

# DEGREE/PROGRAM CHANGE FORM C

Fields marked with \* are required

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Department\* NSMS

Division

Program

Branch

Proposed effective term:

Semester

Fall

Year

2011

## Course Information

Select Appropriate Program

Graduate Degree Program

CIP Code

Name of New or Existing Program

\* New Concentration in NSMS

Catalog Page Number

639

Select Category

Emphasis

Degree Type

Plan II MS

Select Action

Revision

**Exact Title and Requirements as they should appear in the catalog.**

See current catalog for format within the respective college (enter text below or upload a doc/pdf file)

[MS NSMS Prof Sci Master's Concent.doc](#)

☐ This Change affects other departmental program/branch campuses

Reason(s) for Request \* (enter text below or upload a doc/pdf file)

Reason for request- We have recently been awarded an NSF grant to offer fellowships towards a Professional Science Masters Concentration degree. The Professional Science Masters program is essentially a new concentration within the Plan II NSMS degree program. The Professional Science Masters is different only in required courses which include business classes. The requirements as laid out in the attachment have been approved by the Dean of the Anderson School of Management. The faculty members in the Anderson School who are responsible for the Management of Technology (MOT) concentration will be actively involved with this program. Our request is simply to add this concentration listing in the NSMS program description as it stands in the catalog. Rationale- We propose adding a new concentration to the Nanoscience and Microsystems (NSMS) interdisciplinary graduate degree program at UNM. This new concentration will provide a nanoscience to microsystems link in an integrated education, research and training environment. Our approach is to emphasize, in a laboratory based teaching environment, the systems and systems engineering aspects of incorporating nanoscience into technology. Modules involving micro- and nano-electromechanical systems, micro- and nano-fluidics and nanophotonic devices will be expanded or developed within the existing courses. These modules are designed to connect concepts in nanoscience such as surface and interfacial forces, quantum confinement effects, localization of electromagnetic waves, with actual technology and applications. This project-based learning will give students a hands-on experience with the system engineering aspect of microfabrication and manufacture of nanoscience-based devices and applications. The Professional Science Masters Concentration will benefit from a partnership with the Management of Technology program within the Anderson School of Management at UNM. This curriculum provides students the background in finance, marketing, communication, and project management needed to bring new technology to the marketplace. An innovative part of the curriculum is the emphasis on entrepreneurship through cohort-based participation in the UNM Business Plan Competition. Industrial representatives will join the External Advisory Board and participate in advising and improving the program. UNM Impact- Nanoscience will form the basis of important industries in the 21st century and New Mexico is recognized as a center of nanotechnology research and entrepreneurship. The Professional Science Masters Concentration will provide an educational experience emphasizing the innovation and entrepreneurial skills necessary to bring discoveries in nanoscience to the marketplace. UNM is the only Hispanic-Serving Institution that is classified by the Carnegie Foundation as a research university with very high research activity. Undergraduate enrollment at UNM closely tracks the state's overall demographics (e.g. over 45% of the students enrolled are from underrepresented minorities). Hence we are well equipped to provide students with research experiences and well positioned to recruit a diverse student population to the NSMS Professional Science Masters Concentration. By offering a defined-duration (18 month) MS tied with local business, industry and government labs, undergraduates will be encouraged to undertake this graduate masters degree and be prepared to move into leadership positions in business, industry and government labs. Internships and research experiences will ensure that this program's graduates have experience relevant to industry and also are capable of launching their own startups. Based on interest among existing NSMS students and local industry, we expect ten NSMS Professional Science Masters Concentration graduates per year.

[Prof Sci Master's Concent Reason for request.doc](#)

Statements to address budgetary and Faculty Load Implications and Long-range planning

\* (enter text below or upload a doc/pdf file)

There is no budgetary impact from the creation of this new offering because no new course has been created. Existing courses have been packaged together into the new concentration.



Changes from current catalog indicated in red.

# Graduate Program

## **M.S. and Ph.D. in Nanoscience and Microsystems (NSMS)**

The M.S. and Ph.D. degree programs in NSMS prepare individuals for careers in the emerging fields in Nanotechnology and Microsystems. The program includes three PhD Concentrations: Nano-Bio Interfaces, Complex Functional Materials, and Information Nanotechnology. It also includes the Professional Science Masters Concentration. The program is a collaborative effort among several departments in the College of Arts and Sciences and the School of Engineering, as well as the Anderson School of Management, with numerous cross-listed and team-taught courses. The participating departments are: Biology, Biochemistry, Civil Engineering, Chemical and Nuclear Engineering, Chemistry, Computer Science, Earth and Planetary Science, Electrical and Computer Engineering, Mathematics and Statistics, Mechanical Engineering, and Physics and Astronomy. Students who choose the NSMS degree program can continue to be advised by, supported by and conduct research with faculty in these departments. There are numerous courses in these departments that may be of interest as electives—some of which are listed below—for students in the NSMS program. Faculty in the Health Science Center and the UNM Cancer Research center also participate in the NSMS.

The Professional Science Masters Concentration in Nanoscience and Microsystems emphasizes the innovation and entrepreneurial skills necessary to bring discoveries in nanoscience to the marketplace. Candidates for this degree learn the fundamentals of nanoscience, receive hands-on training in microsystems and are introduced to entrepreneurship, innovation and project management. The degree may be completed within one year. This curriculum has been developed in concert with industry and is designed to address present and future professional career needs. Professional Science Masters Concentration students will complete 32 credit hours including stipulated required courses.

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## **Master's Degree (M.S.) Requirements**

### **M.S. Admission Prerequisites**

The general admission requirements described in the Graduate Program in this Catalog apply to the NSMS program. Applicants who plan to apply to the NSMS program must have a bachelor's degree in a natural science or engineering field. All incoming NSMS students should meet a minimum level of competency indicated by passing grade in a math class of MATH 316 or higher. If needed, incoming students who are otherwise qualified may take MATH 316 during their first semester and pass with a B or better or by taking and passing an equivalency exam that certifies their mathematical ability.

### **M.S. Application Process**

The general application process for domestic and international students is described in the graduate program section of this Catalog. In addition to meeting those requirements, applicants must submit the following directly to the NSMS Program Office for the Admissions Subcommittee review and selection process:

1. Letter of Intent from the applicant about why this program is of interest. (Approximately 250 words stating the rationale and motivation for entering the NSMS Program.)
2. Three sealed letters of recommendation (sent directly to the NSMS Office).
3. GRE entrance examination scores.
4. Any other materials that are relevant to this application, such as experiential credit.
5. Departmental application available online or at program office.

### **M.S. Admission and Advising Roles**

The Admissions Subcommittee reviews applications and makes admission decisions. Selected applicants are sent a notice of acceptance. Students are encouraged to meet with the program director or program administrator to discuss fellowship opportunities, class enrollment and UNM standard procedures such as the details of becoming a student, obtaining an ID card and procedures for enrolling in classes.

**M.S. Faculty Advisor/Mentor.** Students are responsible for selecting a faculty mentor who will help them establish a Committee on Studies. The program office will aid students in their selection process. Ideally, students and faculty members will agree about the advising/mentoring relationship but for those who need assistance, the Director will request that the Admissions Subcommittee assist in this process.

**M.S. Committee on Studies.** The student and faculty mentor invite three faculty members to serve on the student's Committee on Studies. The committee members help the student to plan a Program of Studies—a list of courses that meets the student's interests and needs which will be counted toward the degree. This plan must be approved by the student's advisor and the NSMS Program Director prior to being submitted to the OGS. The Committee also supervises the student's progress and conducts the required thesis or other exams. If the student subsequently qualifies for entering the doctoral program, this committee can continue in the role of Doctoral Studies and Dissertation Committee to assist the student in completing the Ph.D.

**M.S. General Degree Completion Requirements.** The maximum time-to-degree for Master's students is 7 years, during which time the student must be enrolled full time for at least three consecutive semesters. A student must take 9 credit hours to be considered a full time student by financial aid. If the student has an assistantship, full time is considered to be 6 credit hours per semester. In order to complete the M.S., students must maintain a minimum cumulative grade point average of 3.0 in graduate-level courses taken in graduate status and a GPA of at least 3.0 for courses listed in the Program of Studies. Students cannot graduate with incompletes pending nor while on probation.

### **Three M.S. Plans: Degree Completion Requirements**

There are **three** options to receive an M.S. in NSMS.

**Plan I (Thesis Option)–**

1. The student must complete all core course requirements.
2. Student must complete a total of 24 credit hours.
3. Student must complete 6 thesis hours.

**Plan II (Standard Plan II)–**

1. Students must **complete all core course requirements.**
2. Student must complete 32 credit hours.

**Plan II (Professional Science Masters Concentration)-**

1. **Students must complete all core course requirements and other stipulated courses.**
2. **Students must complete 32 credit hours.**

All students must pass a master's examination and/or thesis defense.

Students planning on continuing to pursue a Ph.D. are encouraged to follow Plan 1 (Thesis Option). These are the minimal requirements. In most cases the actual course load completed by a student are likely to be more than the minimum requirement, as dictated by their educational needs and committee on studies.

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**Ph.D. Application and Admission Process.** For prospective doctoral students, the process of applying and being selected is the same as for applicants to the Master's program, with the Admissions Subcommittee assuming responsibility for reviewing applications and selecting candidates. Applicants who plan to apply to the NSMS program must have a bachelor's degree in a natural science or engineering field. All incoming NSMS students should meet a minimum level of competency indicated by passing grade in a math class of MATH 316 or higher. If needed, incoming students who are otherwise qualified may take MATH 316 during their first semester and pass with a B or better or by taking and passing an equivalency exam that certifies their mathematical ability.

**Ph.D. Faculty Advisor/Mentor.** Newly admitted doctoral students must also go through the process of selecting an advisor/mentor. They will then request the Graduate Subcommittee that the Qualifying Exam be scheduled sometime during or immediately after they have completed all of the core courses. The program office will aid students as needed in their selection process.

**NSMS Qualifying Examination Procedure.** General requirements for the Ph.D. degree are set by the Office of Graduate Studies and are stated in other pages of this Catalog. Required NSMS core courses are described below. Students who wish to Advance to Candidacy in NSMS must pass a program qualifying examination. This examination covers the four core subject areas listed in this section, and should be taken as soon as possible after entering the program. The qualifying exam is in two parts:

1. Written Examination: Mastery of the core Nanoscience and Microsystems subjects will be demonstrated by the cumulative grades in the Core NSMS classes. The written exam is not required if the student has obtained a grade of A- or better in 3 of the 4 core courses (excluding ethics).
2. Oral Examination: The Ph.D. qualifying exam will consist of an independent, critical analysis of a research article by the student and the preparation of a research proposal. The student will deliver a 30 minute presentation to critique the research paper and present the research proposal. The student will be allowed two attempts for each exam.

**Ph.D. Committee on Doctoral Studies.** The student and faculty mentor invite three faculty members to serve on the student's Dissertation Committee on Studies. The committee members help the student to plan a program of studies that is reflected on the student's Petition for Candidacy form. These courses meet the student's interests and needs which will be counted toward the degree. The Petition for Candidacy must be approved by the student's advisor and the NSMS Program Director prior to being submitted to the OGS. The Dissertation Committee also supervises the student's progress and conducts the required exams.

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## **Ph.D. Degree Requirements**

### **Ph.D. Candidacy Requirements**

To advance to candidacy students must:

1. Satisfactorily complete all NSMS course requirements.
2. Pass a qualifying exam.
3. Pass a comprehensive exam
4. File all required paperwork by required time deadlines.

### **General Degree Completion Requirements**

The NSMS Ph.D. requires that students complete 48 credit hours of courses plus 18 credit hours of dissertation research credit (699). Overall, the basic requirements for Ph.D. candidates includes 4 core courses and an ethics course, plus 4 courses in a Concentration, and 8 additional elective courses as recommended by the students Dissertation Committee. UNM requires 24 credit hours (8 courses) for the M.S. and an additional 24 credits for the Ph.D. Students can enter the Ph.D. degree program after completing their B.S. degree, and proceed directly towards the Ph.D. by taking 48 credit hours past their B.S. degree plus 18 dissertation research (699) credit hours. These are minimum requirements. The actual number of thesis or dissertation credits will in most cases be larger. Students who already have a Master's degree in one of accepted disciplines automatically acquire a Concentration. Ph.D. candidates have a maximum of five years from the semester in which they pass the doctoral comprehensive examination to complete all of the degree requirements.

### **Ph.D. Minor in Nanoscience and Microsystems**

Students who satisfactorily complete 3 of the 4 NSMS core courses required by the NSMS Ph.D. program (NSMS 510, 512, 518, 519) will be awarded a transcribed minor at the Ph.D. level.

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## **Curriculum for Students in the NSMS M.S. & Ph.D. Degree Program**

### **M.S. Plan I and M.S. Plan II**

There are two options to receive an MS in NSMS.

#### **Plan I (Thesis Option)–**

4. The student must complete all core course requirements.
5. Student must complete a total of 24 credit hours.
6. Student must complete 6 thesis hours.

#### **Plan II (Standard Plan II)–**

3. Students must take core course requirements.
4. Student must complete 32 credit hours.

#### **Plan II (Professional Science Masters Concentration)–**

3. Students must take core course requirements
4. Students must complete 32 credit hours.

**Ph.D.** Candidates must complete a total of 48 credit hours past the bachelor's degree, 24 of which are taken as a doctoral candidate. In addition to the courses completed at the M.S. level (the 4 core courses plus an ethics course) the Ph.D. candidate will complete one of the concentrations listed below, or the required core courses in one of the participating departments. Any student who has already completed an M.S. degree in a natural science or engineering field has already acquired a concentration. Ph.D. candidates must also complete 18 dissertation research (699) credit hours.

#### **Core Courses (12 credit hours)**

NSMS 510	Chemistry and Physics at the Nanoscale	3
NSMS 512	Characterization Methods for Nanostructures	3
NSMS 518	Synthesis of Nanostructures	3
NSMS 519	MEMS Transducer Devices and Technology	3

#### **Ethics Course (1-3 credit hours)**

NSMS 550	Social & Ethical Implications of Nanotechnology
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#### **Concentration: Nano-Bio Interfaces (13)**

- This set of courses exposes students to concepts of biological and chemical reactions, biosensor platform fundamentals and applications through nanofluidics and biomimetics. These are a sampling of acceptable courses, additional courses may be substituted or included as approved by the Graduate Advisor or Graduate Committee on a case-by-case basis. Suggested prerequisites are undergraduate-level transport phenomena, organic chemistry, electromagnetism, and quantum chemistry.

NSMS 522L	Fundamentals of Nanofluidics	3
NSMS 530	Surface and Interfacial Phenomena	3
NSMS 538	Biosensors: Fundamentals and Applications	3
BIOC 545L	Intensive Introductory Biochemistry I	4

#### **Concentration: Complex Functional Materials (12)**

- This set of courses exposes students to specific interface science, materials synthesis and processing. These are a sampling of acceptable courses, additional courses may be substituted or included as approved by the Graduate Advisor or Graduate Committee on a case-by-case basis. Suggested prerequisites for this set of courses are undergraduate-level transport phenomena, organic chemistry, electromagnetism, and quantum chemistry.

NSMS 530	Surface and Interfacial Phenomena	3
NSMS 533	Vapor and Aerosol Phase Materials Processing	3
NSMS 569	Advanced Materials Science	3
NSMS 575	Polymer Science and Engineering	3

#### **Concentration: Information Nanotechnology (12)**

- This set of courses exposes students to materials growth processes, quantum devices and nanofabrication techniques. These are a sampling of acceptable courses, additional courses may be substituted or included as approved by the Graduate Advisor or Graduate Committee on a case-by-case basis. Suggested prerequisites are undergraduate-level semiconductor devices, quantum mechanics, electricity and magnetism.

NSMS 532	Nanoscale Electronic and Photonic Devices	3
NSMS 571	Quantum Computation	3
NSMS 572	Semiconductor Physics	3
NSMS 573	Physics and Computation	3
NSMS 574L	Microelectronics Processing	3

#### **Concentration: Professional Science Masters (19)**

ME556	Entrepreneurial Engineering	3
MGMT 513	Assessment & Forecasting	3
MGMT 514	Technology Entrepreneurship	3
MGMT 516	Entrepreneurial Finance	3
NSMS 650	Research Experience	3
NSMS 595	SMP MI & T Workshop/Seminar	2



NSMS 595	<b>Independent Project (Internship)</b>	2
	<b>M.S. Plan I.</b>	
NSMS 599	Master's Thesis	6
	<b>M.S. Plan II.</b>	
	Courses at 500-level or above as approved by Committee on Studies	6
	<b>Ph.D. Dissertation</b>	
NSMS 699	Dissertation Research	18

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## General Electives

Many courses offered at UNM will be accepted for NSMS elective credit with the intent to supplement the nano-based coursework. We have also listed numerous elective courses here, some of which were developed as new courses specifically for this degree program, with very specific relevance to the nanoscience program. This is not an exclusive list. Many other courses will be added as they are developed and identified. Currently, the list of electives includes:

BIOC 545L	Intensive Introductory Biochemistry II
CHNE 515	Topics: Nanoscale Quantum Structure Growth
EPS 538	Analytical Electron Microscopy
EPS 558/BIOL 558	Geomicrobiology
MGMT 594	Topics: Innovation with Technology
MATH *466	Mathematical Methods in Science and Engineering
MATH 579	Selected Topics: Mathematical Methods for Science & Technology
MATH *471	Introduction to Scientific Computing
MATH 504	Introductory Numerical Analysis: Numerical Linear Algebra
MATH 505	Intro. Numerical Analysis: Approximation & Differential Equations
MATH 512	Introduction to Ordinary Differential Equations
MATH 513	Introduction to Partial Differential Equations
MATH 514	Applied Matrix Theory
MATH 557	Selected Topics in Numerical Analysis
MATH 576	Numerical Linear Algebra
MATH 577	Numerical Ordinary Differential Equations
MATH 578	Numerical Partial Differential Equations
MATH 579	Selected Topics in Applied Mathematics
ME 561	Special Topics: Nanomechanics of Materials
PHYC *430	Introduction to Solid State Physics
PHYC 529	Condensed Matter I
PHYC 531	Atomic and Molecular Structure
PHYC 552	Problems: A Quantum Information Theory

PHYC 566	Quantum Optics
PHYC 581	Advanced Topics: Density Functional Theory
STAT 527	Advanced Data Analysis I
STAT 528	Advanced Data Analysis II
STAT 540	Regression Analysis
STAT 545	Analysis of Variance and Experimental Design
STAT 553	Statistical Inference with Applications
STAT 561	Probability
STAT 565	Stochastic Processes with Applications
STAT 570	Industrial Statistics
STAT 576	Multivariate Analysis
STAT 581	Introduction to Time Series Analysis
STAT 586	Nonparametric Curve Estimation & Image Reconstruction