

- 809 Finite Element Method**  
Fall, Spring. 3(3-0) Interdepartmental with Materials Science and Mechanics; Civil Engineering; Biosystems Engineering. Administered by Department of Materials Science and Mechanics. SA: AE 809  
Theory and application of the finite element method to the solution of continuum type problems in heat transfer, fluid mechanics, and stress analysis.
- 812 Conductive Heat Transfer**  
Fall. 3(3-0) P:NM: (ME 391 and ME 411)  
Theory of steady and unsteady heat conduction. Derivation of describing equations and boundary conditions. Numerical methods. Nonlinear problems.
- 814 Convective Heat Transfer**  
Spring. 3(3-0)  
Analysis of convective transfer of heat, mass and momentum in boundary layers and ducts. Thermal instability. Free convection.
- 822 Combustion**  
Spring. 3(3-1) P:NM: (ME 490 and ME 802)  
Thermodynamics and chemical kinetics. Multicomponent systems. Premixed and diffusion flames, flame radiation.
- 830 Fluid Mechanics I**  
Fall. 3(3-0)  
Integral and differential conservation laws, Navier-Stokes' equations, and exact solutions. Laminar boundary layer theory, similarity solutions, and approximate methods. Thermal effects and instability phenomena.
- 832 Fluid Mechanics II**  
Spring of even years. 3(3-0) P:NM: (ME 830 and MTH 425)  
Inviscid flow, vortex motion, flow past bodies. Complex variables and conformal mapping. One-dimensional steady and unsteady compressible flow, shock waves and Prandtl-Meyer expansion. Small perturbations theory and method of characteristics.
- 834 Fundamentals of Turbulence**  
Fall of odd years. 3(3-0)  
Statistical descriptions of turbulent flows: isotropic, free shear and wall bounded. Correlation and spectral descriptions. Conditional probabilities and coherent motions. Experimental methods. Scaling relationships.
- 836 Experimental Methods in Fluid Mechanics**  
Fall of even years. 3(1-4)  
Modern techniques of fluid mechanics measurement and data analysis. Pressure, temperature and velocity measurement techniques. Optical diagnostics.
- 840 Computational Fluid Dynamics and Heat Transfer**  
Spring. 3(3-0) P:NM: (ME 410) and (ME 830 or ME 814) and programming experience.  
Theory and application of finite difference and finite volume methods to selected fluid mechanics and heat transfer models including the full potential flow model, the systems of Euler and Navier-Stokes equations, and turbulence. Grid generation techniques.
- 842 Advanced Turbomachinery**  
Spring of even years. 3(3-0) P:NM: (ME 442) R: Open only to seniors and graduate students in Mechanical Engineering and Chemical Engineering.  
Application of energy, momentum, continuity and heat transfer equations to energy transfer and transformation in turbomachinery.
- 852 Intermediate Control Systems**  
Spring. 3(3-0) P:NM: (ME 451)  
Design of controllers for dynamic systems in mechanical engineering. Modeling, analysis and simulation.
- 855 Digital Data Acquisition and Control**  
Spring of odd years. 3(2-3) P:NM: (ME 451)  
Real-time digital measurement and control programming for mechanical engineering systems. Analog-to digital and digital-to-analog converters, timer/counters, and instrument interfaces. Open-loop and closed-loop control. Laboratory projects.
- 857 Modeling and Simulation of Dynamic Systems**  
Fall. 3(3-0) P:NM: (ME 451)  
Energy-based methods for modeling dynamic engineering components and systems. Systematic formulation of nonlinear state-space equations. Qualitative aspects of response: equilibrium points, linearization. Simulation techniques and design projects.
- 860 Theory of Vibrations**  
Fall. 3(3-0) Interdepartmental with Materials Science and Mechanics.  
Discrete systems and continua. Analytical mechanics. Variational principles. Modal analysis. Function spaces. Eigenfunction expansions. Integral transforms. Stability. Approximations. Perturbations.
- 863 Nonlinear Vibrations**  
Spring of even years. 3(3-0) P:NM: (ME 461)  
Perturbation methods. Weakly nonlinear partial and ordinary differential equations. Modal interactions, internal tuning, saturation, sub/super/composition resonances, jump phenomenon. Nonlinear normal modes.
- 874 Analysis of Metal Forming and Manufacturing Processes**  
Fall of odd years. 3(3-0) P:NM: (ME 471 and MSM 809 and MSM 817 and MSM 810)  
Review of fundamental knowledge in mechanics, materials and numerical analysis. Modeling, simulation and analysis of metal forming and manufacturing processes.
- 875 Optimal Design of Mechanical Systems**  
Spring of odd years. 3(3-0) P:NM: (ME 461)  
Optimal design for static and dynamic response of mechanical and structural systems. Necessary and sufficient conditions for optimality. Discrete and continuous parameter problems. Sensitivity of response to design variations. Algorithms.
- 891 Selected Topics in Mechanical Engineering**  
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Approval of department.  
Special topics in mechanical engineering of current importance.
- 892 Parameter Estimation**  
Fall of odd years. 3(3-0) P:NM: (STT 421 or STT 441)  
Nonlinear estimation of parameters in ordinary and partial differential equations. Related concepts in probability and statistics. Least squares and other estimators. Sequential methods. Optimum experiment design.
- 898 Master's Project Research**  
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 7 credits in all enrollments for this course. R: Open only to master's students in the Mechanical Engineering major. Approval of department.  
Master's degree Plan B individual student project: original research, research replication, or survey and reporting on a topic such as system design and development, or system conversion of installation.
- 899 Master's Thesis Research**  
Fall, Spring, Summer. 1 to 8 credits. A student may earn a maximum of 24 credits in all enrollments for this course.  
Master's thesis research.
- 913 Advanced Heat Conduction**  
Fall of even years. 3(3-0) P:NM: (ME 812 or MTH 849)  
Inverse and ill-posed problems in heat transfer: function estimation, regularization, and adjoint methods in conduction.
- 940 Selected Topics in Thermal Science**  
Spring. 1 to 3 credits. A student may earn a maximum of 12 credits in all enrollments for this course. P:NM: (ME 812 and ME 814 and ME 816) R: Open only to Mechanical Engineering majors.  
Conduction, convection, radiation, phase change and interactive combined modes of heat transfer. Mass transfer. Irreversible thermodynamics.
- 960 Selected Topics in Vibrations**  
Fall. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. P:NM: (ME 860)  
Current topics of interest to the student and faculty.
- 961 Nonlinear Dynamics and Chaos**  
Fall of even years. 3(3-0) P:NM: (ME 857 or ME 860 or EDE 826 or MTH 441)  
Qualitative theory of dynamical systems applied to physical system models. Bifurcation theory for continuous and discrete-time systems, chaos, the Smale horseshoe, Melnikov's method, and nonlinear data analysis.
- 990 Independent Study in Mechanical Engineering**  
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course.  
Individualized study of a current problem in mechanical engineering.
- 999 Doctoral Dissertation Research**  
Fall, Spring, Summer. 1 to 24 credits. A student may earn a maximum of 72 credits in all enrollments for this course.  
Doctoral dissertation research.

**MEDICAL TECHNOLOGY MT**

**Medical Technology Program College of Natural Science**

- 212 Fundamentals of Laboratory Analysis**  
Fall, Summer. 3(3-0) P:M: (MTH 103 or MTH 116 or LBS 117) RB: (BS 111L)  
Chemical, biological and instrumental concepts in laboratory analyses: quality assurance, laboratory mathematics, safety, health care systems and regulatory issues.

## Medical Technology—MT

- 213 Application of Clinical Laboratory Principles**  
Fall, Summer. 1(0-3) P:M: (MT 212 or concurrently) RB: (BS 111L) R: Open only to students in Clinical Laboratory Sciences or Medical Technology or Human Biology major or LBS Medical Technology coordinate major.  
Lab safety and standards of good laboratory practice including specimen handling and processing. Application of technologies and techniques to the performance of clinical diagnostic testing.
- 414 Clinical Chemistry I: Laboratory Analysis and Practice**  
Spring. 3(3-0) P:M: (STT 200 or STT 201 or STT 231 or STT 351 or STT 421) P:NM: (MT 212 and MT 213) RB: (PHY 231 and PHY 232)  
Concepts and principles of analytic methods commonly used in the clinical laboratory are presented. Emphasis on qualitative and quantitative features of instrumental analysis. Issues of QC, QA, method evaluation and standards of laboratory practice.
- 415 Clinical Chemistry and Body Fluid Analysis Laboratory**  
Spring. 1(0-3) P:M: (MT 213) R: Open only to students in the Clinical Laboratory Sciences major. C: MT 414 concurrently.  
Quantitative analysis of blood and body fluids. Spectrophotometry, electrophoresis, chromatography, enzymatic assays, and immunoassays.
- 416 Clinical Chemistry II: Pathophysiology and Body Fluid Analysis**  
Fall. 5(5-0) P:M: (MT 212) and (BMB 401 or BMB 462) and (PSL 250) or (PSL 431 and PSL 432) RB: (MT 414)  
Correlation of laboratory test results with normal physiology and biochemistry and with disease states. Emphasis on metabolic and endocrine systems, and acquired and inherited diseases. Therapeutic drug monitoring, toxicology and urinalysis.
- 422 Hematology and Hemostasis**  
Fall. 4(4-0) P:M: (MT 212 or concurrently) P:NM: (PSL 250) RB: (BS 111 and BS 111L and BMB 401)  
Structure and function of normal blood cells with changes seen in benign and malignant diseases and acquired and hereditary disorders. Mechanisms of hemostasis, fibrinolysis and hemostatic control.
- 423 Hematology and Hemostasis Laboratory**  
Fall. 1(0-3) P:M: (MT 213 or concurrently) R: Open only to students in the Clinical Laboratory Sciences major. C: MT 422 concurrently.  
Diagnostic assessment of blood cells and hemostatic function.
- 432 Clinical Immunology and Immunoematology**  
Spring. 5(5-0) P:M: (MT 212 and BS 111 and BS 111L) P:NM: (MT 422) RB: (PSL 250)  
Cellular and humoral immunity and diseases of immunity. Clinical serology and immunology, blood group serology, and transfusion practices.
- 433 Clinical Immunology and Immunoematology Laboratory**  
Spring. 1(0-3) P:M: (MT 213 and MT 432 or concurrently) R: Open only to students in the Clinical Laboratory Sciences major.  
Immunologic methods for disease detection. Methods of blood typing and pre-transfusion testing.
- 442 Education and Management in the Clinical Laboratory**  
Fall. 3(3-0) P:M: (MTH 116 or LBS 117) or (MTH 103 and MTH 114) or (STT 200 or STT 201 or STT 231 or STT 351 or STT 421) R: Open only to students in the Clinical Laboratory Sciences major.  
Basic principles and concepts in education and management in clinical laboratories. Systematic approach to instructional design, delivery and evaluation. Principles of leadership, personnel management, fiscal management, and regulatory compliance.
- 454 Problem Solving Across Clinical Laboratory Disciplines (W)**  
Spring. 4(4-0) P:M: (MT 414 and MT 416 and MT 422 and MT 432 and MIC 463) and completion of Tier I writing requirement. RB: (MT 442) R: Open only to seniors in the Clinical Laboratory Sciences major.  
Problem-oriented approach integrating topics from previous courses in clinical laboratory sciences. Emphasis on published primary research literature and its critical appraisal.
- 455 Integrating Clinical Laboratory Science Discipline (W)**  
Fall, Spring. 2(2-0) P:M: (MT 422 and MT 432 and MT 414 and MT 416 or concurrently and MIC 463 or concurrently) and completion of Tier I writing requirement. R: Open only to seniors in the Medical Technology major or LBS Medical Technology coordinate major.  
Problem oriented approach integrating topics from Medical Technology courses with emphasis on writing experience in the major and on critical thinking skills.
- 471 Advanced Clinical Chemistry Laboratory**  
Fall, Spring, Summer. 3 credits. P:M: (MT 454)  
Application and integration of theory and technical skills in clinical chemistry and biochemistry.
- 472 Advanced Clinical Chemistry**  
Fall, Spring, Summer. 1 credit. R: Open only to seniors in the Clinical Laboratory Sciences major. C: MT 471 concurrently.  
Theoretical aspects of clinical chemistry, chemical and biochemical reactions, statistical analysis, and pathophysiologic relationships. Integration of cognitive material with clinical laboratory test results.
- 473 Advanced Clinical Hematology and Body Fluids Laboratory**  
Fall, Spring, Summer. 4 credits. P:M: (MT 454)  
Application and integration of theory and technical skills in hematology, hemostasis, and body fluid analysis.
- 474 Advanced Clinical Hematology and Body Fluids**  
Fall, Spring, Summer. 1 credit. R: Open only to seniors in the Clinical Laboratory Sciences major. C: MT 473 concurrently.  
Theoretical aspects of advanced hematology, hemostasis and body fluid analysis. Integration of cognitive material with clinical laboratory test results.
- 475 Advanced Clinical Immunology and Immunoematology Laboratory**  
Fall, Spring, Summer. 2 credits. P:M: (MT 454)  
Application and integration of theory and technical skills in immunology and immunoematology.
- 476 Advanced Clinical Immunology and Immunoematology**  
Fall, Spring, Summer. 1 credit. R: Open only to seniors in the Clinical Laboratory Sciences major. C: MT 475 concurrently.  
Theoretical aspects of immunology and immunoematology. Integration of cognitive material with clinical laboratory test results.
- 477 Advanced Clinical Microbiology Laboratory**  
Fall, Spring, Summer. 3 credits. P:M: (MT 454)  
Application and integration of theory and technical skills in clinical microbiology and infectious disease.
- 478 Advanced Clinical Microbiology**  
Fall, Spring, Summer. 1 credit. R: Open only to seniors in the Clinical Laboratory Sciences major. C: MT 477 concurrently.  
Theoretical aspects of clinical microbiology and infectious disease. Integration of cognitive material with clinical laboratory test results.
- 495 Directed Study**  
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open only to students in the Clinical Laboratory Sciences or Medical Technology major or LBS Medical Technology coordinate major.  
Faculty directed study including assigned readings, reviews of appropriate scientific periodicals, e-search and laboratory experience.
- 801 Medical Technology Seminar**  
Spring. 1(1-0) A student may earn a maximum of 2 credits in all enrollments for this course. R: Open only to graduate students in Clinical Laboratory Sciences.  
Current research topics in clinical laboratory sciences.
- 812 Advanced Clinical Chemistry**  
Spring of even years. 2(2-0) Interdepartmental with Pathology. P:NM: (BMB 462 and MT 414 and MT 416)  
Biochemical basis of selected pathologic conditions including inborn errors of metabolism, endocrine and other genetic disorders. Emphasis on current diagnostic techniques.
- 820 Advanced Human Hematology**  
Fall of even years. 2(2-0) Interdepartmental with Pathology. P:NM: (MT 422)  
Selected topics in hematology including pathogenesis, mechanisms and morphological pictures. Emphasis on laboratory tests and interpretation of results.
- 830 Concepts in Molecular Biology**  
Spring of odd years. 2(2-0) Interdepartmental with Pathology. P:NM: One course in Biochemistry or concurrently.  
Techniques and theories of molecular biology, nucleic acid synthesis and isolation, enzymatic digestion and modification, electrophoresis, hybridization, amplification, library construction, and cloning.
- 831 Clinical Application of Molecular Biology**  
Summer. 2(2-0) P:M: (MT 830) RB: Basic biochemistry, medical or research laboratory experience  
Molecular diagnostic principles. Diagnostic outcomes in traditional and non-traditional laboratory disciplines.

**831L Molecular Pathology Laboratory**  
 Summer. 2(0-4) P:M: (MT 831 or concurrently)

Equipment operation, DNA extraction and measurement, electrophoresis, hybridization and transfers, amplification and detection including SSOP, ARMS, RFLP and SCP as well as automated sequencing will be covered with specific emphasis on clinical applications.

**860 Clinical Laboratory Diagnosis of Infectious Diseases**

Spring of even years. 2(2-0) Interdepartmental with Pathology. P:NM: (MIC 451 and MIC 464)

Laboratory techniques for diagnosing infectious diseases in humans. Emphasis on differential diagnosis and correlation of microbiological results with serology, hematology, and clinical chemistry.

**890 Selected Problems in Clinical Laboratory Science**

Fall, Spring, Summer. 1 to 6 credits. A student may earn a maximum of 12 credits in all enrollments for this course. R: Open only to graduate students in Clinical Laboratory Sciences.

Non-thesis research for Plan B master's students.

**899 Master's Thesis Research**

Fall, Spring, Summer. 1 to 10 credits. A student may earn a maximum of 24 credits in all enrollments for this course. R: Open only to graduate students in Clinical Laboratory Sciences.

Master's thesis research.

**MEDICINE**

**Department of Medicine  
 College of Human Medicine**

**608 Internal Medicine Clerkship**

Fall, Spring, Summer. 2 to 18 credits. A student may earn a maximum of 42 credits in all enrollments for this course. P:NM: (FMP 602) R: Open only to graduate-professional students in College of Human Medicine.

Community hospital clerkship. Interviewing skills, history, physical examination. Problem solving and therapy. Care of the whole patient leading to independence in patient management.

**609 Hematology Clerkship**

Fall, Spring, Summer. 2 to 12 credits. A student may earn a maximum of 12 credits in all enrollments for this course. P:NM: (MED 608) R: Open only to graduate-professional students in College of Human Medicine.

Data collection, problem solving, and management related to common hematologic disorders of children and adults.

**610 Oncology Clerkship**

Fall, Spring, Summer. 2 to 12 credits. A student may earn a maximum of 12 credits in all enrollments for this course. P:NM: (MED 608) R: Open only to graduate-professional students in College of Human Medicine.

Data collection, problem solving and management of prevalent cancers in children and adults.

**611 Cardiology Clerkship**

Fall, Spring, Summer. 2 to 12 credits. A student may earn a maximum of 12 credits in all enrollments for this course. P:NM: (MED 608) R: Open only to graduate-professional students in College of Human Medicine.

Evaluation of patients with cardiac diseases. Special diagnostic procedures including cardiac cuticularization, phonocardiography, echocardiography, and electrocardiography.

**612 Nephrology Clerkship**

Fall, Spring, Summer. 2 to 12 credits. A student may earn a maximum of 12 credits in all enrollments for this course. P:NM: (MED 608) R: Open only to graduate-professional students in College of Human Medicine.

Integrated concepts of renal physiology and pathophysiology of renal disease. Clinical experience.

**613 Dermatology Clerkship**

Fall, Spring, Summer. 2 to 12 credits. A student may earn a maximum of 12 credits in all enrollments for his course. P:NM: (MED 608) R: Open only to graduate-professional students in College of Human Medicine.

Experience in a dermatologist's office to develop clinical, observational, and diagnostic skills in dermatology.

**614 Pulmonary Clerkship**

Fall, Spring, Summer. 2 to 12 credits. A student may earn a maximum of 12 credits in all enrollments for this course. P:NM: (MED 608) R: Open only to graduate-professional students in College of Human Medicine.

Pulmonary physiology. Evaluation of pulmonary function. Diagnosis and treatment of common pulmonary diseases.

**615 Gastroenterology Clerkship**

Fall, Spring, Summer. 2 to 12 credits. A student may earn a maximum of 12 credits in all enrollments for this course. P:NM: (MED 608) R: Open only to graduate-professional students in College of Human Medicine.

Experience with gastrointestinal problems in ambulatory and hospital settings. Emphasis on continuity and comprehensive care.

**616 Allergy Clerkship**

Fall, Spring, Summer. 2 to 12 credits. A student may earn a maximum of 12 credits in all enrollments for this course. P:NM: (MED 608) R: Open only to graduate-professional students in College of Human Medicine.

Ambulatory and hospital based experience to develop diagnostic skills in allergy. Review of basic therapeutics related to allergic diseases.

**618 Infectious Diseases Clerkship**

Fall, Spring, Summer. 2 to 12 credits. A student may earn a maximum of 12 credits in all enrollments for this course. P:NM: (MED 608) R: Open only to graduate-professional students in College of Human Medicine.

Clinical problems in infectious and immunologic diseases. Integrated basic science input is provided in seminars.

**619 Ambulatory Care Clerkship**

Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 15 credits in all enrollments for this course. Interdepartmental with Family Practice; Pediatrics. Administered by Department of Family Practice. P:NM: (FMP 602) R: Open only to graduate-professional students in College of Human Medicine.

Continuous and comprehensive patient care under supervision of appropriate physicians.

**622 Endocrinology and Metabolism Clerkship**

Fall, Spring, Summer. 2 to 12 credits. A student may earn a maximum of 12 credits in all enrollments for this course. P:NM: (MED 608) R: Open only to graduate-professional students in College of Human Medicine. SA: MED 620

Clinical and/or clinical-research clerkship: endocrine diseases, electrolyte abnormalities, endocrine hypertension, or diabetes mellitus.

**623 Advanced Medicine**

Fall, Spring, Summer. 6 to 12 credits. Fall: Lansing-GR-Saginaw-Flint-Kalamazoo-UP. Spring: Lansing-GR-Saginaw-Flint-Kalamazoo-UP. Summer: Lansing-GR-Saginaw-Flint-Kalamazoo-UP. A student may earn a maximum of 12 credits in all enrollments for this course. P:NM: (MED 608) R: Open only to graduate-professional students in the College of Human Medicine.

Hospital-based clinical experience in diagnosing and managing acutely ill patients with non-surgical problems.

**626 Physical Medicine and Rehabilitation Clerkship**

Fall, Spring, Summer. 2 to 12 credits. A student may earn a maximum of 12 credits in all enrollments for this course. P:NM: (MED 608) R: Open only to graduate-professional students in College of Human Medicine.

Developing regimens for physical medicine procedures, occupational therapy and rehabilitation skills.

**627 Rheumatology Clerkship**

Fall, Spring, Summer. 2 to 12 credits. A student may earn a maximum of 12 credits in all enrollments for this course. P:NM: (MED 608) R: Open only to graduate-professional students in College of Human Medicine.

Combined ambulatory and hospital consultative clerkship for diagnostic skills in areas of rheumatic diseases.

**628 Advanced Internal Medicine**

Fall, Spring, Summer. 2 to 12 credits. A student may earn a maximum of 12 credits in all enrollments for this course. P:NM: (MED 608) R: Open only to graduate-professional students in College of Human Medicine.

Clinical experiences to refine diagnostic and management skills in general internal medicine.

**630 Emergency Medicine Clerkship**

Fall, Spring, Summer. 2 to 12 credits. A student may earn a maximum of 12 credits in all enrollments for this course. P:NM: (MED 608) R: Open only to graduate-professional students in College of Human Medicine.

Clinical diagnosis and treatment of emergencies seen in community emergency departments.

**MED**