

MECHANICAL ENGINEERING AND MATERIALS SCIENCE

THE GEORGE R. BROWN SCHOOL OF ENGINEERING

CHAIR

Enrique V. Barrera

ASSOCIATE CHAIR

Andrew J. Meade

PROFESSORS

Pulickel Ajayan

John E. Akin

Andrew R. Barron

Yildiz Bayazitoglu

Michael M. Carroll

Fathi Ghorbel

Rex B. McLellan

Satish Nagarajaiah

Pol D. Spanos

Tayfun E. Tezduyar

James Tour

Boris I. Yakobson

PROFESSORS EMERITI

Franz R. Brotzen

Angelo Miele

Chao-Cheng Wang

ASSISTANT PROFESSORS

Andrew J. Dick

Brent C. Houchens

Jun Lou

Marcia K. O'Malley

PROFESSOR IN THE PRACTICE

David M. McStravick

ADJUNCT PROFESSORS

Steven A. Curley

Thomas J.R. Hughes

LECTURERS

John J. Bertin

Peter J. Loos

ADJUNCT ASSOCIATE PROFESSORS

Sarmed Adnan

Hugh Bannon

Nazareth Bedrossian

Aladin Boriek

Charles Burgar

James Dabney

Chad M. Landis

Michael Massimino

ADJUNCT ASSISTANT PROFESSORS

John Muratore

Robert Platt

DEGREES OFFERED: BA, BSME, BSMS, MME, MMS, MS, PHD

Studies in mechanical engineering may lead to specialization in 1 of several areas, including mechanics, computational mechanics, stochastic mechanics, fluid dynamics, heat transfer, dynamics and control, robotics, biomedical systems, and aerospace sciences. Studies in materials science may lead to specialization in 1 of several areas, including nanotechnology, metals physics, statistical mechanics, metallic solid thermodynamics, materials chemistry, aspects of composites, coatings and thin films, and interface science.

The graduate program offers professional degrees in both materials science and engineering, which is based on undergraduate preparation in a number of related fields, and mechanical engineering, which permits specialization in the areas previously mentioned. Graduate students also may pursue research degrees. Faculty research areas are indicated in the previous paragraph. A joint MBA/Master of Engineering degree is available in conjunction with the Jesse H. Jones Graduate School of Management. Also, a combined MD and advanced research degree for research careers in medicine is available with Baylor College of Medicine.

The graduate program collaborates with other departments in its comprehensive educational and research activities. The Department of Computational and

Applied Mathematics supports research in applied analysis and computational mathematics. Work on expert systems and robotics is done in cooperation with the Departments of Electrical and Computer Engineering and Computer Science. Computer graphics research involves the cooperation of the Department of Computer Science and the School of Architecture. The campus-wide Rice Quantum Institute also is active in the research of electronic materials and other aspects of materials science. Finally, biomechanics and biomaterials research involves several institutions in the Texas Medical Center.

DEGREE REQUIREMENTS FOR BA, BS IN MECHANICAL ENGINEERING OR BA AND BS IN MATERIALS SCIENCE AND ENGINEERING

For general university requirements, see Graduation Requirements (pages 16–19). The BA program in either mechanical engineering or materials science and engineering is highly flexible, involves less technical content than the BS, and allows students greater freedom to pursue areas of interest outside of engineering.

The 2 BS programs prepare students for the professional practice of engineering. During their senior year, mechanical engineering students in the BS program take courses in design application while completing a major design project, and materials science and engineering students in the BS program work on a design problem in an industrial setting. The BSME program is accredited by the Accreditation Board for Engineering and Technology (ABET). Departmental goals and objectives are available at mems.rice.edu/undergraduate/goals.html.

BS in Mechanical Engineering Program—Lists of representative undergraduate courses and the usual order in which students take them are available from the department for either the BA or BS programs in both mechanical engineering and materials science and engineering. The BSME degree contains a core of required courses and selected electives from 1 of 6 specialization areas. The requirements (for a total of 132 hours) are:

Basic Mathematics and Science (30 hours)

CHEM 121–122 *General Chemistry*
 MATH 101 *Single Variable Calculus I*
 MATH 102 *Single Variable Calculus II*
 MATH 211 *Ordinary Differential Equations and Linear Algebra*
 MATH 212 *Multivariable Calculus*
 MSCI 301 *Materials Science*
 PHYS 101 *Mechanics*
 PHYS 102 *Electricity and Magnetism*

Computational and Applied Mathematics (9 hours)

CAAM 210 *Engineering Computation*
 CAAM 335 *Matrix Analysis*
 CAAM 336 *Differential Equations in Science and Engineering*

Senior Design (7 hours)

MECH 407 *Mechanical Design Project I*
 MECH 408 *Mechanical Design Project II*

Labs (4 hours)

MECH 331 *Mechanics Lab*

MECH 332 *Thermo/Fluids Lab*

MECH 340 *Industrial Process Lab*

MECH 431 *Senior Lab*

Mechanical Engineering (31 hours)

MECH 200 *Classical Thermodynamics*

MECH 211 *Engineering Mechanics*

MECH 311 *Mechanics-Deformable Solids*

MECH 343 *Modeling of Dynamic Systems*

MECH 371 *Fluid Mechanics I*

MECH 401 *Machine Design*

MECH 412 *Vibrations*

MECH 420 *Fundamentals of Control Systems*

MECH 472 *Thermal Systems Design*

MECH 481 *Heat Transfer*

Limited Electives:

STAT 305, 310, or 331

Technical Electives (9 hours)

Distribution Electives (24 hours)

Free Electives (15 hours)

Technical Electives—Students are required to take a total of 3 technical electives. A minimum of 2 of these courses must come from Group A. The remaining course can come from Group A or B. Group A courses are fundamental courses in the following focus areas: aerospace engineering (AE), computational engineering (CompE), fluid mechanics and thermal science (FT), solid mechanics and materials (SMM), and system dynamics and control (SDC). Group B courses are additional technical electives that complement the focus areas listed above.

Group A

- MECH 400 *Advanced Mechanics of Materials* (SMM)
- MECH 403 *Computer Aided Design* (COMPE, SMM)
- MECH 411 *Dyn and Control of Mech Sys* (SDC);
- MECH 417 *Finite Element Analysis* (CompE)
- MECH 454 *Comp. Fluid Mechanics* (AE, CompE)
- MECH 471 *App. of Thermodynamics* (FT)
- MECH 473 *Advanced Fluid Mechanics II* (FT)
- MECH 498 *Intro to Robotics* (SDC)
- MECH 594 *Introduction to Aerodynamics* (AE, FT)
- MSCI 402 *Mech Properties of Materials* (SMM)

Group B—See department for current listing

BA with a Major in Mechanical Engineering Program—Students seeking the BA degree with a major in mechanical engineering must complete 120 hours with at least 67 semester hours in courses specified by the department, along with 24 hours of university distribution electives and 29 hours of free electives. Lists of courses, including general university requirements and the usual order in which students take them, are available from the department. The BA program mirrors the BSME program in the freshman and sophomore years, with the exceptions that MECH 331 and MECH 340 are not required. Specific major requirements are completed in the junior and senior years, along with electives. A summary appears below:

Freshman Year

Same as BS with 24 major and 9 elective hours for 33 hours.

Sophomore Year

Same as BS (except MECH 331 and 340 are not required), with 18 major and 15 elective hours for 33 hours.

Junior and Senior Years

25 major and 29 electives for 54 hours. The following courses are required in junior and senior years:

CAAM 335 <i>Matrix Analysis</i> (3)	MECH 401 <i>Machine Design</i> (3)
CAAM 336 <i>Differential Equations in Science and Engineering</i> (3)	MECH 412 <i>Vibrations</i> (3)
MECH 343 <i>Modeling of Dynamic Systems</i> (4)	MECH 420 <i>Fundamentals of Control Systems</i> (3)
MECH 371 <i>Fluid Mechanics I</i> (3)	MECH 481 <i>Heat Transfer</i> (3)

BA with a Major in Materials Science and Engineering Program—Students seeking the BA degree with a major in materials science and engineering must

complete at least 52 hours in courses specified by the department plus additional hours for a total of 120 hours at graduation.

BSMS Program—Students seeking the BSMS must complete at least 91 semester hours in courses specified by the department within the total requirements of 134 hours. Basic departmental course requirements for the BSMS are as follows:

CHEM 121–122 *General Chemistry*
 MATH 101 and 102 *Single Variable Calculus I and II*
 MATH 211 *Ordinary Differential Equations and Linear Algebra*
 MATH 212 *Multivariable Calculus*
 MECH 211 *Engineering Mechanics*
 MSCI 301 *Materials Science*
 PHYS 101 *Mechanics*
 PHYS 102 *Electricity and Magnetism*

Specific requirements

CAAM 210 *Introduction to Engineering Computation*
 CAAM 335 *Matrix Analysis*
 CEVE 300 *Mechanics of Solids*
 ELEC 241 *Fundamentals of Electrical Engineering I* (or ELEC 243 *Introduction to Electronics*)
 MSCI 301 *Materials Science*
 MSCI 303 *Materials Science Junior Lab*
 MSCI 311 *Introduction to Design*
 MSCI 401 *Thermodynamics and Transport Phenomena in Materials Science*

MSCI 402 *Mechanical Properties of Materials*
 MSCI 404 *Materials Engineering and Design*
 MSCI 406 *Physical Properties of Solids* (or MSCI 415 *Ceramics and Glasses*)
 MSCI 411 *Metallography and Phase Relations* (or MSCI 415 *Ceramics and Glasses*)
 MSCI 500/501 *Materials Science Seminar*
 MSCI 535 *Crystallography and Diffraction*
 MSCI 537 *Materials Science Senior Lab*
 MSCI 594 *Properties of Polymers*

1 course from the following

PHYS 201 *Waves and Optics*
 CHEM 211 *Organic Chemistry*
 CHEM 311 *Physical Chemistry*

Electives

1 approved science elective (at the 200 level or higher)
 1 approved engineering science elective (not MSCI)
 1 approved technical elective

DEGREE REQUIREMENTS FOR MME, MMS, MS, AND PHD IN MECHANICAL ENGINEERING OR MATERIALS SCIENCE AND ENGINEERING

Professional Degree Programs—The professional degrees offered by this department, the Master of Mechanical Engineering (MME) and the Master of Materials Science (MMS), involve a 5th year of specialized study, which is integrated with the four undergraduate years leading to either the BA or the BS degree in the same areas of interest. The professional degree programs are open to students who have shown academic excellence in their undergraduate studies.

For general university requirements, see Graduate Degrees (pages 61–62). For both the MME and MMS degrees, students must complete 30 semester hours of course work. Lists of required and suggested courses are available from the department. Students should develop a specific plan of study based on their particular interests.

Research Degree Programs—The programs leading to the MS and PhD degrees are open to students who have demonstrated outstanding performance in their undergraduate studies. The granting of a graduate research degree presupposes academic work of superior quality and a demonstrated ability to do original research.

For general university requirements, see Graduate Degrees (pages 61–62). Course requirements for the research degrees vary, depending on the extent of individual undergraduate preparation as well as each student's performance in graduate courses and on qualifying examinations. For both the MS and PhD degrees, students must present a thesis that comprises an original contribution to knowledge and defend it in a public oral examination.

Each graduate student is expected to render research and/or instructional assistance to the department not to exceed 10 hours per week. Graduate student work assignments will be made by the department chair at the beginning of each semester.

All graduate students (except professional masters students [MME/MMS]) must attend at least 75% of the MEMS seminars. See the MEMS website at mems.rice.edu/graduate/gradregulations.html for details.

I. REQUIREMENTS FOR THE PROFESSIONAL MASTERS DEGREES (MME AND MMS)

Students are expected to complete 30 semester hours of courses approved by the department (a 1-semester course is usually 3 semester hours credit). Specific courses to be taken depend on each student's field of study. Students must discuss their individual degree plans and programs of study with their advisors. Please see the MEMS department website at <http://mems.rice.edu/graduate/gradregulations.html> for details.

Degree At Entrance	4-year BS	4-year BA
Minimum graduate level semester hours required (course work)	30	30

See pages 16–19 for total semester hours required by Rice University.

II. REQUIREMENTS FOR THE MS DEGREE

Full-time students seeking the MS degree are expected to complete all the requirements for the degree within 2 calendar years following entrance into the program. Continuation in the program beyond this time limit will require special approval of the department.

All entering graduate students pursuing a thesis degree program will be subject to a preliminary evaluation of their candidacy for the highest degree program they intend to pursue. The evaluation will be conducted by the end of the 2nd semester of enrollment in the graduate program in the MEMS department.

Each candidate for the MS degree must complete a thesis demonstrating ability in research of a fundamental nature (analytical or experimental). It is expected that the research will be of sufficient importance and quality that positive results would lead to publication. The examination will be conducted by a committee consisting of at least 3 members. Two, including the committee chair, must be members of the department.

The minimum semester hours of course work (a 1-semester course is usually 3 semester hours credit) required for the MS degree are tabulated below as a function of the degree held on entrance into the program. Research and thesis hours do not count towards these course requirements. In all cases, a student's specific course of study is formulated in consultation with the departmental

advisor (thesis director) and must be approved by the department. Please see the MEMS Department website at mems.rice.edu/graduate/gradregulations.html for details.

Degree At Entrance	5-year	4-year BS	4-year BA
Minimum graduate level semester hours required (course work)	12	24	30

See pages 16–19 for total semester hours required by Rice University.

III. REQUIREMENTS FOR THE PHD DEGREE

Full-time students seeking the PhD degree are expected to complete all the requirements for the degree within 5 calendar years following entrance into the program. Continuation in the program beyond this time limit will require special approval of the department.

All entering graduate students pursuing a thesis degree program will be subject to a preliminary evaluation of their candidacy for the highest degree program they intend to pursue. The evaluation will be conducted by the end of the 2nd semester of enrollment in the graduate program in the MEMS department. Students pursuing a PhD degree in materials science will be examined in 4 areas: 1) thermodynamics and kinetics; 2) structures, crystallography, and diffraction; 3) mechanical properties; and 4) electrical, optical, and magnetic properties.

By the end of the 3rd year of enrollment in the graduate program in the MEMS department, the student must pass an oral qualifying examination.

Each candidate for the PhD must complete a thesis that constitutes an original contribution to scientific knowledge (analytical or experimental). It is expected that the research will be of sufficient importance and quality that positive results would lead to publication. On completion of the thesis, each candidate for the PhD degree must pass a final public oral examination. The examination will be conducted by a committee consisting of at least 3 members. Two, including the committee chair, must be members of the department. One member must be from another department within the university.

The minimum semester hours of course work (a 1-semester course is usually 3 semester hours credit) required are tabulated below as a function of the degree held on entrance into the program. In all cases, a student's course of study is formulated in consultation with the thesis director and must be approved by the department. Please see the MEMS department website at mems.rice.edu/graduate/gradregulations.html for details.

Degree At Entrance	MS	5-year	BS	BA
Minimum graduate level semester hours required (course work)	24	30	48	54

See pages 16–19 for total semester hours required by Rice University.

See MECH and MSCI in the Courses of Instruction section.