850. Modern Ceramic Materials I
Fall. 3(3-0) CEM 462; PHY 846; or approval of department.
Crystalline macrostructure and microstructure of ceramics and glasses; dependence of microstructure on amount, size, shape, and distribution of phases; modification of microstructure by control of nucleation and growth; composite materials.

851. Modern Ceramic Materials II
Winter. 3(3-0) 850.
Properties of ceramic materials with specific reference to mechanical, optical, electrical, magnetic and thermal properties.

852. Modern Ceramic Materials III
Spring. 3(3-0) 851.
Application of ceramic materials. Glass-ceramics, nuclear fuel elements, hot-pressed translucent oxides, pre-stressed ceramics, ceramic coatings, pyrolytic materials.

860. Theoretical Metallurgy I
Fall. 3(3-0) 342.
Metallurgical thermodynamics, introduction to statistical thermodynamics, kinetics of metallurgical processes.

861. Theoretical Metallurgy II
Winter. 3(3-0) 860.
Introduction to quantum theory of metals, physical properties of metals and alloys.

862. Theoretical Metallurgy III
Spring. 3(3-0) 861.
Imperfection in crystalline solids, dislocation theory and mechanical properties of metals and alloys.

875. Ferrous Metallurgy
Fall. 3(3-0) 462.
Stoichiometric material and heat balance calculations of the blast furnace, open hearth and electric furnace processes.

876. Nonferrous Process Metallurgy
Winter. 3(3-0) 462.
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) 880. or approval of department.
May re-enroll for a maximum of 16 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 890.) 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.

909. Elastic Thin Shells
Spring. 4(4-0) 415, or C E 804 or approval of department. MTH 421. Interdepartmental with and administered by Civil Engineering.
Elements of differential geometry, membrane theory of shells, Pucher's stress function, deformation and bending of shells of revolution and shallow shells.

910. Nonlinear Continua
Winter of even-numbered years. 4(4-0) 310.
Modern nonlinear theories of continua. Equations of balance and constitutive equations. Topics selected from finite elasticity, nonlinear viscoelasticity, electroelasticity. General tensors are introduced and used throughout.

911. Theory of Elastic Stability
Fall of odd-numbered years. 4(4-0) 515 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) 515 or C E 804 or approval of department. MTH 422. Interdepartmental with Civil Engineering.
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
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); MTH 423 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
Winter of odd-numbered years. 4(4-0); MTH 422; M E 323 or approval of department. Interdepartmental with the Mechanical Engineering Department.

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

933. Advanced Elasticity
Spring of even-numbered years. 3(3-0) 813, 910 or approval of department.
Selected topics in non-linear elasticity.

941. Advanced Topics in Mechanical Metallurgy
Fall of even-numbered years; Winter and Spring of odd-numbered years. 3(3-0) 810 or approval of department.
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) 810 or approval of department.

999. Research
(EGR 999.) Fall, Winter, Spring. Summer. Variable credit. Approval of department.
400. Bacteriology for High School Science
   Summer. 4(4-6) Bachelor's degree and teaching certificate.
   Fundamental concepts, experiments, and projects useful in secondary school science courses.

400H. Honors Work
   Fall, Winter, Spring. 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) BCH 401 or 431 concurrently.
   Comparative biology of microorganisms: viruses, rickettsiae, bacteria, fungi, algae, and protists.

402. General Microbiology Laboratory
   Fall. 3(4-6) Concurrently.
   Laboratory work based upon the subject matter of 401.

401A. General Microbiological Science
   Summer. 4(4-6) Bachelor's degree and teaching certificate.
   Comparative biology of microorganisms: viruses, rickettsiae, bacteria, fungi, algae, and protists.

406. Medical Mycology
   Fall, Spring. 4(2-6) BOT 402 or approval of department. Interdepartmental with and administered by the Botany and Plant Pathology Department.
   Characteristics, habits, and laboratory identification of fungus diseases infecting humans. Emphasis on laboratory techniques and morphological characteristics of the various mycoses.

413. General Virology
   Winter. 3(3-0) 427 or concurrently.
   Physical, chemical, and biological properties of the viruses.

414. General Virology Laboratory
   Winter. 1(0-4) 413 or concurrently.
   Laboratory procedures employed for cultivation and identification of viruses.

416. General Parasitology
   Winter. Summer at W. K. Kellogg Biological Station. 3(3-0) B S 212.
   Life history, host-parasite relationships (including physiology, immunology, immunopathology and pathology) and epidemiology of selected groups and species of protozoan, trematode, cestode and nematode parasites.

417. General Parasitology Laboratory
   Winter. 2(0-4) B S 212.
   Identification and life histories of representative species of major groups of animal parasites. Selected concepts of host-parasite associations will be tested experimentally.

420. Ecology of Animal Parasites
   (426.) Summer. 6 credits. B S 212 or approval of department. Given at W. K. Kellogg Biological Station. Interdepartmental with the departments of Fisheries and Wildlife, and Zoology.
   Parasites of animals by protozoan, helminths and arthropods with emphasis on the interrelationships of host-parasite associations with the natural environments.

421. Microbial Physiology
   Winter. 3(3-0) 401, 402.
   Cell structure and function, growth and death, and metabolism of microorganisms.

422. Microbial Physiology Laboratory
   Winter. 2(0-6) 421 or concurrently.
   Laboratory work based upon the subject matter in 421.

423. Microbial Genetics
   Spring. 3(3-0) BCH 401; ZOL 441 recommended.
   Fundamental genetic concepts as exemplified in microorganisms.

424. Microbial Genetics Laboratory
   Spring. 2(0-6) 423 or concurrently.
   Laboratory work based upon the subject matter in 423.

425. Microbial Ecology
   Summer. 6(3-0) A microbiology course or approval of department. Given at W. K. Kellogg Biological Station.
   Lecture emphasizes the biological properties and diversity of naturally occurring microorganisms. The laboratory treats the analytical techniques involved in study of their metabolic activity.

427. Immunobiology
   Winter. 3(3-0) B S 212; BCH 200 or 401.
   Biological and biochemical mechanisms of the immune response. Emphasis is on concepts of immunity.

428. Immunobiology Laboratory
   Winter. 2(0-6) 427 or concurrently.
   Basic laboratory techniques in immunobiology.

429. Microbiology of Infectious Diseases
   Spring. 5(3-0) 301 or 402 and 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.

430. Veterinary Microbiology and Public Health
   Fall, Spring. 3(2-4) or concurrently.
   Veterinary medical, immunology, and epidemiology of bacterial, viral, and parasitic infections of man.

431. Veterinary Parasitology
   Fall, Spring. 3(2-4) or concurrently.
   Veterinary medical, immunology, and epidemiology of parasitic infections of man.

432. Veterinary Virology
   Fall, Spring. 3(2-4) or concurrently.
   Veterinary medical, immunology, and epidemiology of viral infections of man.

433. Veterinary Microbiology and Public Health
   Fall, Spring. 3(2-4) or concurrently.
   Veterinary medical, immunology, and epidemiology of bacterial, viral, and parasitic infections of man.

434. Environmental Microbiology
   Spring. 3(2-4) 200 or 301 or 401.
   Flora, methods of testing, and purification of environmental air and water. Treatment and disposal of sewage.

441. Veterinary Pathology I
   Winter. 5(3-5) BCH 401; ZOL 441 recommended.
   Fundamental genetic concepts as exemplified in microorganisms.

442. Veterinary Pathology II
   Spring. 3(2-4) 441 recommended.
   Fundamental genetic concepts as exemplified in microorganisms.

512. Infectious Diseases
   Fall. 4(3-3) 511, or approval of department. Interdepartmental with the Department of Medicine.
   Infectious diseases of man, including biology of the causative microorganism, epidemiology, pathogenesis, host-parasite relationships, clinical laboratory diagnosis, and clinical management.

521. Medical Microbiology and Immunology
   Winter. Variable credit. May re-enroll for a maximum of 6 credits. A biochemistry course. Enrollment in College of Orthopaedic Medicine or approval of department.
   Basic principles of microbiology (bacteriology, virology, mycology and parasitology) and immunology. Selected type-infections relate these principles to disease in man.

531A. Medical Microbiology: Immunology
   (531.) Winter. 3(2-4) A course in biochemistry and admission to the veterinary professional program, or approval of department.
   Basic principles of immunology (immunobiology and immunohematology) and their relation to disease in animals.

531B. Medical Microbiology: Bacteriology and Mycology
   Winter. 3(2-4) A course in biochemistry and admission to the veterinary professional program, or approval of department.
   Basic principles of bacteriology and mycology and their relation to disease in animals.

531C. Medical Microbiology: Virology
   Spring. 2(1-2) A course in biochemistry and admission to the veterinary professional program, or approval of department.
   Basic principles of virology and their relation to disease in animals.

531D. Medical Microbiology: Parasitology
   Spring. 3(2-4) Admission to the veterinary professional program, or approval of department.
   Basic principles of parasitology (protozoology, helminthology, and entomology) and their relation to disease in animals.

532. Veterinary Microbiology and Public Health
   Winter. 5(5-11) BCH 401; ZOL 441 recommended.
   Fundamental genetic concepts as exemplified in microorganisms.

533. Veterinary Parasitology I
   Winter. 4(3-4) Veterinary Medicine students or approval of department.
   Distribution, biology, and control of parasitic animals of importance to veterinary medicine.

534. Veterinary Parasitology II
   Fall, Spring. 4(2-6) 536 or approval of department.
   Continuation of 536.
618. Infectious Disease Clerkship
Fall, Winter, Spring. Summer. 1 to 17 credits. May re-enroll for a maximum of 34 credits. If M 602 and M 603 or H D 608. Interdepartmental with and administered by the Department of Medicine.

The clerkship emphasizes acquisition in depth of knowledge and skills essential in solution of clinical problems in infectious and immunologic diseases. Integrated basic science input is afforded through relevant seminars.

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

813. Molecular Virology
Fall. 4(4-0) Background in biochemistry, and approval of department. Molecular nature and biochemistry of replication of bacterial and animal viruses. Emphasis is on current advances, research concepts, and the role of viruses in molecular biology research.

826. Ecology of Animal Parasites
Summer. 3 credits. 416, approval of department. Given at W. E. Kellogg Biological Station.
Interaction of parasitic animals (protozoa, helminthes, and arthropods) with their natural environment, including host, biotic, and physical aspects.

827. Immunology
Spring. 3(3-0) 427; 453, BCH 452, or ZOL 141, and CEM 353 recommended.
Structure and reactivity of antigens and antibodies; synthesis of immunoglobulins. Emphasis is on current advances and research concepts.

828. Immunology Laboratory
Spring. 2(0-2) 427; 887 or concurrently.
Laboratory based partially on subject matter of 827. Experimental techniques used in immunological assays and immune systems.

890. Special Problems in Microbiology
Fall, Winter, Spring, Summer. 2 to 6 credits. May re-enroll for a maximum of 12 credits. Approval of department.

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 topics are taken. Approval of department.
Topics will be selected from taxonomic sub-disciplines such as bacteriology, virology, protozoology, mycology, algalogy, and histopathology, and from teaching 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 16 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

041. General Military Science
Fall, Winter, Spring. Zero credit. Approval of department.
Application of leadership techniques, the decision making process and staff planning. Military customs and traditions. Students will concurrently enroll in a selected non-Military Science course to fulfill military professional requirements.

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

223. Terrain Analysis and Land Navigation
Winter, Spring. 3(3-0) 121 and approval of department.
Military maps, map construction, specifications and uses. Includes both a study of aerial photographs and an introduction to remote energy sensors employed by defense agencies as they relate to tactical operations.

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 sessions.

426. Military Law
Winter. 4(4-0) Approval of department.
Jurisdiction and responsibility of the Army commander and junior leader in the application of military justice. Implications of Army operations as related to the rules of land warfare.

427. Seminar
Spring. 1(1-0) Approval of department.
Precommissioning orientation stressing current military policies, procedures, customs and trends.

499. Independent Study in Military Science
Fall, Winter, Spring, Summer. 1 to 3 credits. May re-enroll for a maximum of 6 credits. Approval of department and Juniors. Individual research and study in an area related to military science as approved and directed by the Department of Military Science.

MUSIC MUS

College of Arts and Letters

094. Band
Fall, Winter, Summer. 2(3-2) For majors who need theory review.
Basic course in fundamentals and ear training.

112. Chamber Music
Fall, Winter, Spring, Summer. 1(1-0)
May re-enroll for a maximum of 18 credits. Approval of department.
Performance of works for small ensembles.

118. Band
A. Marching Band.
Fall. 1 credit. May re-enroll for credit. Membership determined by audition.
The Marching Band participates at football games.

B. Spartan Brass
Winter. 1 credit. May re-enroll for credit. Membership determined by audition.
The Spartan Brass participates at basketball games.

C. Concert Band.
Fall, Winter, Spring. 1 credit. May re-enroll for credit. Membership determined by audition.
Public appearances are scheduled on campus each term.

D. Symphonic Band
Fall, Winter, Spring. 1 credit. May re-enroll for credit. Membership determined by audition. A high level of achievement in performing ability is required.
Concerts are scheduled both on and off campus.

E. Wind Ensemble
Fall, Winter, Spring. 1 credit. May re-enroll for a maximum of 12 credits. Membership determined by audition. The highest level of performance is required.
Full range of wind literature is performed. Public concerts are presented both on and off campus.

133. Orchestra
Fall, Winter, Spring. 1(0-5) May re-enroll for a maximum of 12 credits. Membership determined by audition.
Standard overtures and symphonies studied and publicly performed. Attendance at all rehearsals and public concerts obligatory.

135. Music in Elementary Education
Fall, Winter, Spring. 4(3-2) Elementary education majors.
Basis, scope and sequence of music instruction in the elementary schools with an introduction to basic knowledge and skills used in elementary school music.

141. Class Instruments and Voice
Fall. 1(0-2) Knowledge of notation.
Music majors, or approval of department.
Class instruction in piano, voice, violin, cello, clarinet, and cornet.