students pursue more advanced degrees?

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### 课程表考虑事项

- 聋哑学生需要学习什么样的数学?
  - 技术性的项目需要什么?
  - 每个学生的起点在哪里?
  - 每个学生应进展到哪里?
  - 学生如何才能完成课程?
  - 时间限制是什么?
  - 可以使用什么技术?
  - 学生会不会进修更高学历?






## Advocacy

- Providing appropriate mathematics instruction to deaf students is a matter of advocacy
- College faculty can become advocates for high school and college age deaf students

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### 倡导

- 为聋哑学生提供合适的数学教学在于倡导
- 大学教职工可成为高中和大学年纪的聋哑学生的倡导者




## Optimism

- Given time to learn and appropriate instruction, deaf students can learn mathematics
- Students are generally successful in their mathematics courses at NTID
- Rarely is mathematics the sole barrier to graduation
- Teacher attitude is important

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### 乐观性

- 在足够学习时间和适当指导情况下,聋哑学生可学习数学
- NTID 学生一般情况下都可以成功的完成数学课程
- 数学不是毕业的障碍
- 教学态度十分重要



## (Web) Resources

- Texas Instruments educators (China)  
<http://education.ti.com/china/>
- Rochester Institute of Technology  
<http://www.rit.edu/>
- NTID  
<http://www.ntid.rit.edu/>

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(网络)资源

- 德州仪器教育世界 (中国)  
<http://education.ti.com/china/>
- 罗切斯特理工大学  
<http://www.rit.edu/>
- NTID  
<http://www.ntid.rit.edu/>



结束