# Graduate Handbook

**Electrical Engineering Program**
**Department of Electrical Engineering and Computer Science**
**Howard University**
**Washington, DC 20059, USA**

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## INRODUCTION

In the year 2000, the world will be significantly different from today's world. New technologies, innovative services and applications will produce these changes. These changes will provide challenges and opportunities for those who are charting the course for the 21st century.

Why pursue graduate study in Electrical Engineering? Today, we are being challenges to regain the lead in many areas of technology, improve productivity and strengthen our economy. A key element in realizing this goal is quality electrical engineering manpower. During the 90s we've seen a myriad of technological achievements, many of them dominated by the work of electrical engineering. They were instrumental in the development of new silicon chips and the revolutions in computer technology which yielded increased capabilities with decreased cost. In fact, desktop computers of today are more powerful than mainframe computers that were produced just a few years ago.

We are very concerned about the ecological future of our planet. Electrical Engineers will be among the leaders in monitoring and analyzing the parameters modifying our environment. Solutions to degradation effects will be determined with electrical engineers among those leading the way. Future innovations in space will also involve electrical engineers.

## THE UNIVERSITY

Founded as a private university in 1867 by an Act of Congress of the United States. Howard University is named after general Oliver Howard who was president from 1869-1873. The University has been coeducational as well as multiracial from its first years of operation. Today, the university consists of 17 fully accredited schools and colleges, which offer degree programs in about 200 areas of undergraduate and graduate study.

Howard's faculty of more than 1,200 include the largest concentration of African American scholars in the world. The student body is quite diverse, wit over 12,200 students from every state in the union and over 100 countries. In 1992-93 over 3,000 students were enrolled in graduate or professional programs.

Holdings in the University Library System number more than 1.8 million volumes, in addition to more than 26,280 serial subscriptions, a media center and a microfilm preparation center.

Howard belongs to the consortium of Universities of the Washington Metropolitan Area, which includes Georgetown, George Washington, Catholic, and American Universities, Gallaudet, Mount Vernon and Trinity Colleges, the consortium members share their facilities and give students at any member university the opportunity to take courses not offered by their own school.

## ELECTRICAL ENGINEERING DEPARTMENT: AN OVERVIEW

The Department of Electrical Engineering offers courses of instruction leading to the Bachelor of Science. Master of Engineering and Doctor of Philosophy degrees. The graduate program was initiated in 1967, offering studies leading to the master's degree. In 1977, the graduate program was expanded to include studies leading to the Doctor of Philosophy degree.

The graduate program offers studies and research in central engineering, antennas, communications, microwaves, applied microelectronics, power systems, signal processing and solid-state electronics. The combination of high quality curriculum, research, faculty and facilities enables the department to provide excellent preparation for those who wish to embark on careers in electrical engineering.

With the dynamic growth and change in the electrical engineering profession, theoretical and experimental investigation of current research topics are vital to the electrical engineering program.

Electrical Engineering faculty publishes their scholarly work frequently, chair international and national conferences, serve as reviewers for governmental programs or as referees for scientific journals. Same collaborative efforts extend to foreign lands. The department has sponsored several international workshops in Africa in 1992, Voltage Collapse and Voltage Regulation (1992) and workshop on Power System Planning and Operation (1995). In addition, in 1997, workshop on the Distribution, Operation, and Planning will be sponsored by NSF-Howard an upcoming one in 2000 in privatization and restricting of Power System industry in Accra Ghana. Same members of the faculty were invited to present papers or workshops in Russia. France, Germany, Japan, China, Canada, Greece and Egypt. The Department was selected to host the 26th North American Power Symposium (October 1993).

Three research centers and two departmental laboratories are designed to support graduate research. In addition to graduate faculty, the research staff includes research associates, visiting scholars from different countries, visiting professors from U.S. based companies and graduate students.

Sponsored research is a key ingredient for innovative research efforts, which are underway in the Department. Much of the graduate research is supported by external research grants, totaling in excess of $3 million per year. Among the sponsors are National Aeronautics and Space Administration, National Science Foundation, Standard Oil of Ohio, Office of Naval Research, Westinghouse, Department of Energy, Electric Power Research Institute, New England Power Service, the Army Research Office and Bonneville Power Administration.

The graduate program enrolls ever 60 students per academic year. Students are graduates at a variety of universities in the U.S. and several foreign countries. In May 1996, thirteen (13) students earned the Master of Engineering degree, four (4) students were awarded PhD. Degrees in Electrical Engineering.

## GRADUATE ADMISSION

### Admission requirements

Students may apply for admission when they have satisfied the following requirements:

### Master of Engineering

1. Regular admission to the master's program requires a bachelor's degree in Electrical Engineering with a grade point average of 3.0 on a 4.0 scale.

2. In special circumstances, individuals will be considered on a case-by-case basis. Depending on their background, such students may be required to take additional courses which may not be used to fulfill the degree requirements. In all cases students will have a maximum of one year to qualify as a regular degree student

3. Students who apply for admission from non-English speaking countries are required to pass the TOEFL examination with a score of at least 500. In addition, students are required to take the general part of the GRE.

All applicants are evaluated by the Departmental Graduate Admissions Committee.

**Doctor of Philosophy**

1. Regular admission to the Ph.D. program requires a bachelor s degree in Electrical Engineering with a grade point average of 3.0 on a 4.0 scale. Applications from persons with equivalent qualifications earned at foreign institutions will also be considered.

2. Students must maintain a grade point average above 3.0 in order to remain in the program.

3. Students who apply for admission from non-English speaking countries are required to pass the TOEFL examination with a score of at least 500. In addition, students are required to take the general part of the GRE.

4. Students must submit 1-2-page proposed plan of study as a part of their application,

which includes:

(a) Resume

(b) A statement of study and research interest.

**APPLICATION PROCESS**

The application deadlines are April 1 for fail and November 1 for spring admissions respectively. Students are required to have three letters of recommendation, a resume and have all required academic records received by the Office of Admissions prior to the appropriate deadline.

**Selection**

The Graduate Admissions Committee, on the basis of the submitted material, evaluates applications. In conformance with a standing policy of the University, the Department does not discriminate on the basis of race, color, creed, religion, national origin, sex, sexual orientation, age, marital status disability, or status as a disabled veteran or Vietnam era Veteran.

**Appeals Procedure**

A student denied admission to the Department should first consult with the Graduate Admissions Office. The applicant may then request a review of the Admissions Committe decision by writing a letter to the Chairman of the Department and the graduate study committee chair citing

the reasons for appeal. This letter should be submitted within two weeks after the letter of denial is postmarked.

## THE MASTER OF ENGINEERING IN ELECTRICAL ENGINEERING (M.E.)

### Academic Requirements

A minimum of 24 to 30 credits of course work must be completed, depending on whether the student is taking the thesis or non-thesis option. A cumulative grade point average of 3.0 is required for the master's degree. It is the policy of the Graduate School of Arts and Sciences to withdraw students from the program if they receive more than nine hours of "C" in three or more courses.

### Program of Study

New entrants into the master s program are required to submit a program of study, approved by the student's advisor, to the chairman of the Graduate Studies Committee for approval.

### Graduate Writing Requirement

All graduate students must demonstrate their competency in the English language as evidenced by a passing score on the English Proficiency Examination or the successful completion of the Expository Writing course.

### Admission to Candidacy

A student should file for admission to candidacy after twelve (12) hours of work has been completed and he/she has satisfied the GSAS writing proficiency requirement. The student is required to file on a semester before graduation forms provided by the dean, and approved by his/her thesis committee and the Executive Committee of the Graduate School of Arts and Sciences.

### Thesis Option

To obtain the master's degree under this option, one must complete twenty-four (24) credit hours of course work and six (6) credit hours of thesis. A formal thesis defense must be presented before a thesis examining committee, consisting of at least three of the faculty: academic advisor, chairman of the committee and one additional faculty member. At least two (2) of the committee members must be from the Electrical Engineering Department.

Students are urged to determine the subject of the thesis as early in the program as possible, preferably before the end of the first term of residence.

### Non-thesis Option

This option requires thirty (30) credit hours of course work. Both the student's adviser and the graduate committee chair must approve the course plan.

### Course Viability

It is the policy of the Graduate School of Arts and Sciences that courses taken five (5) years prior to the term in which the student plans to graduate cannot be credited toward fulfillment of the degree requirements. In special cases, this course credit may be restored provided the chairman submits to the Dean of the Graduate School of Arts and Sciences a written petition/recommendation and the student has passed a written exam especially administered for the purpose of restoration of the course credit.

**Length of Time for Completion of M. E Degree**

It is the policy of the Graduate School of Ads and Sciences that a student has a maximum of five calendar years from the date of Initial registration to complete the Master's degree program. In addition. students must be enrolled during the semester in which the degree is conferred.

**Satisfactory Progress Policy**

Students admitted to the Electrical Engineering Graduate Program should be aware that certain levels of academic performance are required in order to continue. The following department criteria are designed to assist me student in making satisfactory progress towards the degree while avoiding problems.

**Basic Criteria**

1. Students are expected to maintain a grade point average above 3.0 and follow course prerequisites.

2.Petitions for admission to candidacy, thesis defense. and graduation must be filed in accordance with the regulations of the Graduate School of Arts and Sciences to ensure that graduation occurs on time.

3.Students pursuing the thesis option should be careful to adhere to the GSAS procedures and guidelines for defense and submittal of the thesis.

4 It Is the policy of the University to disallow credit for courses taken through the Consortium If a course covering the same material was taught at Howard during the same semester.

**Field of Study**

The master's program offers the following specialized fields of research and study: antennas, microwaves, control engineering, power systems, communications, signal processing and solid-state electronics. Irrespective of the area of specialization, ail students are required to satisfactorily complete Engineering Analysis A & B (6 credits) and Graduate Seminar (non-credit, two semesters). The suggested core and elective courses for each of the specialized fields follows:

**Fields of Study** **Credit Hour**

**Antennas and Microwave**

**Suggested Core Courses**

Antenna Theory.....3

Electromagnetic Theory.....3

Microwave Transmission & Radiation.....3

**Suggested Elective courses**

Any nine credits approved by the student's advisor

**Communication and Signal Processing**

**Suggested Core Courses**

Communication and Signal Processing Lab.....3

Communication Theory 1.....3

Signal Processing 1.....3

Communications & Signal Processing Seminar.....0

**Suggested Elective Courses**

Communication Theory II.....3

Introduction to Coding Theory.....3

Signal Processing II .....3

Optimization Theory.....3

Introduction Detection & Estimation.....3

Computer Modeling & Simulation.....3

**Power Systems & Control**

**Suggested Core Courses**

Computer Language Course.....3

Linear Digital Control Systems I &II.....6

Power Systems Control.....3

Computer-aided Power System.....3

**Suggested Elective Courses**

Advanced Power Systems.....3

Random Processes.....3

Intelligent Systems and Application.....3

Optimization Theory.....3

Advanced Power Electronics.....3

**Solid State Electronics**

Suggested Core Courses

Solid State Physics I & II.....6

Electromagnetic Theory.....3

**Suggested Elective Course**

Any nine credits approved by the student's advisor.....9

## REQUIREMENTS FOR THE DOCTOR OF PHILOSOPHY IN ELECTRICAL ENGINEERING

### Academic Requirements

A minimum of seventy-two (72) semester-hours of credit above the bachelor s degree is required for the Ph.D. A student admitted to the program with the M.S. or M.E. degree may be granted up to 30 semester hours of course credit (thesis credit excluded). A cumulative average of 3.0 "B" is required for graduation. A student will be permitted (at most) two "C" grades.

### Residence

Residence begins upon admission into the Doctorate Program. The course of study must include a minimum of six semesters of full-time residence. At least four semesters in residence and full-time study must be completed in the Graduate School of Ads and Sciences at Howard University Two of these four semesters must be consecutive.

### Departmental Examination

All Ph.D. students must pass Qualifying and Preliminary examinations. The Qualifying examination is designed to ensure that all doctoral students have sufficient background knowledge in electrical engineering. This exam must be taken within first year of residence. The Student's Ph.D. Committee administers the Preliminary examination. This exam is designed to ensure that the student has in-depth knowledge of his/her specialized area.

**Publishing Requirement**

Ph.D. students are required to provide evidence that they have submitted a manuscript based on their dissertation research to a refereed journal or presented a talk on thesis research at a professional conference before scheduling the final oral defense.

**Admission to Candidacy**

Ph.D. students are admitted to candidacy after passing the preliminary examination and obtaining approval of the dissertation topic as described in a formal dissertation proposal.

**Course Viability**

It is the policy d the Graduate School of Ads and Sciences that courses taken seven (7) years prior to the tam in which the student plans to graduate cannot be credited toward fulfillment of the degree requirements. However, credit for such course may be restored and counted toward the fulfillment of the requirements for the degree provided:

1. The chairperson submits to the Dean of Graduate School of Ads and Sciences, a written petition/recommendation and

2. The student passes a written examination administered for the purpose of restoration of course credits.

Credits will not be restored nor counted toward the degree if taken more than ten (10) years prior to the time the student presents himself or herself for the oral defense.

**Satisfactory Progress Policy**

Students admitted to the Doctoral Program are expected to engage in full-time study. In order to complete the degree requirements in a timely manner, entering students should plan on taking a minimum of nine (g) credits each semester. The following criteria and procedures will be used in administering the Satisfactory Progress Policy of the Department. These criteria are in addition to those of the University and the Graduate School of Arts and Science.

**Basic Criteria**

1. Students are expected to maintain a grade point average above 3.0 and follow course prerequisites.

2. Petitions for admission to candidacy, dissertation defense, and graduation must be filed in accordance with the regulations of the Graduate School of Arts and Sciences to ensure that graduation occurs on Oms. (Approved candidacy forms and other documentation related to dissertation defense are maintained in the department's student file.)

3. Doctoral students must follow the Departmental Guidelines for Ph.D. Examinations. Students are also required to submit the Intent to Take Ph.D. Examination Form signed by the

Adviser and Graduate Committee Chair. (Deadlines for submitting an application to take the exam for either semester will be announced during the first week of that semester.)

4. It is the policy of the University to disallow credit for courses taken through the Consortium if a course covering the same material was taught at Howard during the same semester.

**Graduate Writing Requirement**

All graduate students must demonstrate their competency in the English language as evidenced by a passing score on the English Proficiency Examination or the successful completion of the Expository Writing course.

**Enrollment and Grades for Dissertation Courses**

A candidate for a degree must be enrolled in the Graduate School of Arts and Sciences during the semester in which the degree Is conferred.

Dissertation moves shall be assigned a grade of Incomplete. These incompletes are removed after the dissertation defense.

**Fields of Study**

The areas of concentration are: applied electromagnetics, communications and signal processing, power systems, control engineering and solid-state electronics.

**Applied Electromagnetics**

The Ph.D. program in Applied Electromagnetics provides research in electro-optical devices, fiber optics, modeling of microwave devices/circuits, antenna theory, superlattices/quantum well devices, applied superconductivity, microwave theory and bioelectromagnetics.

**Suggested Core Courses**

Antenna Theory ..... 3

Array Theory ..... 3

Solid State Microwave Devices ..... 3

Electro-Optics ..... 3

**Suggested Elective Courses**

Radar Systems ..... 3

Numerical Techniques for Superconductivity & Superconducting Devices ..... 3

Special Topics in Microwaves A & 8 ..... 6

Numerical Analysis ..... 3

Complex Analysis ..... 3

Microwave Transmission and Radiation ..... 3

Electromagnetic Theory ..... 3

Dissertation (maximum) ..... 12

**Communications and Signal Processing**

The Ph D. program In Communications and Signal Processing is designed to provide the student with a broad working knowledge of the basic theory of modem communications and signal processing systems and a facility for using state-of-the-art laboratory and simulation techniques. The goal of this program Is to produce graduates who are adept at designing modem telecommunications and signal processing systems as well as testing and evaluating their designs using modem laboratory test equipment and simulation techniques.

**Suggested Core Courses**

Detection Theory ..... 3

Dissertation (maximum) ..... 12

Estimation & Filtering ..... 6

Special Topics in Communications A & 8 ..... 6

**Suggested Elective Courses**

Advanced Mathematics ..... 12

Optimization Theory ..... 3

Reading and Research ..... 3

Any Additional related advanced graduate course as approved by the student's adviser

**Power Systems and Control Engineering**

The Ph.D. Program in Power Systems and Control Engineering provides students with a strong grasp of systems in order to respond to the need for specialists in various areas of system& in engineering. The research focus of this program entails analysis and design of power system operations and planning. System theories and emerging technologies such as artificial intelligence, expert system, artificial neural network, and fuzzy logic are investigated to improve quantitative and qualitative analysis of design making for power system studies. in addition, modem control theories are applied to solve large scale engineering problems by various investigators of the Center for Energy Systems and Control (CESaC).

Current externally funded projects involve research on dynamic security assessment. Optimal power flow, Var planning using branch and bound/interior point method, distribution,

automation and control, load shedding and emerging technologies (genetic algorithms and pattern recognition to solve power systems research problems.

**Suggested Core Courses**

Computer Aided Power System ..... 3

Optimal Controls ..... 3

Advanced Power Systems ..... 3

Power Systems Controls..... 3

Optimization Theory ..... 3

Dissertation (Maximum) ..... 12

**Suggested Elective Courses**

Power System Deregulation.....3

Digital Controls I and II ..... 3

Special Topics in Power Systems I & II ..... 6

Real Analysis I & II ..... 6

Intelligent System and Application ..... ..... ... .....3

Advanced Power Electronics ..... 3

Advanced Control..... ..... 3

Reading & Research ..... 3

**Solid State Electronics**

The Ph.D. program in Solid State Electronics offers both experimental and theoretical studies in semiconductor materials growth, and techniques of material characterization. The scope of material systems studied include the III-V compounds such as Sic and waveband gap semiconductors such as AIM and GaN

The devices of interest include millimeter-wave mixer diodes, resonant tunneling devices produced using MBE, sub-micron gate MESFETS. solar cells and temperature SIC FETS.

**Suggested Core Courses**

Microwave Transmission and Radiation ..... 3

Solid State Physics I & II ..... 6

Electromagnetic Theory .....,,..... 3

Dissertation (maximum) .....,.....,..... 18

Methods of Applied Mathematics I & II .....,....,.....,.....,..... 6

**Suggested Elective Courses**

Electro-Optics ..... 3

Solid State Microwave Devices ..... 3

Quantum Electronics ..... 3

Reliability & Failure ..... 3

Analysis of Semiconductor Devices ..... 3

Special Topics in Semiconductors A & 8 ..... 3

Quantum Mechanics I & II ..... 6

**Financial Aid**

Financial aid includes fellowships, graduate, teaching and research assistantships. The stipends Fangs from $8,000 to $18,000 per academic year plus tuition.

Students may be eligible for special awards from industry or government. These awards usually offer a higher stipend and require the student to conduct research at the work site during the academic year or in the summer.

Most Electrical Engineering graduate students serve as research assistants and receive funding through externally sponsored research grants. Such support requires twenty (20) hours of work in the assigned laboratory per week. Students may receive additional compensation through summer research assignments or may secure summer employment from sponsors of research center or laboratory in which they are affiliated. For example, several students who are affiliated with the Center tor Energy Systems and Controls have been able to secure summer employment from sponsors such as Pacific Gas and Electric, Department of Water and Power in Los Angeles, Bonneville Power Administration in Portland, Oregon, Commonwealth Edison, Chicago and as professors in US University.

Applications for financial aid should be completed by April 1 tor the Fall semester and November 1 for the Spring semester.

Further information and application forms may be secured from the Electrical Engineering Office or from individual faculty members who are involved in externally funded research projects. Students are encouraged to apply for all available grants and fellowships prior to and during their graduate career.

**Advising**

After admission is granted, students will be notified of the registration process. Generally, during the first semester of study, the Chairman of the Graduate Studies Committee assists in guiding the initial advising and registration of new entrants.

Electrical Engineering students are requested to submit a Graduals Plan of Study during their first semester of studies. A permanent graduate advisor is assigned by the Chairman of Graduate Studies Committee for the student during the first semester if the student does not have an advisor.

**Probation and Dismissal**

A student who fails to meet the grade requirements or fails departmental examinations (comprehensives preliminary) or qualifying or the final examination for defense of thesis or dissertation) will be dropped from the graduate program. A student who fails below the grade-point average of 3.0 will be warned by the Graduate School of Arts and Sciences and informed that he or she must raise his or her quality point index to 3.0 by the end or his or her next two terms in residence. Failure to do so will result in dismissal from the graduate program.

**Registration within the Department**

Electrical Engineering graduate students are to report to the Electrical Engineering Department for registration materials before meeting with their adviser. All students should complete a Graduate Student Data from which provides information regarding their current residence, phone number, area of study, source of support, etc. This form may be secured from the Electrical Engineering Office and should be submitted to the office upon completion. The information is needed so that students can be contacted and also to report statistical data to the GSAS.

Students are urged to register for classes during the official registration period. Principal investigators who are providing financial support for research assistants should make an effort to identify students who they will sponsor and prepare paperwork required for tuition before the registration period. Only under exceptional circumstances will a student be permitted to register after the official GSAS registration period has ended. No student who has not returned his or her completed enrollment forms will be allowed to register for classes.

Medical forms are required for old students returning and new students.

**Appeal of Academic Decisions**

The Graduate School of Arts and Sciences has implemented the following procedure for cases of changes of decisions made about course work or examinations required for graduate degree programs.

A. Changes may be considered only when a student has grounds for challenging the decision which reflects legally impermissible considerations.

B. Students should begin the appeals process by requesting a conference with the instructor. If the process fails, the student should then meet with the Chairman of the Electrical Engineering

Department and request that a committee be appointed to investigate the problem and settle the dispute.

C. Should the above processes fall. the problem should be taken to the Dean of the Graduate School of Arts and Sciences.

**Graduate Research Facility**

The Department of Electrical Engineering has seven laboratories/or centers for conducting state-of-the-art research at the graduate level. These laboratories/or centers include: Material Science Research Center, Center for Energy Systems and Controls, Computational Science and Engineering Research Center, Communications and Signal Processing, Digital Systems. Microwave devices, Antennas, and Electro-Optics.

**Materials Science Research Center (MSRCE)**

The primary mission of the MSRCE is to advance the frontiers of knowledge through basic research of electronic and electro-optic materials and devices.

The Center's investigations focus on researching, understanding and optimizing the growth of artificially structured materials and wide-bandgap semiconductors. Improvements in the growth of these materials allows for the fabrication of high-power devices which promise to extend the performance of microwave and optical power devices to higher frequencies and higher power levels.

**Center for Energy Systems end Controls (CESaC)**

The Center is dedicated to research and development of efficient tools for analysis and design for power system operations and planning. System Theories for stability assessment and emerging technologies such as artificial intelligence, expert system, artificial neural network and fuzzy logic are genetic algorithms are investigated to improve quantitative and qualitative analysis of decision making for power system studies. Also, modem control theories and Optimization Theories are applied to solve large scale engineering problems by the various investigators at the Center.

**Communications and Signal Processing Laboratory**

This laboratory is equipped with modem equipment to facilitate research and instruction in selected areas of communications and signal processing. The facility is designed to provide practical and hands-on experience in these areas. Some areas of focus are: simulation of communications and signal processing systems and functions, detection and estimation algorithms, adaptive filters and arrays; emulation and application studies of digital signal processing chips (TMS 32010 & AT & T); time-domain and frequency-domain measurements and analysis of real time signals and computer-generated animated video tape movies.

**Microwave Laboratory**

This laboratory provides fixed and swept-frequency systems for a wide rouge of millimeter wave, microwave, waveguide and coaxial component studies and designs. X-band equipment is available for power, frequency, insertion loss, return loss and scalar and vector s-parameter measurements. The laboratory is furnished with advanced and high frequency equipment such as a spectrum analyzer (up to 40 GHz), reflectometer, noise figure meter and HP8409B automatic network analyzer system.

**Course Description**

**5 0 1 Graduate Seminar 1(0 Crs.)**

Presentation of current engineering topics by faculty, students and invited guest speakers. (Required for 2 semesters of new graduate students)

**5 0 2 Engineering Analysis A (3 Crs.)**

Ordinary differential equations finite differences and their applications to engineering problems. Fourier series and integrals, Laplace transform, partial differential equations, Bessel & Legendre polynomials.

**5 0 3 Engineering Analysis B (3 Crs.)**

Vector calculus, vector fields, dyadics, tensors, boundary value problems, solutions to linear homogeneous boundary value problem, separation of variables and Green's functions, two-dimensional potential problem and informational mapping, introduction to non-linear differential equations and variations and perturbation methods.

**5 0 5 Power systems Control (3 Crs.)**

Elementary constrained optimization. optimum operating strategies, control system structure, megawatt frequency control, voltage control, optimum systems control, power-pool control, contingency analyses and power systems state estimation.

**5 0 6 Advanced Power System Analysis (3 Crs.)**

Power System Control Models, Power flow equation and solution, unbalanced fault analysis, iterative method for fault analyses, sensitivity analysis, transient stability using time dimension, Energy function, voltage stability, voltage collapse application of Intelligent Systems for stability assessment.

**5 0 7 Computer-Aided Power System Control (3 Crs.)**

Computer application to operation, control and analysis of power systems. Topics Include load flow, load forecasting. unit commitment, load scheduling, network modeling, fault study, transient stability analysis, reliability, future expansion of systems, security and contingency analysis, on-line dispatch techniques and state estimation in power systems.

**5 0 8 Intelligence Systems and Engineering Application (3Crs.)**

Overview of artificial intelligence, representation of knowledge rule based expert systems, introduction to expert system languages such as LISP, OPS series and PROLOG. Basic concepts of fuzzy theory, relations, regression models, mathematical programming. Introduction to neural networks, learning architectures. Applications of neural networks, expert system, fuzzy systems to control, communications and power systems.

**5 0 9 Linear Digital Control systems I (3 Crs.)**

Areas covered include writing systems equations, system representation, control system characteristics, root locus, frequency response, closed loop performance, root locus compensation and cascade and feedback compensation.

**5 1 0 Linear Digital Control System II (3 Crs.)**

Areas covered include writing systems equations, systems representation, control system characteristics, root locus, frequency response, closed loop performance, root locus compensation and cascade and feedback.

**5 2 0 Electromagnetic Theory (3 Crs.)**

This course is meant for second semester graduate students who have already taken electromagnetic theory as undergraduates. Topics include: Static and time-varying fields, transmission in different media. polarization. the Smith chart, waveguides, resonators and some special topics.

**5 2 5 Microwave Transmission and Radiation (3 Crs.)**

Overview of various microwave transmission structures, linear passive devices, solid-state and electron-beam devices and microwave processing networks leading to the state-of-the-art in microwaves and radiation.

**5 2 6 Antenna Theory (3 Crs.)**

Topics include aperture and frequency independent antenna, array analysis and synthesis, applications.

**5 3 1 Solid State Physics I (3 Crs.)**

Introduction to the quantum mechanics of crystalline solids. Topics include: introduction wave mechanics of electrons, classical Crude theory and quantum mechanical Sommerfeid models of electrons in metals crystal lattices and the concept of the Bravais lattice, determination of crystal structures by x-ray diffraction, electrons in a periodic potential Bloch's Theorem, quantum mechanics of electrons in a weak periodic potential, energy band theory, band structures of selected metals and semiconductors.

**532 Solid State Physics If (3 Crs.)**

Continuation of 235-531 with emphasis on the physics of semiconductors. Topics include an introduction to: Lattice vibrations in crystalline solids, introduction to the physics of semiconductors, concept of effective mass in semiconductors, electrons and holes in semiconductors, optical properties of semiconductors and metals, and an introduction to carrier statistics in semiconductors, quantum mechanics of superlattices and quantum well structures.

**5 3 3 Microelectronics (3 Crs.)**

Analysis of modern processing methods and technology in the manufacture of microelectronic devices. Topics include device structure, diffusion theory, dynamics of oxide growth, effects of change and contamination levels on device parameters, ion implantation, measurement techniques, elipsometry and future process technology.

**5 3 4 Electro.-Optics (3 Crs.)**

Topics include lasers from physical phenomena to applications.

**5 3 5 Solid State Devices I (3 Crs.)**

Covers electronic structure of solids, electronic conduction in solids radiation and impurity effects and semiconductor contracts and junctions, diodes. transistors, transistor structures, two terminal devices, integrated circuits and device reliability.

**5 3 6 Solid State Microwave Devices (3 Crs.)**

Theories of solid state devices at microwave frequencies. Transfer-electron and avalanche diodes, transistors, device-circuit interactions.

**5 4 1 Probability and Random Variables (3 Crs.)**

Axioms of probability measure, random variables, functions of random variables, stochastic processes, stationary and ergodic processes, correlation and power spectrum, linear mean-square estimation, application.

**5 4 2 Communication Theory (3 Crs.)**

Bounds on performance of communication systems, union bounds and Chernoff bounds; analysis of convolutional codes, Viterbi algorithm and sequential decoders; quantization effects; performance of communication systems with combined modulation and coding over Gaussian and fading dispersive channels.

**5 4 4 Introduction to Coding Theory (3 Crs.)**

Design and characterization of error correction and detection codes, encoder and decoder design, and forward and ARQ error correction concepts.

**5 4 5 Introduction to Detection and Estimation Theory (3 Crs.)**

Statistical detection theory; signal and parameter estimation theory; likelihood-ratio decision rules; Bayes, maximum-likelihood, maximum-posterior, Neyman-Pearson, and minimum-error criteria; Cramer-Rao Bound. unbiased estimators, Kalman and Weiner filters, estimators; simple and composite hypothesis testing.

**5 4 7 Telecommunications I (3 Crs.)**

Review of probability. Random variables, random processes and queuing theory with applications to telecommunication networking and traffic engineering (i.e. arrival processes,ccs,eriangs.etc.)introduces fundamental telecommunication network end channel models including satellites, microwave, coaxial cable and fiber optical channels. Fundamentals of telephony, switching and networking including message circuit and packet switching, digital switching theory and techniques; wide area networks (WAN), public data networks, local area networks (LAN), layered network architecture, protocols and ISO reference.

**5 4 8 Telecommunications II (3 Crs.)**

Detailed treatment of advanced topics in telecommunication systems engineering, including formal protocol specification and verification techniques, protocol designs Including virtual terminal and file transfer protocols; packet switching concepts and standards including APARNET, x25, x75 and packet assembly dissemble (PAD) standards (i.e. x3, x28, x29); advanced networking concepts including routing, congestion and flew controls local area networking topics such as topologies, protocols and design and implementation issues.

**5 5 1 Network Theory I (3 Crs.)**

Fundamental concepts of network analysis synthesis of real functions, characteristics of real functions, properties of 2-port networks, synthesis of voltage transfer functions and transfer matrix synthesis of grounded multiports.

**5 5 2 Network Theory (3 Crs.)**

imminence of RLC networks, series-paralleled realization, Darlington synthesis, cascade i-port synthesis, even port synthesis, even port synthesis, and three RC networks with arbitrary gain.

**5 5 5 Digital Control (3 Crs.)**

Z-transform digital filter, sampled data systems, design of digital control by transform and state-space methods, quantization effects. system identification, multi-variable and optimal control and sample rate selection.

**5 6 1 Signal Processing I (3 Crs.)**

Continuous-time and discrete-time invariant systems; Fourier series and transforms, Z-transforms; DFTs and FFTs; frequency response; final impulse response (FIR) and infinite impulse response (IR) digital filter response, digital filter characterization, design and analysis; windowing and window functions; quantization and finite world- length effects.

**5 6 2 Signal Processing II (3 Crs.)**

Adaptive signal procession concepts. Wiener filters and normal equations; forward and backward linear prediction, Levinson-Durgin recursion, and Lattice Predictors; adaptive transversal filters and algorithms (steepest-decent, LMS, LS, RLS, FLS, etc.);adaptive ionics filters and algorithms (8URG, GAL, LSLS, FAST, etc.); joint Process estimation; adaptive arrays.

**5 6 4 Communication And Signal Processing Lab I (3 Crs.)**

Practical and hands on experience in fundamental concepts of communications and signal processing geared to help develop tools and techniques for research and practices. Focus on simulation methodologies and techniques, system medaling for design and Performance analysis, and use of modem laboratory equipment such as spectrum analyzers, signal generators, oscilloscopes, array processors, personal computers, and related software.

**5 6 7 Communication And Signal Processing Seminar (3 Crs.)**

Presentation and discussion of current communications and signal processing topics obtained from a variety of sources; guest speakers, projects and theses of graduate students and relevant publications.

**5 9 1 Engineering Project (3 Crs.)**

An engineering design and analysis investigation at the masters level. Topic to be decided between student and adviser and should be relevant to student's specialty area. The project plus the comprehensive examination are to demonstrate the student's mastery of theory and laboratory skills.

**5 9 9 Thesis. Credit varies**

**6 0 3 Control Theory (3 Crs.)**

State variable description of dynamic systems, solutions of differential and difference equations by transition matrix. control-ability and observability of linear systems, perturbation of nonlinear systems, stability of nonlinear systems. Liapunov's direct method, realization of transfer matrices by state equations, state and output feedback, pole assignment using state and output feedback reconstruction of state from output.

**6 0 4 Optimization Theory (3 Crs.)**

Theorems on extremum. Applications of the theorems, illustrative problem. Theorems on necessary conditions for extremum of functions and functionals, theorems on sufficient conditions for extremum of functions and functionals, simplex method for solving linear programming problems, dynamic programming and decomposition theorem, non-linear optimization.

**6 0 5 Optimal Control (3 Crs.)**

Optimal principle, special cases of the optimal principle, illustrative problem, linear regulator and Riccati equation, discrete optimal principle, power spectrum density. Theorem on the necessary and sufficient condition for an optimal fitter, design of the optimal filter, illustrative problems.

**6 1 1 Detection Theory (3 Crs.)**

Statistical detection theory, hypothesis testing, optimum decision rule, Bayes criterion, Nyaman-Pearson criterion, minmax testing, multiple observation, composite hypothesis testing, sequential detection.

**6 1 2 Estimation and Filtering (3 Cre.)**

Gaussian and Markov processes, stochastic differential equations, single and multiple' observation decision theory. Bayesian estimation theory, maximum likelihood estimation. optimum linear filtering, smoothing and prediction, nonlinear estimation.

**6 1 3 Information And Coding Theory (3 Cre.)**

Measures of information; Shannon theorems for noiseless and noisy channel coding; channel capacity; techniques for block coding and decoding, hamming codes, cyclic codes, BCH codes, Beriekamp-Massey decoding algorithm.

**6 2 9 Numerical Technique for Electromagnetics (3 Cre.)**

Arrangement of electromagnetic field equations for numerical solution methods is covered. Iterative methods, moments method, characteristic modes methods, and geometric diffraction techniques are covered.

**6 3 5 Quantum Electronics (3 Crs.)**

Interaction of atomic systems with high frequency radiation and optical radiation fields utilization of these phenomena for coherent amplification and generation of radiation, nonlinear phenomena involving radiation fields, and principles of operations of lasers and masers.

**6 3 7 Superconductivity and superconducting Devices (3 Crs.)**

Applied analysis of Superconducting devices.

**6 8 0 Reading and Research In engineering (3 Crs.)**

**6 8 1 Special Topics in Power systems Deregulation A (3 Crs.)**

**6 8 2 Special Topics in Power systems Deregulation B (3 Crs.)**

**6 8 8 Special Topics in Signal Processing A (3 Crs.)**

**6 8 9 Special Topics in Signal Processing B (3 Crs.)**

**6 9 1 Special Topics in Controls A (3 Crs.)**

**6 9 2 Special Topics in Controls B (3 Crs.)**

**6 9 3 Special Topics in Communications A (3 Crs.)**

**6 9 4 Special Topics in Communications 8 (3 Crs.)**

**6 9 6 Special Topics in Microwaves A (3 Crs.)**

**6 9 6 Special Topics in Microwaves 8 (3 Crs.)**

**6 9 7 Special Topics in Semiconductors (3 Cre.)**

**6 9 6 Special Topics in Microelectronics (3 Cr.)**

**6 9 9 Special Topics in Power systems A (3 Crs.)**

**7 0 0 Special Topics in Power systems B (3 Crs.)**

**Ph.D. Dissertation. Credit varies**

**Procedures given by the GSAS for writing the oral Examination for the Master's Degree**

**Examining Committee for Master's Degree**

All members of an official examining committee for candidates for either a Master of Arts or a Master of Science degree are recommended for approval to the Dean of the Graduate School of Arts and Sciences by a department. The examining committee is to be composed of a minimum of a three (3) members; the chairman of the examination committee, and two additional faculty members from the major department, if no minor area. The chairman of a Master's oral examination committee must be a member of the Graduate Faculty. Other members of the Graduate Faculty may be invited to attend but shall not Participate in the proceedings unless invited to do so by the chairman of the examination committee.

A quorum will consist of three committee members with voting rights, including the chairman and one representative from each, the major and minor (if applicable) areas, all of whom must be physically present throughout the time of the oral examination. No on-the-spot substitutions in the membership of the committee are acceptable.

The department chairman will appoint a chairman of the examination committee. This person may not be the candidate's major adviser.

A favorable unanimous vote of the examining committee (including the presiding chairman) will certify that the candidate has successfully passed the final oral examination in defense of the thesis.

**Scheduling of the Examination**

The final oral examination for master's degree will be scheduled by the department not by the Office of the Graduate Dean. However, departments are to notify the Graduate Dean of each examination by listing the students name, names of the members of the committee. the date, time, and place of the final om! examination and provide a copy of Form GSAS-EA-3 (See section under "Forms of Certification").

A synopsis of the thesis must also accompany the notification. The Graduate Dean or his designated representative(s) is an ex-officio member of the examining committee and may be present during the oral examination to observe and pose questions. Other members of the University community may attend the examination but may not take pad in the proceedings unless invited by the chairman of the examination committee.

The oral examination for the master's degree should be held in a room that is conducive to this academic activity. The room should be large enough to accommodate comfortably the candidate, members of the committee, and guests. It should be well lighted and equipped with sufficient electrical outlets and other furnishings necessary for a successful oral defense.

**Forms for Certification**

Three forms are to be completed and submitted. They are labeled GSAS-EA-3, GSAS-EA-5, and GSAS-EA-6. Form GSAS-EA-3 is submitted along with the notification of the oral examination. The form must be accompanied by an abstract of the thesis and must be signed by the candidate's major advisor and the department chairman.

Form GSAS-EA-5 certifies that the candidate has defended successfully the thesis and that the thesis is complete and acceptable. Form GSAS-EA-5 must be signed by each member of the examining committee.

Form GSAS-EA-6 certifies that the candidate has fulfilled all departmental requirements for the master's degree and that the requisite number of copies (the original and two copies) of the thesis, duly approved by the department, is being submitted.

**Acceptance of the Thesis**

while it is to be expected that there may be some modifications in the thesis n a result of an in-depth probe of the candidate during the oral defense, it should be understood that such modifications will be minor and will not require any substantial length of time to effect.

The thesis must be thoroughly scrutinized by all members of the examination committee prior to the oral examination itself If in the judgment of any member of the committee, the document will require further detailed and extensive modifications, the nature of these changes should be communicated to the candidate, me committee chairman, and the Dean of Graduate School. The date of the examination must then be postponed. Upon the resolution of difficulties or the completion of whatever modifications that may be required, the Dean should be notified (in writing) and the examination may then be rescheduled. The proposed date should not come earlier than three (3) weeks after the date of the request to re-schedule the examination.

Upon completion of the oral examination, the original and two copies of the completed thesis in its final form are to be submitted to the Graduate Dean.

Form GSAS-EA-5 is to be signed by all voting members of the oral examination committee. Submission of the thesis and forms GSASEA-5 and GSASEa-6 signal that the candidate has completed all requirements for the degree and that both the thesis and all forms become the joint property of the department and the Graduate School of Arts and Sciences.

The final copy of the thesis in triplicate (original and two copies), incorporating any Changes resulting from the oral defense, must be submitted to the Graduate School within ten (10) working days following the examination date. Detailed and extensive modifications in the thesis which require more than ten working days should be communicated to the candidate in writing. Failure to submit the thesis within the prescribed time period win require a second Examination.

**Failure of the Oral Examination**

Any candidate who fails the oral examination may be given a second oral examination provided the second oral examination does not come earlier than two months (60 days) from the date of the first oral examination. Application for a second oral examination must have the approval of the department in which the candidate is specializing. Failure on the second oral examination is final.

**Non-Thesis option**

For students who do not write theses, the department is required to submit to the Graduate Dean's office only Form GSAS-EA-6, in triplicate.

**Conducting the Oral Examination**

The final oral examination is the culmination of several years of formal study and several months of intensive research. Therefore, it is expected that the examination will be conducted in a professional manner in keeping with the importance attributed to this activity by the Graduate School of Arts and Sciences.

The chairman of the examination committee is responsible for conducting the final oral examination equitably and with dispatch. The accepted duration of a final oral examination is two hours.

**Procedures for Administering the Final Oral Examination for the Doctor of Philosophy Degree**

**Examining Committee for Ph.D. Degree**

All members of the official examining committee for the Ph.D. degree are to be appointed by the Dean of the Graduate School of Arts and Sciences upon recommendation of the department.

The examining committee is to be composed of a minimum of five members, a majority of whom should represent the major department. One member should represent the minor or an

allied department (if applicable), and one member, designated as the external examiner must have academic and professional credentials comparable to those of Howard University's Graduate Faculty*. A curriculum vitae of the outside examiner is to be submitted along with the request for the student's final Ph.D. oral examination. Five members, present with voting rights, including the committee chairman and others specified above, will constitute a quorum.

Effective August 1, 1977, examiners from the University serving on Ph.D. oral examination committees for all students who were not admitted to candidacy prior to !ha! date, must be members of the Graduate Faculty.

Upon a favorable, unanimous vote of the examining committee (including the presiding chairman) the candidate will be certified as having passed the final oral examination in defense of the dissertation.

The Dean of the Graduate School of Arts and Sciences (GSAS) or his designated representative is a member ex-officio of the doctoral examination committee and may be present during a

**External Examiner for Ph.D. Examination**

The external examiner must be a recognized authority in the area of research and scholarship treated in the doctoral dissertation. His/Her role on the examining committee is that of an impartial and disinterested examiner and arbiter. He/She must not have had any interaction with the candidate or with the candidate's research or investigation prior to receipt of the completed dissertation. Specialists in the area of the dissertation research who have been involved in any way with the dissertation or advisement thereof are not eligible to serve as external examiners.

**Chairman of Final Oral Examination**

The chairman of the department in which the candidate is enrolled is responsible for planning and executing all facets of the final oral examination for the masters and doctoral degrees. He/She may serve as chairman of the examining committee and may preside at the oral defense provided he/she is not the candidate's major advisor. Under no circumstance should the candidate's major advisor or the external examiner chair the final oral examination.

**Scheduling the Ph.D. Oral Examination**

The request for scheduling an oral examination for a Ph.D. candidate must be submitted by the Dean of the Graduate School within the time-frame specified by the Graduate School and submitted to the department. Included in the request should be the full morns and department of each proposed committee member, the complete name and mailing address of the external examiner, and the designation of the committee chairperson. The Graduate Dean will assume responsibility for scheduling the Ph.D. oral examination, informing the examiners of the time and location of the examination, and publishing an announcement of the dissertation defense. The candidate's major advisor and the departmental chairman have the responsibility to insure that all dissertations are of highest quality prior to their approval and prior to making the request to schedule the final oral examination. One copy of the dissertation in its final form must accompany the request.

**Forms for Certification**

Six forms must be used in computing the process of administering the Ph.D. final oral examination. They are labeled GSAS-EA-1-6.

GSAS-EA-1 consists of the biographical data of the student.

GSAS-EA-2 consists of the dissertation summary.

GSAS-EA-3 consists of a certification of the fact that all work on the dissertation has been completed and that the document is now ready to be defended. A synopsis of the dissertation research (typed as a pad of GSAS-EA-2) must accompany this form. The form and the synopsis must be submitted with the request for scheduling the oral examination. Ones submitted, both become the joint property of the department and the Graduate School of Arts and Sciences.

GSAS- EA- 4 provides certification from all committee members stating that the dissertation meets the standard of the Graduate School of Ads and Sciences. The outside examiner is not required to sign this form.

Form GSAS-EA-5 certifies that the candidate successfully defended the dissertation and that the document is complete and in acceptable form. Form GSAS-EA-5 must be signed by all voting members of the examining committee.

Form GSAS-EA-6 certifies that the candidate has fulfilled all departmental requirements for the doctoral degree and that the requisite number of copies of the dissertation, duly approved the department, is being submitted. This form must be signed by the chairman of the department. Upon submission, the dissertation and forms GSAS-EA-5 & 6 become joint property of the department and the Graduate School of Ads and Sciences.

**Conducting the Final Oral Examination for the Ph.D. Degree**

The final oral examination marks the culmination of many years of formal study and several months of intensive research on the part of the candidate it represents the highest level of achievement in preparation for a career of active scholarship and research. This examination affords the candidate an opportunity to demonstrate the depth and breadth of blamer knowledge in a particular field of specialization, ability to conduct research and to present and defend the findings before a select delegation of researchers, specialists and scholars. Therefore, it is expected that the final oral examination will be conducted in a dignified and scholarly manner befitting this important occasion and that the candidate's attire will be in keeping with the significance which the Graduate School attributes to the final oral examination.

A suggested format for conducting the final oral examination in defense of the dissertation has been Established and will be made available by the Graduate School of Arts and Sciences for each department. The committee chairman is responsible for conducting each phase of the final oral examination equitably and with dispatch.

Members of the examination committee are expected to remain on the committee until the final oral examination has been completed. A member who finds it necessary to withdraw from the

committee must write a loner to the Dean of the Graduate School informing him of the same and asking to be relieved of his/her committee obligations, whereupon the Graduate Dean, in consultation with the department, will appoint a replacement for that member.

**Parking Permit for External Examiners**

Parking permits for external examiners for Ph.D. final oral examinations are available in the University's Office of Security and Parking. Department Chairmen should request a parking permit well in advance of the date of the examination.

**Acceptance of the Dissertation**

The dissertation must be thoroughly scrutinized by all members of the committee prior to submitting the document to the Graduate School for review and for scheduling a defense date. If the review reveals deficiencies in the document, they must be communicated to the committee chairman and the candidate and they must be corroded before the final oral examination date can be set.

Under no circumstance is a committee chairperson or department chairperson authorized to convene a final oral examination, if any voting committee member has knowledge that substantial modifications of a clerical, organizational, or substantive nature remain to be done. The passing of the final oral examination Is taken to mean that all requirements for the degree have been met, and that no further work beyond cosmetic changes in the dissertation is to be demanded of the student in order for the degree to be awarded.

**Final examination is not intended as a review session for making last minute suggestion for changes and corrections in the dissertation**. It is to be expected that there may be occasion for some modifications in the work as a result of the in-depth probe of the candidate's knowledge of his research area by the committee, and it should be understood by the candidate that such modifications as may be required be either major or minor and that they may or may not take a substantial length of time to affect. This statement, however, is not meant to encourage the committee to recommend major changes and corrections; a well-written dissertation should need only minor modifications that do not require any substantial length of time to be affected. Therefore, in order to protect and defend the prerogatives and authority of the examining committee, on the one hand, and the candidate, on the other, **it is incumbent upon both the candidate's major adviser and the departmental chairman to insure that all dissertations which meet with their approval are of the highest quality before the committee convenes for the oral defense.**

The final copy of the dissertation in triplicate (original and two copies) incorporating any changes resulting from the oral defense, must be submitted to the Graduate School within ten (10) working days following the date of the final oral examination. If, following the oral Examination, the dissertation still requires modifications which cannot be completed within the prescribed ten working days, the modifications could be considered major and thus may require a repeat of the oral defense All major modifications in the dissertation recommended by

the examining committee must be given in writing to the candidate. Also, the plan for making the modifications, including the names of members of the committee who will be responsible for making certain that the desired changes are made, must be listed and communicated to the candidate. A copy of this plan must also be submitted to the Graduate Dean.

**Locus of the Ph.D. Oral Examination**

All oral examinations in defense of doctoral dissertations will be held in Room 205, Graduate School of Arts and Sciences Building, Annex III, 4th and College Streets, N.W

**Failure of the Final Oral Examination**

Any candidate who falls the final oral examination may be given a second oral examination, provided the second oral examination does not come earlier than two months (60 days) from the date of the first oral examination. Application for a second oral examination must be approved by the department in which the candidate is specializing. Failure on the second oral examination is final.

**EE Faculty:**

**Professors**

James A. Momoh, Ph.D. - Howard University: Systems Engineering, Power Systems and Controls, Expert Systems, Neural Networks

Tepper L. Gill, Ph.D - Wayne State University: Mathematical Physics, Quantum Field Theory and Magnesium

Gary L. Harris, PhD. - Cornell University: Electro physics, Device Fabrication, Characterization in Materials and Devices

Ahmed Rubaai, Ph.D. - Cleveland State University: Motion Control and Drives

Chang J. Kim, Ph.D. - Texas A&M University: Electric Power Systems Operation, Control and Protection

**<u>Associate Professor</u>**

Peter Bofah, Ph.D. - Howard University: Controls and Energy Systems, Large space Structures Modeling and Power Electronics

**Policy on Equal Opportunity**

The mission of Howard University includes the provision of qualify education for any student, but with emphasis upon the provision of educational opportunities for those students who may not otherwise have an opportunity to acquire an education of the type provided at Howard. In

fulfilling its mission, the university does not discriminate on the basis of race, color, national and ethnic origin, sex, marital status, religion, or handicap in the administration of its educational policies, admissions policies, scholarship and loan programs, and other University administered programs and employment.

Howard University is committed to equal opportunity in all aspects of its relations with faculty. students, and staff members without regard to race, color, national and ethnic origin, sex, marital status, religion, age or handicap. The requirement not to discriminate in education programs and activities extends to employment therein and admission thereto.