

**GRADUATE  
PROGRAM  
HANDBOOK**

VISION  
SCIENCE

**COLLEGE OF OPTOMETRY  
THE OHIO STATE UNIVERSITY**

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### **1. Purpose of the Handbook**

The purpose of this handbook is to describe the policies, rules and procedures of the graduate program in Vision Science, and particularly to define distinctions between the information relating to this program and the general information already described in the *Graduate School Handbook*.

### **2. Goals of the Program**

The goals of the graduate program in Vision Science are:

- a) To train researchers in the latest and most effective approaches for solving vision science problems;
- b) To train educators for professional programs that train eye care providers; and
- c) To produce scientists for the conduct of vision science in military, government, industrial and other professional settings.

### **3. Relationship between the Graduate School and the Research and Graduate Studies Committee**

- a) The Graduate School of The Ohio State University includes faculty members authorized to provide graduate instruction, the graduate faculty, the Council on Research and Graduate Studies, and administration. The Council on Research and Graduate Studies is the principal legislative body of the Graduate School and initiates policies and rules governing Graduate Programs. The policies, rules, procedures and general information concerning graduate education and research at The Ohio State University are embodied in the *Graduate School Handbook*.
- b) The Research and Graduate Studies Committee conducts the graduate program in Vision Science. This committee oversees and administers the graduate program and serves as the liaison between the Graduate School and the graduate faculty members. The responsibilities of the Research and Graduate Studies Committee are described in detail in the *Graduate School Handbook*. They include but are not limited to: monitoring courses proposed for graduate credit; establishing procedures for assigning advisors; appointing graduate faculty, reviewing graduate faculty membership; making recommendations on student admissions; monitoring student progress; and establishing rules and procedures for the conduct of Master's Examinations, General Examinations and Final Oral Examinations. The Research and Graduate Studies Committee is appointed by the College of Optometry Dean from the Category P, tenured graduate faculty in Vision Science.
- c) The Committee publishes this *Graduate Program Handbook* embodying the policies, rules and procedures of the program. This handbook is available through the Research and Graduate Studies Committee Chairman.

#### **4. Admission, Registration and Scheduling**

- a) The admission criteria that are outlined in the *Graduate School Handbook* apply to the graduate program in Vision Science. The Research and Graduate Studies Committee evaluates the applicant's credentials and admits graduate students to the graduate program.
- b) The admission procedure is a competitive process that examines the applicant's overall undergraduate/professional grade point average (GPA), Graduate Record Examination (GRE) results (required of all applicants), and other qualifications. Admissions assessments may also include publications, scores on the National Board of Optometry examinations, and professional and research experience.
- c) The Research and Graduate Studies Committee may wish to conduct a personal interview with the applicant.
- d) A limited number of Graduate Teaching Associate (GTA) positions are available in the College of Optometry. Students will be notified at the time of the offer of admission whether he/she will receive a GTA position and for what period of time. The conditions of the GTA position are described in Section 10 of this manual.
- e) Likewise, Graduate Research Associate (GRA) positions are sometimes available on the College of Optometry, typically funded through individual faculty members' extramural funding. Students will be notified at the time of the offer of admission whether he/she will receive a GRA position and for what period of time. The conditions of the GRA position are described in Section 10 of this manual.
- f) Applicants are normally expected to have completed an appropriate baccalaureate degree or a Doctor of Optometry degree at an institution accredited by the Association of Schools and Colleges of Optometry to be considered for the program. Other potential applicants should make inquiry directly to the chair of the Research and Graduate Studies Committee to determine their eligibility.
- f) Registration and scheduling requirements, including course loads for graduate associates, are commensurate with the conditions outlined in section II.2 of the *Graduate School Handbook*. Procedures for determination of course credit and the general setting of academic standards comply fully with the descriptions in the respective sections of the *Graduate School Handbook*.

#### **5. Advisors and Committees**

- a) Advisors are selected by the graduate student with consent of the selected advisor. The Research and Graduate Studies Committee chair serves as the interim advisor for all graduate students prior to selection of a regular advisor. The advisor must be selected prior to beginning thesis/dissertation research or undertaking any VS 999 coursework.

- b) The advisor is responsible for the student's quarterly scheduling, monitoring academic progress, and supervision of graduate research.
- c) The advisor is responsible for proposing the composition of examination committees (subject to approval by the Research and Graduate Studies Committee) and chairs all such committees.
- d) A student may, without prejudice, request a change of advisor by writing to the Research and Graduate Studies Committee. The Research and Graduate Studies Committee and the student must concur on the particular choice of the new advisor. A change of advisor does not reset time limits defining adequate "academic progress" except at the discretion of the Research and Graduate Studies Committee.

## **6. Description of Fields of Study**

Vision Science is the science concerned with the study of all aspects of vision. Among the active research programs within The Ohio State University's graduate program in Vision Science are:

- (1) geometrical and physical optics (e.g., the study of ophthalmic and ocular optics);
- (2) ocular development (e.g. etiology of refractive error and growth of the ocular components);
- (3) visual psychophysics (e.g., color vision and monocular sensory processes);
- (4) infant vision (e.g. development of visual acuity and stereopsis);
- (5) binocular vision and space perception (e.g., correspondence, fixation disparity and spatial localization);
- (6) ocular motility (e.g., accommodative - convergence interactions, sports vision, eye movements);
- (7) ocular physiology (e.g., corneal metabolism and chemistry of the tears);
- (8) environmental vision (e.g., vision standards and quality of life issues);
- (9) epidemiology of vision (e.g., progression of keratoconus, natural history of eye growth);
- (10) pediatric vision (e.g., amblyopia, vision screening, convergence insufficiency, management of refractive error);
- (11) contact lenses; and

(12) dry eye.

## **7. Master's Degree Programs**

- a) The degree offered is a Master's (MS) in Vision Science.
- b) A minimum of 45 graduate credit hours is required to earn a Master's degree. No more than 10 credit hours of 999 coursework may count toward this minimum. The student must complete at least two 800 level courses in Vision Science, with at least one being one of the five-credit 80X core courses. Three other courses are required: Vision Science 740 (survival skills for graduate students), Vision Science 796 (ethics in biomedical research), and Vision Science 798 (Statistics in Clinical Research). The remaining coursework is selected according to the student's interests, as recommended by the student's advisor.
- c) The MS degree normally is completed in two years. A student may be considered lacking in academic progress after this period.
- d) Part-time students are permitted, but first priority is given to full-time students. If permitted, the time limit for part-time attendance is determined by the Research and Graduate Studies Committee prior to the admission of the student. If a full-time student wishes to change to part-time status, he or she must petition the Research and Graduate Studies Committee who will provide written terms for continuation on part-time status.
- e) Only the Plan A (thesis) program is offered.
- f) Where human subjects or animals are involved in the thesis research, it is the responsibility of the student to assure that the appropriate institutional review is obtained. When appropriate, the student is also required to obtain signed informed consent from his/her subjects and maintain these records in the laboratory.
- g) The thesis examination is a two-hour, oral examination with emphasis on the thesis material. Typically, the first hour of the examination consists of the student presenting his or her thesis work, followed by one hour of questioning on the work and related topics. The examination committee consists of three graduate faculty (M or P category), and the examination is scheduled by the student in close consultation with his or her advisor.
- h) A combined program OD/MS (OPT 7) is available to outstanding students wishing to simultaneously pursue the OD degree offered by the College of Optometry and the Master's degree in Vision Science program offered by the Graduate School. Optometry students may apply for this program to begin enrollment no sooner than autumn quarter of their second year in the optometry program. Admission of the applicant is competitive and based on the student's academic performance and the Research and Graduate Studies Committee's assessment of his or her motivation and capability to complete a program of independent research in combination with the regular

optometry curriculum. A minimum GPA of 3.0 in the optometry program is required. This program also requires the completion of 45 graduate credit hours as specified in item 7b above. All Vision Science courses 6xx and higher contribute to these 45 graduate credit hours, up to a limit of 15 credit hours.

- i) The College of Optometry offers an MS degree in conjunction with a Post-Graduate Advanced Practice Fellowship in: 1) Cornea and Contact Lenses; 2) Pediatrics and Binocular Vision; 3) Vision Rehabilitation; and 4) Family Practice. Applicants to this program must be eligible for licensure to practice optometry in the state of Ohio. This is a two-year program that provides the opportunity to obtain a MS degree in Vision Science combined with clinical experience. Students in this program must meet all requirements for the MS degree outlined in this document and proscribed coursework and clinical assignments that are specified in the College document, *Post-Graduate Advanced Practice Fellowship in: Cornea and Contact Lenses, Pediatrics and Binocular Vision, Vision Rehabilitation, and Family Practice* (Appendix A).
- j) The current policies of the Graduate School apply with regard to academic performance requirements, transfer of credit, residence, and time limits, except as specified in this document.

## **8. Doctoral Degree Program**

- a) The doctoral degree offered is a PhD in Vision Science. Special departmental requirements include:
  - (1) Students whose highest academic degree is a baccalaureate must complete an MS degree before being admitted to the PhD program. Students with higher academic degrees may also be required to complete the MS degree, at the discretion of the Research and Graduate Studies Committee.
  - (2) A student who completes the MS degree in the graduate program in Vision Science at The Ohio State University then petitions the Research and Graduate Studies Committee for approval to enter the PhD. Surplus MS hours may be transferred to the doctoral program if approved by the Research and Graduate Studies Committee, subject to limits established by the Graduate School.
  - (3) A minimum of two quarters of teaching experience as a Graduate Teaching Associate is required as part of the doctoral program. At least one of these quarters must encompass teaching in a laboratory course. In the event that the student is funded through a source outside the College (e.g., a training grant) such that the student cannot receive compensation for teaching, then the student's participation to fulfill this requirement would be participation as an "extra" teaching associate alongside another student who is being compensated as a teaching associate.
- b) A minimum of 135 graduate credit hours (or 90 graduate credit hours beyond the Master's degree) is required to earn the doctoral degree. No more than 30 hours of

- Vision Science 999 (research) may count toward the total. The minimum program of study consists of four Vision Science 80X courses (20 quarter hours), three elective Vision Science 81x courses (9-15 quarter hours), and 12 quarter hours of graduate level courses taken outside the department. Three other courses are required: Vision Science 740 (survival skills for graduate students), Vision Science 796 (ethics in biomedical research), and Vision Science 798, Statistics in Clinical Research. Beyond this minimum, each program of study is designed according to the student's interests in consultation with his or her advisor. For PhD students pursuing patient-oriented research, completion of Public Health 701, 702, and 703 is strongly recommended.
- c) The student is expected to schedule his or her candidacy examinations within two quarters after completion of 105 credit hours (exclusive of Vision Science 999) and all required coursework.
  - d) Candidacy (General) Examinations are arranged by the graduate student's advisor, in consultation with the Research and Graduate Studies Committee. The General Examination has both written and oral portions and is conducted by a committee of four graduate faculty members, chaired by the student's advisor. The advisor and candidate will work together to select the Candidacy Examination Committee, and the make-up of the committee must be approved by the Research and Graduate Studies Committee. Not all of the committee members should be directly expert in the candidate's field of study.

#### *Written Portion*

The written portion may be either: (1) a grant proposal similar in length and scope to the narrative portion of an R01 grant application or (2) substantial essays on four questions administered in an open-book format. After the student has chosen one of the options, he/she may not switch to the other without the approval of the Research and Graduate Studies Committee. Such a switch may be treated as an extension or a failure.

#### *Grant Proposal Option*

If the student chooses the grant proposal option, he or she writes an R01-type grant proposal: specific aims, background and significance, and research methods and design, not to exceed 25 single-spaced pages in length. A preliminary studies section is neither required nor appropriate. The topic of the proposal must be distinct from the candidate's proposed dissertation topic but may be in a related area. The grant proposal cannot be one that has been created for any other purpose previously. Writing on the grant proposal cannot begin until its topic has been approved by the Candidacy Examination Committee. After the topic has been finalized and approved by the committee, candidates are not permitted to seek advice regarding the proposal from anyone other than the Candidacy Examination Committee. The entire proposal will be evaluated by the Candidacy Examination Committee.

1. Background and Significance. The Candidacy Examination Committee will evaluate the candidate on his/her ability to demonstrate a thorough command of the

important and/or classic literature and an appreciation for the issues involved in the area of research interest.

2. Research Methods and Design. The Candidacy Examination Committee will evaluate the ability of the candidate to frame the research question, state hypotheses, outline the goals of the study and explain their significance, form a theoretical model, describe experiments to be performed, and demonstrate how hypotheses will be tested.

3. Analysis Plan and Interpretation of Results. The Candidacy Examination Committee will examine the candidate's data analysis plan and will evaluate his or her ability to interpret results: both expected and unexpected. The candidate will be expected to be facile with the proposed methods of analysis and their interpretation.

#### *Written Essays Option*

If the student chooses the written essays option, he or she will be expected to write essays on four questions generated and approved by the committee as a whole. These questions should represent both the student's major area of research interest and general vision science. The questions will be general yet touch on important areas and controversies in order for the student to show a thorough command of the important and/or classic literature and an appreciation for the issues involved. Each question would be answered with an essay of approximately 5,000 words or more. The committee's evaluation of the written essays should concentrate on whether the candidate has the ability to write the introductory section of a grant proposal or manuscript: has he or she read the relevant literature; can he or she critically evaluate and distill relevant papers in vision science? The emphasis on these essays will not be on the candidate's ability to recite the literature but instead on the ability of the candidate to critically evaluate the studies' methods, results, and analyses; to recognize limitations of the studies; to discuss reasons for controversies and discrepancies in the literature; and to use the data from previous studies to support or refute a particular point of view, theory, or idea. Candidates are not permitted to seek advice regarding the questions from anyone other than the Candidacy Examination Committee. Each Candidacy Examination Committee member reads and evaluates every essay.

#### *Oral Portion*

The oral examination and the written portion should be scheduled within no more than a ten-week period, beginning with the Candidacy Examination Committee's approval of the written grant proposal topic or four essay questions, with at least two weeks between submission of the last written material and the oral examination. Extensions must be approved by the Research and Graduate Studies Committee.

The oral examination is two hours in length. Each Candidacy Examination Committee member is expected to participate fully in the oral questioning of the student. Questions must relate to the written materials but can draw from related areas

in vision science and other related disciplines. Questions at the oral examination will require the candidate to understand important and classic papers in vision science. The candidate should also be prepared to discuss strengths and limitations of various study designs and methods, potential threats to validity, and other pitfalls in the area of research interest.

*Outcome of the Candidacy Examination*

Satisfactory completion of the Candidacy Examination is achieved by unanimous affirmative vote of the Candidacy Examination Committee. If the examination is judged unsatisfactory, a second examination may be permitted on the recommendation of the Candidacy Examination Committee, according to the guidelines in the *Graduate School Handbook*. Satisfactory completion of the Candidacy Examination admits the student to candidacy for the doctoral degree.

- e) The graduate student, in consultation with his or her advisor, selects the dissertation topic. Within one quarter of successful completion of his or her general examinations, the student must prepare a comprehensive research plan of the planned research for the dissertation committee. This plan should include proposed methodologies, analyses and expected outcomes and must be approved by each member of the dissertation committee.
- f) The dissertation committee consists of a minimum of three “P” category graduate faculty (including the advisor) selected by the advisor and agreed upon by the student. The dissertation committee must be provided with a copy of the student’s research plan for approval prior to the beginning of the dissertation research. A change in committee membership subsequent to approval of the research plan must be approved by the Research and Graduate Studies Committee.
- g) Where human subjects or animals are involved in the dissertation research it is the responsibility of the student to assure that the appropriate institutional review is obtained. When appropriate, the student is also required to obtain informed consent from his/her subjects and maintain these records in the college.
- h) The Oral Dissertation Defense examination takes the form of oral questioning by the dissertation committee and a graduate school representative. Questioning is focused on the dissertation material, although it also may be comprehensive of the major field. The examination is approximately two hours in duration and is scheduled by the student’s advisor.

**9. Departmental Research Facilities**

In addition to providing access to clinical facilities for research, the graduate faculty members in Vision Science maintain specialized laboratories that offer a varied research environment for graduate students in the Vision Science program.

## **10. Departmental Graduate Associate Policies**

- a) The rules and procedures relating to Graduate Associate (both Graduate Teaching Associates [GTA] and Graduate Research Associate [GRA]) responsibilities, appointments, and benefits, as described in the *Graduate School Handbook* in Section II.8, apply to the graduate program in Vision Science.
- b) Graduate Associate positions are normally awarded on an annual or academic year basis and may be terminated by providing a one-quarter notice.
- c) Graduate Teaching Associates are normally evaluated annually on the basis of their teaching performance; however, evaluations may be conducted quarterly if deemed warranted by the Research Graduate Studies Committee. Evaluations are conducted by the Chairman of the Research and Graduate Studies Committee and are based on information provided by the instructors of the courses in which the GTA has had involvement, research job performance, faculty reviews, and/or teaching evaluations.
- d) GA appointments may be terminated on the basis of unsatisfactory evaluations or failure to make adequate academic progress. A one-quarter notice of termination shall be provided.
- e) Graduate Associates should only undertake employment outside of the college after consultation with their advisor.

## **11. Academic Progress**

- a) Graduate students who fail to make adequate academic progress may be dismissed from the graduate program in Vision Science by the Research and Graduate Studies Committee.
- b) Doctoral students who fail to take the candidacy examinations within two quarters of the completion of 105 credit hours and all core course requirements of the PhD program may be considered failing to make adequate academic progress.
- c) Doctoral students who fail candidacy examinations and are permitted to retake the examination may be considered failing to make adequate academic progress if they fail to retake the General Examinations within two quarters.
- d) Doctoral candidates who do not complete their dissertation within two years of being admitted to candidacy may be considered to be failing to make adequate academic progress.
- e) Master's students who do not complete the program in two years may be considered to be failing to make adequate academic progress.
- f) To be considered in good standing, a student must maintain a graduate cumulative grade point average of 3.0 or better in all graduate credit courses. Note that for

optometry students enrolled in the OPT 7 program, all Vision Science credit hours 6xx or higher count toward this graduate cumulative grade point average, even those in excess of the 15 credit hours maximum from the professional optometric curriculum that also count toward the Master's degree.

## **12. Special Features**

- a) The graduate program in Vision Science participates in the combined program (OPT7) for concurrent enrollment in the College of Optometry and in the Graduate School for the MS degree offered by the Vision Science program.
- b) There are two training grant support options for PhD students. Both the T32 Training Program and the K12 Training Program support PhD students generally later in their studies, although this is not a requirement of either program. Details on both programs can be obtained from the Associate Dean for Research and Graduate Studies.

## Appendix A

### Post-Graduate and Advanced Practice Fellowships in: Cornea and Contact Lenses Binocular Vision and Pediatrics Vision Rehabilitation Family Practice

The Advanced Practice Fellowship program is a two-year program involving work toward a Master's degree in Vision Science combined with clinical experience. Its purpose is to provide advanced optometric and research training with particular emphasis on the chosen specialty (cornea and contact lenses, binocular vision and pediatrics, vision rehabilitation, or family practice).

The program consists of course work in Vision Science, statistics, and general issues related to research plus elective courses specific to the student's areas of interest. A total of 45 credit hours, including independent research credits, must be completed for the Master's degree. The remaining time is devoted to clinical teaching, serving as a teaching assistant in appropriate laboratories, patient care from the routine to the most complex phases of optometric practice, and completion of a research project and Master's thesis.

The Advanced Practice Fellowship program requires that a successful trainee complete an initial summer quarter of direct patient care experience followed by seven quarters of graduate teaching experience as a Graduate Teaching Associate at 50% full-time equivalent (FTE). Any student with the option of serving as a Graduate Research Associate (rather than Graduate Teaching Associate) for all or part of that 50% FTE will need to petition the Research and Graduate Studies Committee at least one quarter prior to the change (i.e., such a petition for spring quarter would have to be filed the previous autumn quarter). The Research and Graduate Studies Committee, in conjunction with the Associate Dean for Clinical Services and Professional Program, would then make a decision on a case-by-case basis as to whether to approve the proposed research appointment because it would enhance the fellow's clinical education and would serve the trainee and the College well.

There are specific training and experience aspects to the various specialties as follows:

**Cornea and Contact Lenses:** The first summer quarter of the program is typically spent full-time in contact lens clinic and possibly other clinical settings, providing direct patient care to sharpen clinical skills before the academic program formally begins in autumn quarter.

**Binocular Vision and Pediatrics:** The first summer quarter of the program is typically spent full-time in binocular vision/pediatrics clinic and possibly other clinical settings, providing direct patient care to sharpen clinical skills before the academic program formally begins in autumn quarter.

**Vision Rehabilitation:** In addition to examining patients within the Vision Rehabilitation Service at the College of Optometry, the resident may work at a multidisciplinary blind rehabilitation center that provides vocational, homemaking, and mobility training. The initial quarter in the program will be spent in full-time direct patient care in Vision Rehabilitation and other clinical settings, e.g., Primary Vision Care and Ocular Disease.

**Family Practice:** The first summer quarter of the program is typically spent full-time in primary vision care clinic and possibly other clinical settings, providing direct patient care to sharpen clinical skills before the academic program formally begins in autumn quarter.

**Required coursework specific to the specialty:**

**Cornea and Contact Lenses:**

- Vision Science 804
- Vision Science 790 (Autumn, winter, and spring quarters in the first year of the fellowship)

**Binocular Vision and Pediatrics:**

- Vision Science 802

**Vision Rehabilitation**

- Vision Science 801

**Family Practice:**

- Public Health 711

**Clinical Curriculum**

The graduate optometrist will instruct students and/or provide direct patient care in his or her chosen area of specialization, and (in order to maintain scope and skill levels) some additional clinical services, e.g., Primary Vision Care, Binocular Vision and Pediatrics, Vision Rehabilitation, and Contact Lenses.

Individual sequences will be established by consultation among the graduate optometrist, his or her advisor, his or her clinical mentor, the Clinic Director, and the individual Clinic Chief, and may be influenced by thesis project requirements.

Sample clinical training sequences are provided in Table 1.

## **Teaching Experience**

### **(1) General and Specialty Clinic Services**

The graduate optometrist has the opportunity to work with fourth year optometry students in providing care to patients seen in The Ohio State University College of Optometry.

### **(2) Optometry and Vision Science Course Laboratories**

The graduate optometrist will instruct optometry students in selected laboratories.

### **(3) Lecture Experience**

The graduate optometrist will have the opportunity to present lectures in selected courses within the optometry curriculum and at continuing education conferences presented by the College of Optometry.

## **Appendix B**

### **Graduate Curriculum in Vision Science**

#### **1. Courses in Vision Science primarily intended for graduate students**

##### **VIS SCI 740 Survival Skills for Graduate Students P G 2**

Provides “survival skills” for beginning graduate students. These include critiquing papers, writing abstracts, presenting data and analysis, preparing visual aids and some experimental design techniques.  
Au Qtr 2 cl.

##### **VIS SCI 790 Advanced Topics in Anterior Segment and Contact Lenses G 2**

Intended for students furthering their research experience in the areas of anterior segment (e.g., cornea, conjunctiva, tear system) or contact lenses.  
Au, Wi, Sp Qtrs. 2 cl. Prereq: Optometry 654 or permission of instructor. Repeatable to a maximum of 16 cr hrs.

##### **VIS SCI 795 Seminar P G 1-5**

A series of seminars dealing with new developments in vision science.  
Au, Wi, Sp, Su Qtrs. 1 cl.

##### **VIS SCI 796 Ethics in Biomedical Research P G 2**

Provides a general understanding of the issues surrounding the ethical conduct of science including issues related to research involving human subjects, scientific misconduct and authorship of scientific papers. Real-life case studies will be used.  
Au Qtr 2 cl.

##### **VIS SCI 797 Grantsmanship P G 2**

Designed to explain the structure of the National Institutes of Health, especially the National Eye Institute, to illustrate the principles of good grantsmanship and to describe the review process grants undergo. Emphasis will be focused on two particular grant mechanisms: the Mentored Clinical Scientist Development award and the Research Grant (R01)  
Every other Wi Qtr. 2 cl.

##### **VIS SCI 798 Statistics in Clinical Research P G 2**

Introduction to the basic concepts and methods of statistical analysis of clinical research data. Statistical software packages will be demonstrated along with interpretation of output  
Sp Qtr 2 cl.

##### **VIS SCI 799 Assessing the Literature**

Provides a framework to develop skills to critically evaluate the literature, improve data presentation skills, summarize information efficiently, and improve statistical knowledge by critically reviewing published literature.  
Au, Wi, Sp, Su, Qtrs. 2 cl.

#### **2. Core Courses in Vision Science G 5**

Core courses present a comprehensive background in vision science and are not intended as introductory. The listed prerequisites refer to Vision Science courses taught in the College of Optometry at the Ohio State University. Graduates of other institutions should have the graduate program evaluate the suitability of similar courses at their institution as substitutions. Open to graduate students only.

**VIS SCI 801 Optics of the eye and specification of the visual stimulus G5**

Ocular image-forming mechanisms of the eye and optics of ophthalmic instrumentation, specification of light, calibration and control of intensity and spectral composition of light.

**Au. Qtr. 4 cl, 1 2-hr lab. Prereq: 501, 511, 520**

**VIS SCI 802 Ocular Motility and Binocular Vision G5**

Advanced topics on eye movements, intraocular motility, sensorimotor aspects of visual perception and binocular vision.

**Wi. Qtr. 4 cl, 1 2-hr lab. Prereq: 512, 715, 716**

**VIS SCI 803 Monocular Sensory Processes of Vision G5**

Spatial, temporal and spectral properties of photopic and scotopic vision; color vision and color deficiencies; visual development; clinical psychophysics

**Sp. Qtr. 4 cl, 1 2-hr lab. Prereq: 511, 520, 613**

**VIS SCI 804 Anatomy and Physiology of the Visual System G5**

Advanced anatomy, physiology and neurology of the visual system.

**Su. Qtr. 4 cl, 1 2-hr lab. Prereq: 608, 626**

**3. Advanced Seminars in Vision Science G 3-5**

Advanced seminars present current and recent advances. Seminar format may require student presentations and participation. Courses are repeatable at the discretion of the instructor.

**VIS SCI 810 Image Evaluation G 3-5**

Evaluation of optical systems and image forming systems including the eye by objective and subjective methodologies.

**Prereq: 801**

**VIS SCI 811 Color Vision G 3-5**

Spectral sensitivity; color vision deficiency; color matching and color appearance; theory and laws of color mixture.

**Prereq: 803**

**VIS SCI 814 Ocular Motility G 3-5**

The oculomotor system: advanced concepts of eye movement, accommodation, pupillary response and sensorimotor interactions.

**Prereq: 802**

**VIS SCI 815 Binocular Vision and Perception G 3-5**

Study of binocular vision and visual spatial localization including the perception of distance, direction, form and motion.

**Prereq: 802**

**VIS SCI 812 Neurophysiology of Vision G 3-5**

Phototransduction; photoreceptor recordings; horizontal, bipolar and amacrine cells; ganglion and LGN cells: M and P pathways and relationship to optic nerve disorders; striate and extrastriate cortex.

**Prereq: 804**

**VIS SCI 813 Physiology of the Eye G 3-5**

Recent developments in the respiration, metabolism and mechanics of ocular tissues; aqueous dynamics of the eye.

**Prereq: 804**

**VIS SCI 816 Visual Development G 3-5**

Functional development of the visual system.

**Prereq: 803**

**VIS SCI 818 Anatomy of the Eye G 3-5**

Advanced study of the neuroanatomy of the visual system; recent advances in ocular anatomy and neuroanatomy of the visual pathway.

**Prereq: 804**

**VIS SCI 820 Specification of the visual stimulus G 3-5**

Assessment of critical detail of visual tasks to determine visual standards and appropriate level and distribution of light; study of apparatus to control intensity and composition of visual stimuli, measurement of light.

**Prereq: 801**

**VIS SCI 891 Interdisciplinary seminar G 1-2**

Graduate seminar for graduate interdisciplinary studies. Cross-listed in Biomedical Engineering, Biomedical Informatics, Biophysics, Computer Science and Engineering, Electrical and Computer Engineering, Integrated Biomedical Science, Pathology, Radiology, and Statistics.

**Prereq: Graduate standing**

**VIS SCI 891 Interdisciplinary seminar on biomedical images G 1-2**

Graduate seminar for Graduate Interdisciplinary Specialization in Comprehensive Engineering and Science of Medical Images.

**Prereq: Graduate standing**

Au, Wi, Sp, Su, Qtrs. 1 cl.