

**870. Ferrous Physical Metallurgy**  
Fall. 3(3-0) 342, 362.

Theory of steel hardening and hardenability from nucleation, growth, and shear considerations.

**871. Nonferrous Physical Metallurgy**  
Winter. 3(3-0) 342, 361.

Binary, ternary and complex alloy systems, shear mechanism, recrystallization and grain growth, age hardening, and other diffusion mechanisms.

**872. Physical Metallurgy of Alloy Steels**

Spring. 3(3-0) 870, 871.

Steels for extreme service conditions.

**875. Ferrous Metallurgy**  
Fall. 3(3-0) 465.

Stoichiometric material and heat balance calculations of the blast furnace, open hearth and electric furnace processes.

**876. Nonferrous Process Metallurgy**  
Winter. 3(3-0) 465.

Stoichiometric material and heat balance calculation in nonferrous extractive metallurgy.

**880. Metals and Alloys I**  
Fall. 3(3-0) 372.

Topics in engineering properties and application of wrought steels for engineers other than metallurgical.

**881. Metals and Alloys II**  
Winter. 3(3-0) 372.

Similar to 845, but with reference to nonferrous alloys.

**882. Metals and Alloys III**  
Spring. 3(3-0) 372.

Similar to 845, but with reference to cast alloys.

**885. Seminar**  
Fall, Winter, Spring. 1 credit. 899 concurrently.

**890. Selected Topics**  
Fall, Winter, Spring, Summer. 3(3-0)  
May re-enroll for a maximum of 13 credits if a different topic is taken. Approval of department.

A newly developing area in metallurgy, mechanics, or materials science selected by the department for offering each term. Information on the specific topic to be covered should be obtained from the department office before registration.

**899. Research**  
(EGR 899.) Fall, Winter, Spring, Summer. Variable credit. Approval of department.

**900. Special Problems**  
Fall, Winter, Spring Summer. 1 to 6 credits. May re-enroll for a maximum of 6 credits. Approval of department.

Individualized reading and research compatible with the student's interest and ability.

**901. Modern Mathematical Mechanics**  
Winter of odd-numbered years. 3(3-0)  
Approval of department.

Application of functional analysis and tensor theory to classical and contemporary problems in dynamics and material properties.

**909. Elastic Thin Shells**  
Summer. 5(5-0) 815 or C E 804 or approval of department; MTH 421. Interdepartmental with and administered by the Civil Engineering Department.

Elements of differential geometry, membrane theory of shells, Fucher's stress function, deformation and bending of shells of revolution and shallow shells.

**910. Nonlinear Continua**  
Winter of even-numbered years. 4(4-0)

810.  
Modern nonlinear theories of continua. Equations of balance and constitutive equations. Topics selected from finite elasticity, nonlinear viscosity and viscoelasticity, electroelasticity. General tensors are introduced and used throughout.

**911. Theory of Elastic Stability**  
Fall of odd-numbered years. 4(4-0)  
815 or approval of department.

Theory and methods of determining buckling strength and post-buckling behavior of bar, plate and shell elements and of elastic systems.

**912. Theory of Plates**  
Winter. 4(4-0) 815 or C E 804 or approval of department; MTH 422. Interdepartmental with the Civil Engineering Department.

Bending of thin elastic plates with various shapes and boundary conditions; application of energy principles and approximate methods of solution; thick plates; large deflection theory; sandwich plates.

**915. Theory of Elasticity II**  
(913.) Spring. 3(3-0) 813 or approval of department.

Saint-Venant bending and torsion. Problems in three-dimensional linear elasticity using the Galerkin vector and Neuber-Papkovich functions.

**918. Theory of Viscoelasticity**  
Fall of even-numbered years. 3(3-0)  
810; MTH 422 or approval of department.

Fundamental linear viscoelastic stress-strain relations. Model representation. Three dimensional and general deformation laws. Correspondence principle. Quasi-static, dynamic and buckling problems.

**920. Theory of Vibrations II**  
(904.) Winter of odd-numbered years.  
4(4-0) MTH 422; M E 823 or approval of department. Interdepartmental with the Mechanical Engineering Department.

Vibrations of one, two, and three-dimensional models of elastic and inelastic continua. Interaction phenomena. Stability. Variational methods. Applications to aeronautics, aerospace, and undersea technology.

**921. Theory of Vibrations III**  
(903.) Spring of odd-numbered years,  
Summer. 4(4-0) 920 or approval of department. Interdepartmental with the Mechanical Engineering Department.

Nonlinear oscillations. Resonance; subharmonics; self-sustained motions; stability. Methods of Poincare, van der Pol, etc. Random vibrations. Parametric excitations; stochastic processes; power spectra. Applications.

**933. Advanced Elasticity**  
Spring of even-number years. 3(3-0)  
813, 910 or approval of department.

Selected topics in non-linear elasticity.

**935. Mechanics of the Fluid State**  
Winter of even-numbered years. 3(3-0)  
322 or 803.

Boltzmann's equation and the molecular theory of fluids; equations of state of gases, liquids and plasmas; transfer and flow processes.

**936. Mechanics of the Solid State**  
Spring of even-numbered years. 3(3-0)  
322 or 803.

Particle calculations of typical mechanical, thermal and electrical properties of crystals. Defect theory; elasticity, plasticity and fracture; phonon and electron scattering.

**941. Advanced Topics in Mechanical Metallurgy**

Fall of even-numbered years; Winter and Spring of odd-numbered years. 3(3-0)  
May re-enroll for a maximum of 9 credits.

Various aspects of dislocation theory and its application to the mechanical and physical properties of solids.

**942. Advanced Topics in the Kinetics of Phase Transformation**

Fall of odd-numbered years; Winter and Spring of even-numbered years. 3(3-0)  
May re-enroll for a maximum of 9 credits.

**999. Research**  
(EGR 999.) Fall, Winter, Spring  
Summer. Variable credit. Approval of department.

**MICROBIOLOGY AND PUBLIC HEALTH MPH**

College of Human Medicine  
College of Natural Science  
College of Veterinary Medicine

**100. Preview of Microbiology**  
Winter. 1(1-0)

Science and scientists of microbiology, presented in historical perspective and carried to the forefront of current research. A rigorous preview for students seriously curious about microbiology.

**200. Elementary Microbiology**  
Fall, Winter. 4(3-2) N S 193.

Description of bacteria and related forms of microorganisms, their growth and nature, their application in industry, and their control in public health.

**234. Introductory Medical Microbiology**  
Fall. 5(4-4) N S 193.

Survey of immunology and microbiology with emphasis on pathogenic microorganisms, antimicrobial agents, and laboratory diagnosis.

**301. Introductory Microbiology**  
Fall. 4(3-4) B S 212; BCH 200.

Fundamentals of microbiology with emphasis on the comparative nature of the various groups of microorganisms, their distribution and activities.

**336. Introductory Medical Parasitology**  
(309.) Fall. 5(3-6) Medical Technol-  
ogy students, or approval of department.

Biology and laboratory diagnosis of protozoan, helminth, and arthropod infections of man.

**400. Bacteriology for High School Science**  
Summer. 4(4-4) Bachelor's degree  
and teaching certificate, or approval of department.

Fundamental concepts, experiments, and projects useful in secondary school science courses.

**400H. Honors Work**  
Fall, Winter, Spring, Summer. 1 to 6  
credits. May re-enroll for a maximum of 12  
credits. Approval of department.  
Tutored reading and experimentation.

**401. General Microbiology**  
Fall. 5(5-0) B S 212; BCH 401 or concurrently.

Comparative biology of microorganisms: viruses, rickettsiae, bacteria, fungi, algae, and protozoa.

**402. General Microbiology Laboratory**  
Fall. 2(0-6) 401 concurrently.

Laboratory based on the subject matter of 401.

**413. General Virology**  
(463.) Winter. 4(3-4) 427 or concurrently.

Physical, chemical, and biological properties of viruses; laboratory procedures employed for cultivation and identification of viruses.

**416. General Parasitology**  
(406.) Winter. Summer at W. K. Kellogg Biological Station. 3(2-4) B S 212.

Biology of parasitic animals.

**421. Microbial Physiology**  
(331.) Winter. 4(3-4) 401, 402.

Cell structure and function, growth and death, and metabolism of microorganisms.

**423. Microbial Genetics**  
(431.) Spring. 4(2-6) BCH 401; ZOL 441 recommended.

Fundamental genetic concepts as exemplified in microorganisms.

**425. Microbial Ecology**  
Summer. 6(3-9) 402, approval of department. Given at W. K. Kellogg Biological Station.

Interrelationships of individual microbial cells or of microbial populations with their macro- or microenvironment. Dispersal and activity of microorganisms. Methodology of assessment of microbial substance and activity. Analysis of the habitat.

**427. Immunobiology**  
(460.) Winter. 4(3-4) B S 212; BCH 200 or BCH 401.

Biological and biochemical mechanisms of the immune response; immunological tolerance, antibody production, antigen-antibody reactions, immunological diseases.

**429. Microbiology of Infectious Diseases**  
(461.) Spring. 5(2-8) 402, 427.

Biology, immunology, pathogenicity, and medical aspects of microorganisms associated with infectious diseases of man. Methods of isolation and identification are emphasized in the laboratory.

**440. Food Microbiology**  
(371.) Spring. 4(2-6) 200 or 401, or approval of department. Interdepartmental with and administered by the Food Science Department.

Major groups of microorganisms of importance to the food industry are studied with emphasis on ecological, physiological, and public health aspects.

**442. Soil Microbiology**  
(481.) Spring. 3(2-4) 200 or 401. Interdepartmental with the Soil Science Department.

Major groups of microorganisms of importance in soils are studied with emphasis on ecological, biochemical, and physical aspects.

**444. Environmental Microbiology**  
(351.) Spring. 3(2-4) 200 or 401.

Flora, methods of testing, and purification of environmental air and water. Treatment and disposal of sewage.

**531. Medical Immunology and Microbiology**  
(566.) Fall, Spring. 5(5-0) or 8(5-11)  
Professional medical students or approval of department.

General immunology; comparative biology of microorganisms that have medical significance.

**532. Veterinary Microbiology and Public Health**  
(567.) Winter. Summer. 8(5-11)  
531 or approval of department.

Biology, immunology, pathogenicity, and medical aspects of microorganisms associated with infectious diseases of animals. Epidemiology of animal diseases significant to human health.

**536. Veterinary Parasitology I**  
(501.) Winter, Summer. 4(3-4) Veterinary Medicine students or approval of department.

Distribution, biology, and control of parasitic animals of importance to veterinary medicine.

**537. Veterinary Parasitology II**  
(502.) Fall, Spring. 4(2-6) 536 or approval of department.

Continuation of 536.

**800. Seminar**  
(830.) Fall, Winter, Spring, Summer. 1(1-0).

**816. Parasitic Metazoa**  
(802.) Spring of odd-numbered years. 4(3-4) 416 or ZOL 481 or approval of department.

Comparative biology, physiology, and host-parasite relationships of parasitic helminths and arthropods.

**817. Parasitic Protozoa**  
(803.) Spring of even-numbered years. 3(2-4) 416 or ZOL 482 or approval of department.

Comparative biology, physiology, and host-parasite relationships of parasitic protozoa.

**826. Ecology of Animal Parasites**  
Summer. 3 credits. 416, approval of department. Given at W. K. Kellogg Biological Station.

Interaction of parasitic animals (protozoa, helminths, and arthropods) with their natural environment, including host, biotic, and physical aspects.

**827. Immunochemistry**  
Spring. 3(3-0) 427 or approval of department; CEM 383 recommended.

Structure and reactivity of antigens and antibodies; synthesis of immunoglobulins. Emphasis is on current advances and research concepts.

**828. Immunochemistry Laboratory**  
Summer. 3(0-9) May re-enroll for a maximum of 6 credits if different project is studied. 827 and approval of department.

Research-oriented laboratory, based on current advances in immunochemistry.

**899. Research**  
Fall, Winter, Spring, Summer. Variable credit. Approval of department.

**900. Topics in Microbiology**  
Fall, Winter, Spring Summer. 2(2-0) May re-enroll if different topic is taken. Approval of department.

Topics will be selected from taxonomic sub-science such as bacteriology, virology, protozoology, mycology, algology, and helminthology; and from transecting disciplines such as microbial genetics, immunology, physiology, and ecology.

**901. Experimental Microbiology**  
Fall, Winter, Spring, Summer. 3(0-9) May re-enroll for a maximum of 9 credits. Approval of department.

Experiments, demonstrations, and discussions of current research programs in various areas of microbiology.

**999. Research**  
Fall, Winter, Spring, Summer. Variable credit. Approval of department.

## MILITARY SCIENCE M S

### All University

**121. Preview of Military Science**  
Fall, Winter. 1(1-0) Approval of department.

Role of the ROTC officer in the Army. Assists the student in planning a curriculum to satisfy requirements for a commission.

**122. Marksmanship and Hunter Safety**  
Fall, Spring. 1(0-2) 121 or approval of department.

Small arms marksmanship and safety. Practical exercises on local firing ranges. Individual basic military marksmanship and the skills necessary to participate in a competitive or recreational shooting program.

**324. Military Teaching**  
Fall, Winter. 4(4-2) Basic course, approval of department.

Methods of teaching manipulative skills to groups with varying educational backgrounds. Emphasis on determination of entry behavior, progress analysis, testing and test construction. Introduction to current teaching aids. Practical experience in simulated field situations is stressed during laboratory.

**325. Military Management**  
Spring. 4(3-2) 324 or approval of department.

Task analysis approach to missions. The subject of tactics is used as a teaching vehicle for the managerial approach to the preparation and execution phases of military operations. Emphasis is placed on physical and moral leadership during the laboratory sections.

**426. Military Law**  
Winter. 4(4-0) Approval of department.

Civilian and military law as they pertain to individuals and organizations associated with the Department of Defense.

**427. Seminar**  
Spring. 1(1-0) Approval of department.

Precommissioning orientation stressing current military policies, procedures, customs and trends.

## MUSIC MUS

### College of Arts and Letters

**094. Band**  
Summer. Zero credit. Membership determined by audition.

Attendance at all rehearsals and public concerts obligatory. See Music 117, 118, 318.