

# MATERIALS SCIENCE (MTSC)

## MTSC 60199 THESIS I 2-6 Credit Hours

Thesis students must register for a total of 6 credit hours, 2 to 6 credit hours in a single semester or distributed over two semesters if desired.

**Prerequisite:** Graduate standing; and special approval.

**Schedule Type:** Masters Thesis

**Contact Hours:** 2-6 other

**Grade Mode:** Satisfactory/Unsatisfactory-IP

## MTSC 60299 THESIS II 2 Credit Hours

Thesis students must continually register each semester until all degree requirements are met.

**Prerequisite:** MTSC 60199; and graduate standing.

**Schedule Type:** Masters Thesis

**Contact Hours:** 2 other

**Grade Mode:** Satisfactory/Unsatisfactory-IP

## MTSC 60498 RESEARCH 1-15 Credit Hours

(Repeatable for credit) Research or individual investigation. Credits earned may be applied toward meeting degree requirements with department approval. **Prerequisite:** Graduate standing; and special approval

**Schedule Type:** Research

**Contact Hours:** 3-45 other

**Grade Mode:** Satisfactory/Unsatisfactory

## MTSC 62241 STATISTICAL MECHANICS OF SOFT MATTER 3 Credit Hours

(Slashed with MTSC 72241) Lectures on order, disorder and phase transitions in soft matter. Materials include magnets, gases, liquids, crystalline and amorphous solids and liquid crystals. Theoretical concepts include order parameters to describe broken symmetry, mean-field theory, Landau theory for uniform and nonuniform systems, elasticity of orientational order and topological defects.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

## MTSC 62242 CHARACTERIZATION OF SOFT MATTER 3 Credit Hours

(Slashed with MTSC 72242) Course provides students with the fundamentals of the most commonly used techniques for the study and understanding of soft matter at the macroscopic and microscopic level, especially at the nanometer scale. The advancement in basic soft matter research is generally driven by the experimental techniques available and the interdisciplinary knowledge among condensed matter physicists, biologists, synthetic and physical chemists, as well as chemical and polymer engineers.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

## MTSC 62245 FUNDAMENTALS OF LIQUID CRYSTAL SCIENCE 4 Credit Hours

(Slashed with MTSC 72245) Basic liquid crystals structures and their main physical properties, such as visco-elastic, electric, magnetic and optical properties, except the nature of their phase transitions. Also discussed are their interactions with surfaces and the structural defects that they can form.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 4 lecture

**Grade Mode:** Standard Letter

## MTSC 62248 LIQUID CRYSTAL OPTICS AND PHOTONICS 4 Credit Hours

(Slashed with MTSC 72248) Optics of cholesterics, liquid crystalline photonic bandgap materials, nonlinear optics of liquid crystals; optomechanical effects in liquid crystal elastomers.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 4 lecture

**Grade Mode:** Standard Letter

## MTSC 62249 LABVIEW FOR DATA ACQUISITION AND INSTRUMENT CONTROL 1 Credit Hour

(Slashed with MTSC 72249) Introduction to laboratory data acquisition and instrument control using LabVIEW software.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 1 lecture

**Grade Mode:** Satisfactory/Unsatisfactory

## MTSC 62335 ADVANCED LIQUID CRYSTALLINE AND POLYMERIC MATERIALS 4 Credit Hours

(Slashed with MTSC 72335) Course introduce students to recent advances in liquid crystals and polymers with emphasis on structure-property relationships, physical and optical properties, and their applications. Liquid crystals and polymers are soft matters of two important disciplines of science and technology. They both have a similar history and are rich in physical and optical properties useful for fundamental and applied research.

**Prerequisite:** Graduate standing.

**Schedule Type:** Laboratory, Lecture, Combined Lecture and Lab

**Contact Hours:** 3 lecture, 2 lab

**Grade Mode:** Standard Letter

## MTSC 62450 LIQUID CRYSTAL OPTICS I: THEORY 2 Credit Hours

(Slashed with MTSC 72450) Provides an introduction to optical phenomena with an emphasis on liquid crystals, from geometrical optics to Maxwell's equations. Basic principles are used to analyze and solve optics problems arising in liquid crystal engineering.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 2 lecture

**Grade Mode:** Standard Letter

**MTSC 62452 LIQUID CRYSTAL OPTICS II: OPTICAL SYSTEMS 2 Credit Hours**

(Slashed with MTSC 72452) Focuses on the study of practical optical systems with an emphasis on liquid crystals. Students study the principles of optical system design starting with the understanding of basic optical components such as lenses, mirrors, filters and polarizers. Practical concepts and techniques for the implementation of optical instruments and displays are mastered through lectures and lab work.

**Prerequisite:** MTSC 62450; and graduate standing.

**Schedule Type:** Laboratory, Lecture, Combined Lecture and Lab

**Contact Hours:** 1 lecture, 2 lab

**Grade Mode:** Standard Letter

**MTSC 62460 LIQUID CRYSTAL MATERIALS SCIENCE 2 Credit Hours**

(Slashed with MTSC 72460) Familiarizes students with the basic, underlying chemical concepts in liquid crystal science. These concepts include molecular structures and properties of liquid crystal molecules, miscibility rules and micro-segregation of chemically incompatible molecular segments, physical and electronic properties of aromatic compounds including heterocycles and fluorinated aromatics, properties of aliphatic and perfluorinated hydrocarbons, unsaturation, and chirality. Other aspects covered in later sections of this course relate to auxiliary and novel materials used in liquid crystal devices such as polymers, carbon nanomaterials, metal and semiconductor nanoparticles and photo-responsive organic materials.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 2 lecture

**Grade Mode:** Standard Letter

**MTSC 62462 LIQUID CRYSTAL SCIENCE: PHYSICAL PROPERTIES 3 Credit Hours**

(Slashed with MTSC 72462) Basics of liquid crystal defects and their behavior in magnetic and electric fields.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**MTSC 62640 LIQUID CRYSTAL, POLYMER AND COLLOID COMPOSITES 4 Credit Hours**

(Slashed with MTSC 72640) Interdisciplinary science of systems consisting of liquid crystal, polymer and colloid. Statistical physics of composite systems, mixing free energy, phase separation principle, phase diagrams and phase separation dynamics. States, structures and free energies of liquid crystal, polymer and colloidal systems. Polymer dispersed liquid crystals (PDLC), polymer stabilized liquid crystals (PSCT) and their applications. Laboratory experiments on composite systems and fabrication of PDLC and PSCT light shutters.

**Prerequisite:** Graduate standing.

**Schedule Type:** Laboratory, Lecture, Combined Lecture and Lab

**Contact Hours:** 3 lecture, 2 lab

**Grade Mode:** Standard Letter

**MTSC 62643 ELECTRO-OPTICS OF LIQUID CRYSTALS: MODELING AND DEVICE DESIGN 3 Credit Hours**

(Slashed with MTSC 72643) Apply knowledge of liquid crystals and optics to the design of liquid crystal electro-optical devices. Emphasis is on modeling of devices and the use of that modeling to optimize device characteristics. Several particular device designs are considered to familiarize students with the state of the art in electro-optical applications of liquid crystals and to prepare them to advance the art in future designs.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**MTSC 62647 STRUCTURED FLUIDS 3 Credit Hours**

(Slashed with MTSC 72647) The basics of fluids having internal structures, such as long range orientational order and or one and two dimensional positional order. Materials include thermotropic smetic, lamellar lyotropic and columnar liquid crystals, soap films, fluid foams, fluid fibers and Langmuir monolayers.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**MTSC 62650 COMPUTATIONAL MATERIALS SCIENCE 3 Credit Hours**

(Slashed with MTSC 72650) Materials modeling at the classical (i.e. non-quantum) level. Monte Carlo methods; molecular dynamics simulation; mesoscale models; numerical methods; case studies.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**MTSC 62651 NANOTECHNOLOGY 3 Credit Hours**

(Slashed with MTSC 72651) Course presents the concepts, principles and the state-of-the-arts of nanotechnologies and their applications in biological and biomedical science and engineering. Focus is on the fundamental physical principles and engineering technologies of device miniaturization and system integration for bioapplications.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**MTSC 63000 PHYSICS OF SOFT MATTER 3 Credit Hours**

(Slashed with MTSC 73000) Students learn the basics of physics of soft matter, including polymers, liquid crystals, colloids, reduced dimensionality fluids and active matter. Course provides students a coherent and deep understanding of the most important concepts and scientific results of soft matter, such as nano-, and microscopic structures, mechanical, electrical and optical properties.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**MTSC 63010 LYOTROPIC LIQUID CRYSTALS 3 Credit Hours**

(Slashed with MTSC 73010) Course covers the fundamentals and the chemical aspects of different types of lyotropic liquid crystals (organic, inorganic, composites) leading to a discussion of phase diagrams and a comprehensive discussion of the characterization techniques of lyotropic liquid crystals. Focuses on some key aspects related to the use of lyotropic liquid crystals in pharmacological and medical applications such as drug delivery and the use of lyotropic liquid crystals as templates or 'reactors' for nanoscale synthesis and mesoscale manufacturing.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**MTSC 63015 CHEMISTRY OF SOFT MATTER 3 Credit Hours**

(Slashed with MTSC 73015) Course familiarizes students with the basic underlying chemical concepts in soft matter science, focusing on the most important chemical building blocks in soft matter, IUPAC rules for naming them, miscibility rules and micro-segregation of chemically incompatible molecular segments, physical and electronic properties of aromatic compounds, including heterocyclic and fluorinated aromatics, properties of aliphatic and perfluorinated hydrocarbons, unsaturation, structure-property relationships and all levels of chirality (molecular to supramolecular). Other topics focus on specific types of materials explored in soft matter such as polymers, liquid crystals, carbon nanomaterials, metal and semiconductor nanoparticles and light-responsive organic materials, gels, foams and colloids.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**MTSC 63020 APPLICATIONS OF SOFT MATTER 3 Credit Hours**

(Slashed with MTSC 73020) Course covers the applications of soft matter that include electro-optical, sensor and biological applications. Recent developments related to emerging applications are covered.

**Prerequisite:** MTSC 63000; and graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**MTSC 63025 ACTIVE MATTER 2 Credit Hours**

(Slashed with MTSC 73025) The course is designed to teach the science of active matter which embraces a broad range of dynamic out-of-equilibrium systems comprised of interacting units that are capable of converting stored energy or the energy of the environment into systematic motion. Examples include colloids powered by an electric field, swimming bacteria and living liquid crystals. Theoretical models considered are Vicsek model and Toner-Tu model. The course will provide a coherent picture of the dynamic out-of-equilibrium phenomena.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 2 lecture

**Grade Mode:** Standard Letter

**MTSC 63100 EMERGING DISPLAY TECHNOLOGIES 2 Credit Hours**

(Slashed with MTSC 73100) This course focuses on the fundamentals and applications of latest display technologies in transmissive, reflective and emissive displays as well as free-space display technologies. This course is aimed for students who wish to learn more, not limited to liquid crystal devices and applications, but also wide ranges of current and future display technologies, and will intergrate among materials science, physics and engineering with display technologies ranging from direct-view, flexible, wearable and free-space displays.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 2 lecture

**Grade Mode:** Standard Letter

**MTSC 64491 SEMINAR: LIQUID CRYSTALS 1 Credit Hour**

(Repeatable for credit) (Slashed with MTSC 74491) Discussion of current literature or original research in liquid crystals. Participation by students, faculty and guests.

**Prerequisite:** Graduate standing; and special approval.

**Schedule Type:** Seminar

**Contact Hours:** 1 other

**Grade Mode:** Satisfactory/Unsatisfactory

**MTSC 64495 SPECIAL TOPICS IN CHEMICAL PHYSICS 1-3 Credit Hours**

(Repeatable for credit)(Slashed with MTSC 74495) Topic varies per course offering.

**Prerequisite:** Graduate standing; and special approval.

**Schedule Type:** Lecture

**Contact Hours:** 1-3 lecture

**Grade Mode:** Standard Letter

**MTSC 65006 LIQUID CRYSTAL DEVICE PROTOTYPING 2 Credit Hours**

(Slashed with MTSC 75006) Liquid crystal device prototyping; introduction to liquid crystal device manufacturing methods.

**Prerequisite:** Graduate standing.

**Schedule Type:** Laboratory, Lecture, Combined Lecture and Lab

**Contact Hours:** 1 lecture, 2 lab

**Grade Mode:** Standard Letter

**MTSC 65008 LIQUID CRYSTAL DEVICE CONSTRUCTION 1 Credit Hour**

(Slashed with MTSC 75008) Students acquire the knowledge and experience in basic techniques and procedures for the construction of liquid crystal cells. Students are prepared for successive lab courses and the capstone project based on the clean-room techniques, ITO glass handling, film deposition, surface alignment treatment and cell assembly experienced.

**Prerequisite:** Graduate standing.

**Schedule Type:** Laboratory

**Contact Hours:** 2 lab

**Grade Mode:** Standard Letter

**MTSC 65032 SCIENTIFIC COMMUNICATION 1 Credit Hour**

(Slashed with MTSC 75032) Course aims to help graduate students in STEM fields improve their skills in scientific writing and presentations. Activities include a mock panel review of scientific proposals. Students produce a final paper that could serve as the introductory chapter of a thesis or dissertation.

**Prerequisite:** Graduate standing.

**Schedule Type:** Lecture

**Contact Hours:** 1 lecture

**Grade Mode:** Standard Letter

**MTSC 72241 STATISTICAL MECHANICS OF SOFT MATTER 3 Credit Hours**

(Slashed with MTSC 62241) Lectures on order, disorder and phase transitions in soft matter. Materials include magnets, gases, liquids, crystalline and amorphous solids and liquid crystals. Theoretical concepts include order parameters to describe broken symmetry, mean-field theory, Landau theory for uniform and nonuniform systems, elasticity of orientational order and topological defects.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**MTSC 72242 CHARACTERIZATION OF SOFT MATTER 3 Credit Hours**

(Slashed with MTSC 62242) Course provides students with the fundamentals of the most commonly used techniques for the study and understanding of soft matter at the macroscopic and microscopic level, especially at the nanometer scale. The advancement in basic soft matter research is generally driven by the experimental techniques available and the interdisciplinary knowledge among condensed matter physicists, biologists, synthetic and physical chemists, as well as chemical and polymer engineers.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**MTSC 72245 FUNDAMENTALS OF LIQUID CRYSTAL SCIENCE 4 Credit Hours**

(Slashed with MTSC 62245) Basic liquid crystals structures and their main physical properties, such as visco-elastic, electric, magnetic and optical properties, except the nature of their phase transitions. Also discussed are their interactions with surfaces and the structural defects that they can form.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 4 lecture

**Grade Mode:** Standard Letter

**MTSC 72248 LIQUID CRYSTAL OPTICS AND PHOTONICS 4 Credit Hours**

(Slashed with MTSC 62248) Optics of cholesterics, liquid crystalline photonic bandgap materials, nonlinear optics of liquid crystals; optomechanical effects in liquid crystal elastomers.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 4 lecture

**Grade Mode:** Standard Letter

**MTSC 72249 LABVIEW FOR DATA ACQUISITION AND INSTRUMENT CONTROL 1 Credit Hour**

(Slashed with MTSC 62249) Introduction to laboratory data acquisition and instrument control using LabVIEW software.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 1 lecture

**Grade Mode:** Satisfactory/Unsatisfactory

**MTSC 72335 ADVANCED LIQUID CRYSTALLINE AND POLYMERIC MATERIALS 4 Credit Hours**

(Slashed with MTSC 62335) Course introduce students to recent advances in liquid crystals and polymers with emphasis on structure-property relationships, physical and optical properties, and their applications. Liquid crystals and polymers are soft matters of two important disciplines of science and technology. They both have a similar history and are rich in physical and optical properties useful for fundamental and applied research.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Laboratory, Lecture, Combined Lecture and Lab

**Contact Hours:** 3 lecture, 2 lab

**Grade Mode:** Standard Letter

**MTSC 72450 LIQUID CRYSTAL OPTICS I: THEORY 2 Credit Hours**

(Slashed with MTSC 62450) Provides an introduction to optical phenomena with an emphasis on liquid crystals, from geometrical optics to Maxwell's equations. Basic principles are used to analyze and solve optics problems arising in liquid crystal engineering.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 2 lecture

**Grade Mode:** Standard Letter

**MTSC 72452 LIQUID CRYSTAL OPTICS II: OPTICAL SYSTEMS 2 Credit Hours**

(Slashed with MTSC 62452) Focuses on the study of practical optical systems with an emphasis on liquid crystals. Students study the principles of optical system design starting with the understanding of basic optical components such as lenses, mirrors, filters and polarizers. Practical concepts and techniques for the implementation of optical instruments and displays are mastered through lectures and lab work.

**Prerequisite:** MTSC 72450; and doctoral standing.

**Schedule Type:** Laboratory, Lecture, Combined Lecture and Lab

**Contact Hours:** 1 lecture, 2 lab

**Grade Mode:** Standard Letter

**MTSC 72460 LIQUID CRYSTAL MATERIALS SCIENCE 2 Credit Hours**

(Slashed with MTSC 62460) Familiarizes students with the basic, underlying chemical concepts in liquid crystal science. These concepts include molecular structures and properties of liquid crystal molecules, miscibility rules and micro-segregation of chemically incompatible molecular segments, physical and electronic properties of aromatic compounds including heterocycles and fluorinated aromatics, properties of aliphatic and perfluorinated hydrocarbons, unsaturation, and chirality. Other aspects covered in later sections of this course relate to auxiliary and novel materials used in liquid crystal devices such as polymers, carbon nanomaterials, metal and semiconductor nanoparticles and photo-responsive organic materials.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 2 lecture

**Grade Mode:** Standard Letter

**MTSC 72462 LIQUID CRYSTAL SCIENCE: PHYSICAL PROPERTIES 3 Credit Hours**

(Slashed with MTSC 62462) Basics of liquid crystal defects and their behavior in magnetic and electric fields.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**MTSC 72640 LIQUID CRYSTAL, POLYMER AND COLLOID COMPOSITES 4 Credit Hours**

(Slashed with MTSC 62640) Interdisciplinary science of systems consisting of liquid crystal, polymer and colloid. Statistical physics of composite systems, mixing free energy, phase separation principle, phase diagrams and phase separation dynamics. States, structures and free energies of liquid crystal, polymer and colloidal systems. Polymer dispersed liquid crystals (PDLC), polymer stabilized liquid crystals (PSLC) and their applications. Laboratory experiments on composite systems and fabrication of PDLC and PSLC light shutters.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Laboratory, Lecture, Combined Lecture and Lab

**Contact Hours:** 3 lecture, 2 lab

**Grade Mode:** Standard Letter

**MTSC 72643 ELECTRO-OPTICS OF LIQUID CRYSTALS: MODELING AND DEVICE DESIGN 3 Credit Hours**

(Slashed with MTSC 62643) Apply knowledge of liquid crystals and optics to the design of liquid crystal electro-optical devices. Emphasis is on modeling of devices and the use of that modeling to optimize device characteristics. Several particular device designs are considered to familiarize students with the state of the art in electro-optical applications of liquid crystals and to prepare them to advance the art in future designs.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**MTSC 72647 STRUCTURED FLUIDS 3 Credit Hours**

(Slashed with MTSC 62647) The basics of fluids having internal structures, such as long range orientational order and or one and two dimensional positional order. Such materials include thermotropic smectic, lamellar lyotropic and columnar liquid crystals, soap films, fluid foams, fluid fibers and Langmuir monolayers.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**MTSC 72650 COMPUTATIONAL MATERIALS SCIENCE 3 Credit Hours**

(Slashed with MTSC 62650) Materials modeling at the classical (i.e. non-quantum) level. Monte Carlo methods; molecular dynamics simulation; mesoscale models; numerical methods; case studies.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**MTSC 72651 NANOBIO TECHNOLOGY 3 Credit Hours**

(Slashed with MTSC 62651) Course presents the concepts, principles and the state-of-the-arts of nanotechnologies and their applications in biological and biomedical science and engineering. Focus is on the fundamental physical principles and engineering technologies of device miniaturization and system integration for bioapplications.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**MTSC 73000 PHYSICS OF SOFT MATTER 3 Credit Hours**

(Slashed with MTSC 63000) Students learn the basics of physics of soft matter, including polymers, liquid crystals, colloids, reduced dimensionality fluids and active matter. Course provides students a coherent and deep understanding of the most important concepts and scientific results of soft matter, such as nano-, and microscopic structures, mechanical, electrical and optical properties.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**MTSC 73010 LYOTROPIC LIQUID CRYSTALS 3 Credit Hours**

(Slashed with MTSC 63010) Course covers the fundamentals and the chemical aspects of different types of lyotropic liquid crystals (organic, inorganic, composites) leading to a discussion of phase diagrams and a comprehensive discussion of the characterization techniques of lyotropic liquid crystals. Focuses on some key aspects related to the use of lyotropic liquid crystals in pharmacological and medical applications such as drug delivery and the use of lyotropic liquid crystals as templates or 'reactors' for nanoscale synthesis and mesoscale manufacturing.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**MTSC 73015 CHEMISTRY OF SOFT MATTER 3 Credit Hours**

(Slashed with MTSC 63015) Course familiarizes students with the basic underlying chemical concepts in soft matter science, focusing on the most important chemical building blocks in soft matter, IUPAC rules for naming them, miscibility rules and micro-segregation of chemically incompatible molecular segments, physical and electronic properties of aromatic compounds, including heterocyclic and fluorinated aromatics, properties of aliphatic and perfluorinated hydrocarbons, unsaturation, structure-property relationships and all levels of chirality (molecular to supramolecular). Other topics focus on specific types of materials explored in soft matter such as polymers, liquid crystals, carbon nanomaterials, metal and semiconductor nanoparticles and light-responsive organic materials, gels, foams and colloids.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter

**MTSC 73020 APPLICATIONS OF SOFT MATTER 3 Credit Hours**

(Slashed with MTSC 63020) Course covers the applications of soft matter that include electro-optical, sensor and biological applications. Recent developments related to emerging applications are covered.

**Prerequisite:** MTSC 73000; and doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 3 lecture

**Grade Mode:** Standard Letter



**MTSC 73025 ACTIVE MATTER 2 Credit Hours**

(Slashed with MTSC 63025) The course is designed to teach the science of active matter which embraces a broad range of dynamic out-of-equilibrium systems comprised of interacting units that are capable of converting stored energy or the energy of the environment into systematic motion. Examples include colloids powered by an electric field, swimming bacteria and living liquid crystals. Theoretical models considered are Vicsek model and Toner-Tu model. The course will provide a coherent picture of the dynamic out-of-equilibrium phenomena.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 2 lecture

**Grade Mode:** Standard Letter

**MTSC 73100 EMERGING DISPLAY TECHNOLOGIES 2 Credit Hours**

(Slashed with MTSC 63100) This course focuses on the fundamentals and applications of latest display technologies in transmissive, reflective and emissive displays as well as free-space display technologies. This course is aimed for students who wish to learn more, not limited to liquid crystal devices and applications, but also wide ranges of current and future display technologies, and will intergrate among materials science, physics and engineering with display technologies ranging from direct-view, flexible, wearable and free-space displays.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 2 lecture

**Grade Mode:** Standard Letter

**MTSC 74491 SEMINAR: LIQUID CRYSTALS 1 Credit Hour**

(Repeatable for credit) (Slashed with MTSC 64491) Discussion of current literature or original research in liquid crystals. Participation by students, faculty and guests.

**Prerequisite:** Doctoral standing; and special approval.

**Schedule Type:** Seminar

**Contact Hours:** 1 other

**Grade Mode:** Satisfactory/Unsatisfactory

**MTSC 74495 SPECIAL TOPICS IN CHEMICAL PHYSICS 1-3 Credit Hours**

(Repeatable for credit) (Slashed with MTSC 64495) Topic varies per course offering.

**Prerequisite:** Doctoral standing; and special approval.

**Schedule Type:** Lecture

**Contact Hours:** 1-3 lecture

**Grade Mode:** Standard Letter

**MTSC 75006 LIQUID CRYSTAL DEVICE PROTOTYPING 2 Credit Hours**

(Slashed with MTSC 65006) Liquid crystal device prototyping; introduction to liquid crystal device manufacturing methods.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Laboratory, Lecture, Combined Lecture and Lab

**Contact Hours:** 1 lecture, 2 lab

**Grade Mode:** Standard Letter

**MTSC 75008 LIQUID CRYSTAL DEVICE CONSTRUCTION 1 Credit Hour**

(Slashed with MTSC 65008) Students acquire the knowledge and experience in basic techniques and procedures for the construction of liquid crystal cells. Students are prepared for successive lab courses and the capstone project based on the clean-room techniques, ITO glass handling, film deposition, surface alignment treatment and cell assembly experienced.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Laboratory

**Contact Hours:** 2 lab

**Grade Mode:** Standard Letter

**MTSC 75032 SCIENTIFIC COMMUNICATION 1 Credit Hour**

(Slashed with MTSC 65032) Course aims to help graduate students in STEM fields improve their skills in scientific writing and presentations. Activities include a mock panel review of scientific proposals. Students produce a final paper that could serve as the introductory chapter of a thesis or dissertation.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Lecture

**Contact Hours:** 1 lecture

**Grade Mode:** Standard Letter

**MTSC 80199 DISSERTATION I 15 Credit Hours**

(Repeatable for credit) Doctoral dissertation for which registration in at least two semesters is required, first of which will be semester in which dissertation work is begun, and continuing until the completion of 30 hours.

**Prerequisite:** Doctoral standing; and special approval.

**Schedule Type:** Dissertation

**Contact Hours:** 15 other

**Grade Mode:** Satisfactory/Unsatisfactory-IP

**MTSC 80299 DISSERTATION II 15 Credit Hours**

(Repeatable for credit) Continuing registration required of doctoral students who have completed the initial 30 hours of dissertation and continuing until all degree requirements are met.

**Prerequisite:** MTSC 80199 and doctoral standing.

**Schedule Type:** Dissertation

**Contact Hours:** 15 other

**Grade Mode:** Satisfactory/Unsatisfactory-IP

**MTSC 80498 RESEARCH 1-15 Credit Hours**

(Repeatable for credit) Research or individual investigation for doctoral student who has not yet passed candidacy exam. Credit earned may be applied toward degree.

**Prerequisite:** Doctoral standing.

**Schedule Type:** Research

**Contact Hours:** 3-45 other

**Grade Mode:** Satisfactory/Unsatisfactory-IP