952. Slip and Free (Newtonian) Molecular Flows
Spring. 3(3-0) 412, 432.
Distribution function; Boltzmann equation; solutions of Enskog equations; slip flow; drag coefficient; heat transfer. Free molecule flow; elastic and inelastic reflections; flow around bodies; resistance coefficient; heat; oblation; meteors.

953. Plasma Dynamics (Magneto-Gas Dynamics)
Winter. 3(3-0) 432; PHY 491.
Fundamental equations of hydrodynamics; Maxwell equations; continuum; channel flow; boundary layer; shocks; Alfven wave propagation; one and two fluid theories; discrete particle approach; plasma oscillations; flow around bodies and in nozzles; space propulsion systems.

954. Ion Flow Dynamics
Spring. 3(3-0) 983.
Continuation of 953 as applied to the ion flow; extension of the neutral flow turbulence into electromagnetic turbulence, and method of characteristics applied to the ion flow dynamics.

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

MEDICAL TECHNOLOGY M T

College of Human Medicine
College of Osteopathic Medicine
College of Veterinary Medicine

201. Medical Technology
Fall. 1(1-0) Approval of school.
Relationship of medical technology to medicine and research, and the necessary interaction with other paramedical sciences.

401. Seminar in Medical Technology
Fall. 1 credit. Seniors.
Acquaints students with the operation and administration of a hospital, the philosophy and understanding of the entire profession of medical technology.

MEDICINE MED

College of Human Medicine

590. Special Problems in Medicine
Fall, Winter, Spring, Summer. 1 to 6 credits. May re-enroll for a maximum of 12 credits. Human Medicine students.
Each student will work under direction of a staff member on an experimental, theoretical, or applied problem.

608. Senior Medical Clerkship
Fall, Winter, Spring, Summer. 17 credits. Primarily clerkship, third year Human Medicine students.
Based in community hospitals, this clerkship will stress interviewing skills, history, physical examination, along with problem solving and therapy, and care of the whole patient leading to independence in patient management.

METALLURGY, MECHANICS AND MATERIALS SCIENCE MMM

College of Engineering

205. Mechanics I
Fall, Winter, Spring, Summer. 4(4-0) MTH 214 or concurrently.

206. Mechanics II
Fall, Winter, Spring, Summer. 4(4-0) MTH 215 or concurrently.
Dynamics of rigid bodies in general motion, plane motion, rotation, statics, variational methods.

211. Mechanics of Deformable Solids
Fall, Winter, Spring, Summer. 4(4-0) or Statics; MTH 215.
Deformable solids, stress and strain, principal axes, material behavior (elastic, plastic, viscoelastic, temperature dependent). Boundary value problems, torsion, beams. Stability, columns.

215. Materials Testing Laboratory
Fall, Winter, Spring, Summer. 1(0-3)
Physical properties of engineering materials, resistance to primary types of static loading.

230. Introduction to Materials Science
Fall. 4(4-0) Sophomore.
A qualitative survey of metals, ceramics, and polymers, and the relationship of electronic, molecular, and crystal structure to the physical, mechanical, thermal, electrical and magnetic properties.

304. Dynamics
Fall. 4(5-0) Statics; MTH 215 or concurrently.
Dynamics of particles and rigid bodies for those students who have had Statics.

320. Analytical Mechanics I
Fall. 3(3-0) MTH 215, PHY 259.
Measures of point motion, individal notation, vector space and time transformations. Newton's, Lagrange's and Hamilton's equations. Motions of point objects; limiting wave forms.

321. Analytical Mechanics II
Winter. 3(3-0) 320.
Schrödinger's equation. Particle motions in various potentials; hydrogen-like atoms and molecules. Continuum models of particle systems; tensor properties, rigid and elastic solids, transfer of heat and electricity, flow relations.

322. Analytical Mechanics III
Spring. 3(3-0) 321.
Quantum and statistical models of particle systems; the Maxwell-Boltzmann, Einstein-Boose and Fermi-Dirac distributions; analysis of ideal atomic, electron and photon gases; properties of dense gases and liquids; thermal, elastic and electrical properties of crystals.

340. Materials Chemistry I
(4(0)) Fall. 4(4-0) CEM 152.
An integrated treatment of the physical chemistry of metals and other engineering materials is presented by 340, 341 and 342. Physicochemical systems; thermodynamics and thermochemistry; equilibrium; solutions and phase equilibria; electrochemistry, corrosion; reaction kinetics in condensed phases; diffusion; surface phenomena.

341. Materials Chemistry II
(4(4)) Winter. 4(4-0) 340 or approval of department.
Continuation of 340.

342. Materials Chemistry III
(4(4)) Spring. 4(4-0) 341.
Continuation of 340, 341.

350. Physical Metallurgy I
Fall. 4(4-0) CEM 153 or approval of department.
Relationship of properties to microstructure as affected by solidification transformations in heterogeneous systems; cold work, recrystallization, and grain growth. Emphasis on the important commercial metals and alloys.

351. Physical Metallurgy II
Winter. 4(4-0) 350.
Continuation of 350.

361. Physical Metallurgy III
Spring. 4(4-0) 350, 351.
Continuation of 350, 351.

370. Metals and Alloys I
Fall, Winter. 3(3-0) 370.
Principles of physical metallurgy applied to engineering metals and alloys.

371. Metals and Alloys II
Winter. 3(3-0) 370.
Continuation of 370.

372. Metals and Alloys III
Spring. 3(3-0) 371.
Continuation of 371.

380. Physical Metallurgy Laboratory I
Fall. 1(0-3) 360 or concurrently.
First of an integrated sequence of laboratory courses designed to illustrate the parallel theory courses. Introduction to metallography, pyrometry, and testing of metals.

381. Physical Metallurgy Laboratory II
Winter. 1(0-3) 380; 381 concurrently.
Continuation of 380.

382. Physical Metallurgy Laboratory III
Spring. 1(0-3) 381; 362 concurrently.
Continuation of 381.

400. Special Problems
Fall, Winter, Spring, Summer. 1 to 3 credits. May re-enroll for a maximum of 6 credits. Approval of department. Individualized reading and research.

404. Dynamics of Mechanical Systems
Fall. 3(3-0) 206.

411. Mechanics of Deformable Solids II
Spring. 3(3-0) 311.
Continuation of 211. Unsymmetrical bending.
413. **Applied Solid Mechanics**

*Winter.* 3(3-0) 211

Methods of solution of problems in elasticity, plasticity and viscoelasticity. One- and two-dimensional mathematical models will be considered.

414. **Principles and Techniques of Experimental Solid Mechanics**

*Spring.* 3(3-0) 211

Fundamental concepts and current technology for static and dynamic measurement of strain and acceleration. Main topics discussed are resistance strain gauges, accelerometers, bottle coils, Moire patterns, and holography.

430. **X-Ray Crystallography**

*Fall.* 4(3-2) 342 or approval of department.

Symmetry, elementary crystallography, general properties of x-rays, introduction to radiation safety, interaction of x-rays with matter, application of x-ray diffraction to materials problems.

440. **Color Technology in Materials Science**

*Winter.* 3(3-0) Approval of department.

Color in art and technology, light and its interaction with colored materials; light sources and illuminants; color notation and classification; colored materials.

455. **Advanced Physical Metallurgy I**

*Winter.* 3(3-0) PHY 364 or approval of department.


456. **Advanced Physical Metallurgy II**

*Spring.* 3(3-0) 455


460. **Metallurgical Engineering I**

*Fall.* 4(3-2) 362 or approval of department.


461. **Metallurgical Engineering II**

*Winter.* 4(3-2) 460 or approval of department.


462. **Metallurgical Engineering III**

*(465).* *Spring.* 4(3-2) 461 or approval of department.


470. **The Cast Alloys**

*Winter.* 4(4-0) 362, or 372


475. **Alloy Development and Application**

*Fall.* 4(4-0) 361, 363, or approval of department.

Physical metallurgy, development, and applications of special steels and alloys: high-strength structural steels, maraging steels, ultra-high-strength steels, maraging steels, corrosion-resistant steels and alloys, high-temperature alloys.

480. **Metallurgy Laboratory IV**

*Fall.* 1(2-1) 392.

Continuation of 382.

500. **Special Problems**

*Fall, Winter, Spring.* 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.

501. **Advanced Engineering Mechanics I**

*Fall, Summer.* 3(3-0) 206 or 320.

Principles of classical dynamics; Lagrangian equations for electromechanical systems; Hamiltonian formulation; matrix treatment of vibrations.

502. **Advanced Engineering Mechanics II**

*Winter.* 3(3-0) 801.

Rigid-body mechanics; the gyroscope; canonical transformations; Hamilton-Jacobi theory; engineering applications of advanced mechanics.

503. **Advanced Engineering Mechanics III**

*(820).* *Spring.* 3(3-0) Approval of department.

Variational methods for point objects; wave motion. Schroedinger's equation and particle motions in potential wells. Continuum, quan­tum and statistical models of particle systems.

505. **Strain and Motion Measurement**

*Spring, Summer.* 4(3-2) Approval of department.

Resistance strain gages and accelerometers are examined in detail with particular regard to the analysis and design of the whole measuring system. Student project involving transducer design. Other motion measurement techniques.

506. **Optical Strain Measurement**

*(814).* *Winter of even-numbered years.* 4(3-3) Approval of department.

Whole-field techniques such as photelasticity, photoelastic coatings, Moiré techniques, and brittle coating. Interferometers and model analysis. Necessary theory of optics is presented.

510. **Introduction to the Mechanics of Continua**

*(865).* *Fall, Summer.* 4(4-0) 311; MTH 421 concurrently or approval of department.


513. **Theory of Elasticity I**

*Fall.* 4(4-0) 819; MTH 422 or approval of department.


514. **Advanced Strength of Materials I**

*Fall, Summer.* 3(3-0) 211.

Elasticity, energy methods, general bending of straight bars, curved beams, shear center, torsion.

515. **Advanced Strength of Materials II**

*Winter.* 3(3-0) 815; MTH 215.

Beam on elastic support, beam columns, axially symmetric stress distribution, symmetrical bending of circular plates, introduction to theory of elasticity.

517. **Plasticity**

*Spring.* 4(4-0) MTH 422 or approval of department.

Yield conditions, stress-strain relations, plastic potential, hardening theories, torsion, bending, thick-walled spherical and cylindrical shells under internal pressure, plane strain of perfectly plastic metal.

523. **Theory of Vibrations I**

*Fall.* 4(4-0) M M E 455. Interdepartmental with and administered by the Mechanical Engineering Department.

Discrete and continuous parameter systems with linear and non-linear characteristics. Variational principles; equations of motion. Matrices, quadratic forms; self-adjoint operators; eigenvalues. Transient and random excitations. Theory developed through physical problems.

531. **Advanced X-Ray Metallography**

*Winter.* 3(3-0) Approval of department.

Development of x-ray metallographic space groups, theory of the intensity of diffracted X-rays; Weissenberg method, crystal structure analysis.

532. **Electron Microscopy**

*Spring.* 4(3-3) 831 or approval of department.

Theory of image formation in electron microscopy and intensity of electron diffraction. Transmission and replicas microscopy.

535. **Orthopedic Biomechanics**

*Fall.* 3(3-0) Approval of department.

Basic theories of mechanics with application to orthopedics. Elastic and viscoelastic materials will be considered and experimental demonstrations of tissue response.

840. **Symmetry and the Properties of Crystals**

*Spring.* 3(3-0) Point-group theory and symmetry in tensor properties of crystals; systematic treatment of properties, e.g., electrical polarization, magnetic induction, pyro- and piezoelectricity, elasticity, transport properties and heredogeneity.

850. **Modern Ceramic Materials I**

*Fall, Winter.* 3(3-0) CEM 462; PHY 840; or approval of department.

Crystalline macrostructure and microstructure of ceramics and glasses; dependence of microstructure on amounts, size, shape, and distribution of phases; modification of microstructure by control of nucleation and growth; composite materials.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Term</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>861.</td>
<td>Modern Ceramic Materials II</td>
<td>Winter</td>
<td>3(3-0)</td>
</tr>
<tr>
<td>862.</td>
<td>Theoretical Metallurgy I</td>
<td>Fall</td>
<td>3(3-0)</td>
</tr>
<tr>
<td>863.</td>
<td>Modern Ceramic Materials III</td>
<td>Spring</td>
<td>3(3-0)</td>
</tr>
<tr>
<td>864.</td>
<td>Theoretical Metallurgy II</td>
<td>Winter</td>
<td>3(3-0)</td>
</tr>
<tr>
<td>865.</td>
<td>Theoretical Metallurgy III</td>
<td>Spring</td>
<td>3(3-0)</td>
</tr>
<tr>
<td>866.</td>
<td>Ferrous Physical Metallurgy</td>
<td>Fall</td>
<td>3(3-0)</td>
</tr>
<tr>
<td>867.</td>
<td>Nonferrous Physical Metallurgy</td>
<td>Winter</td>
<td>3(3-0)</td>
</tr>
<tr>
<td>868.</td>
<td>Physical Metallurgy of Alloy Steels</td>
<td>Spring</td>
<td>3(3-0)</td>
</tr>
<tr>
<td>869.</td>
<td>Ferrous Metallurgy</td>
<td>Fall</td>
<td>3(3-0)</td>
</tr>
<tr>
<td>870.</td>
<td>Nonferrous Process Metallurgy</td>
<td>Winter</td>
<td>3(3-0)</td>
</tr>
<tr>
<td>871.</td>
<td>Metals and Alloys I</td>
<td>Winter</td>
<td>3(3-0)</td>
</tr>
<tr>
<td>872.</td>
<td>Metals and Alloys II</td>
<td>Winter</td>
<td>3(3-0)</td>
</tr>
<tr>
<td>873.</td>
<td>Theoretical Metallurgy III</td>
<td>Spring</td>
<td>3(3-0)</td>
</tr>
<tr>
<td>874.</td>
<td>Seminar</td>
<td>Fall</td>
<td>1 credit</td>
</tr>
</tbody>
</table>

A-104