DESCRIPTION OF UNDERGRADUATE STUDIES

All programs are designed to fulfill the expectations of the *Profile of the Colorado School of Mines Graduate* in accordance with the mission and goals of the School. To enable this, the curriculum is made up of a common core, twelve undergraduate degree granting programs, and a variety of support and special programs. Each degree granting program has an additional set of goals which focus on the technical and professional expectations of that program. The common core and the degree granting programs are coupled through course sequences in mathematics and the basic sciences, in specialty topics in science and/or engineering, in humanities and the social sciences, and in design. Further linkage is achieved through a core course sequence which addresses system interactions among phenomena in the natural world, the engineered world, and the human world. Through the alignment of the curriculum to these institutional goals and to the additional degree-granting program goals, all engineering programs are positioned for accreditation by the Accreditation Board for Engineering and Technology, and science programs are positioned for approval by their relevant societies, in particular the American Chemical Society for the Chemistry program.

DESCRIPTIONS OF COMPUTER SCIENCE COURSEWORK

CALCULUS FOR SCIENTISTS AND ENGINEERS I First course in the calculus sequence, including elements of plane geometry. Functions, limits, continuity, derivatives and their application. Definite and indefinite integrals;.

CALCULUS FOR SCIENTISTS AND ENGINEERS II Vectors, applications and techniques of integration, infinite series, and an introduction to multivariate functions and surfaces.

CALCULUS FOR SCIENTISTS AND ENGINEERS III Multivariable calculus, including partial derivatives, multiple integration, and vector calculus.

DIFFERENTIAL EQUATIONS Classical techniques for first and higher order equations and systems of equations. Laplace transforms. Phase plane and stability analysis of non-linear equations and systems. *Applications to physics, mechanics, electrical engineering, and environmental sciences.*

PROGRAMMING CONCEPTS Computer programming in a contemporary language such as C++ or Java, using software engineering techniques. Problem solving, program design, documentation, debugging practices. Language skills: input/output, control, repetition, functions, files, classes and abstract data types, arrays, and pointers. Introduction to operating systems and object-oriented programming.

DATA STRUCTURES Defining and using data structures such as linked lists, stacks, queues, binary trees, binary heap, hash tables. Introduction to algorithm analysis, with emphasis on sorting and search routines. Language skills: abstract data types, templates and inheritance.

SOFTWARE ENGINEERING Introduction to the software life cycle, including planning, design, implementation and testing. Topics include top down program design, problem decomposition, iterative refinement, program modularity and abstract data types. Course work emphasizes good programming practices via models, metrics and documents created and used throughout the software engineering.

PROBABILITY AND STATISTICS FOR ENGINEERS Elementary probability, propagation of error, discrete and continuous probability models, interval estimation, hypothesis testing, and linear regression with emphasis on applications to science and engineering. algebra, with emphasis on sets of simultaneous equations.

LINEAR ALGEBRA Systems of linear equations, matrices, determinants and eigenvalues. Linear operators. Abstract vector spaces. Applications selected from linear programming, physics, graph theory, and other fields. analysis of algorithms; sets and combinatorics; relations, functions, and matrices; Boolean algebra and computer logic; trees, graphs, finite-state machines and regular languages.

COMPUTER ORGANIZATION Covers the basic concepts of computer architecture and organization. Topics include machine level instructions and operating system calls used to write programs in assembly language. This course provides insight into the way computers operate at the machine level.

DISCRETE MATHEMATICS This course is an introductory course in discrete mathematics and algebraic structures. Topics include: formal logic; proofs, recursion, analysis of algorithms; sets and combinatorics; relations, functions, and matrices; Boolean algebra and computer logic; trees, graphs, finite-state machines and regular languages.

FIELD COURSE This is the Computer Science option's capstone course where the students apply their course work knowledge to a challenging applied problem in mathematics or computer science. In this course they analyze, modify and solve a significant applied problem. The students work in groups of three or four for a period of six forty-hour weeks. By the end of the field session they must have a finished product with appropriate supporting documents.

ARTIFICIAL INTELLIGENCE General investigation of the Artificial Intelligence field. During the first part of the course a working knowledge of the LISP programming language is developed. Several methods used in artificial intelligence such as search strategies, knowledge representation, logic and probabilistic reasoning are developed and applied to problems. Learning is discussed and selected applications presented. Focusing on the construction of models and evaluation of their fit. Techniques covered will include stepwise and best subsets regression, variable transformations, and residual analysis. Emphasis will be placed on the analysis of data with statistical software.

ALGORITHMS Divide-and-conquer: splitting problems into subproblems of a finite number. Greedy: considering each problem piece one at a time for optimality. Dynamic programming: considering a sequence of decisions in problem solution. Searches and traversals: determination of the vertex in the given data set that satisfies a given property. Techniques of backtracking, branch-andbound techniques, techniques in lower bound theory. methods will be applied to population dynamics, epidemic spread, pharmcokinetics and modeling of physiologic systems. Modern Control Theory will be introduced and used to model living systems. Some concepts related to self-organizing systems will be introduced.

PRINCIPLES OF PROGRAMMING LANGUAGES Study of the principles relating to design, evaluation and implementation of programming languages of historical and technical interest, considered as individual entities and with respect to their relationships to other languages. Topics discussed for each language include: history, design, structural organization, data structures, name structures, control structures, syntactic structures, and implementation of issues. ***The primary languages discussed are FORTRAN, PASCAL, LISP, ADA, C/C++, JAVA, PROLOG, PERL, Scheme, Bison-Flex***.

INTRODUCTION TO SCIENTIFIC COMPUTING Round-off error in floating point arithmetic, conditioning and stability, solution techniques (Gaussian elimination, LU factorization, iterative methods) of linear algebraic systems, curve and surface fitting by the method of least-squares, zeros of nonlinear equations and systems by iterative methods, polynomial interpolation and cubic splines, numerical integration by adaptive quadrature and multivariate quadrature, numerical methods for initial value problems in ordinary differential equations. Emphasis is on problem solving using efficient numerical methods in scientific computing.

USER INTERFACES User Interface Design is a course for programmers who want to learn how to create more effective software. This objective will be achieved by studying principles and patterns of interaction design, critiquing existing software using criteria presented in the textbook, and researching and analyzing the capabilities of various software development tools. Students will also learn a variety of techniques to guide the software design process, including Goal-Directed Design, Cognitive Walkthrough, Talk-aloud and others.

OPERATING SYSTEMS Covers the basic concepts and functionality of batch, timesharing and singleuser operating system components, file systems, processes, protection and scheduling. Representative operating systems are studied in detail. Actual operating system components are programmed on a representative processor. This course provides insight into the internal structure of operating systems; emphasis is on concepts and techniques which are valid for all computers.

DESCRIPTION OF ENGINEERING/SCIENCE COURSEWORK

PHYSICS I MECHANICS A first course in physics covering the basic principles of mechanics using vectors and calculus. The course consists of a fundamental treatment of the concepts and applications of kinematics and dynamics of particles and systems of particles, including Newton's laws, energy and momentum, rotation, oscillations, and waves.

PHYSICS II-ELECTROMAGNETISM AND OPTICS Introduction to the fundamental laws and concepts of electricity and magnetism, electromagnetic devices, electromagnetic behavior of materials, applications to simple circuits, electromagnetic radiation, and an introduction to optical phenomena.

PRINCIPLES OF CHEMISTRY I Study of matter and energy based on atomic structure, correlation of properties of elements with position in periodic chart, chemical bonding, geometry of molecules, phase changes, stoichiometry, solution chemistry, gas laws, and thermochemistry.

PRINCIPLES OF CHEMISTRY II Concentrating on chemical kinetics, thermodynamics, electrochemistry, organic nomenclature, and chemical equilibrium (acid- base, solubility, complexation, and redox).

STATICS Forces, moments, couples, equilibrium, centroids and second moments of areas, volumes and masses, hydrostatics, friction, virtual work. Applications of vector algebra to structures.

MECHANICS OF MATERIALS Fundamentals of stresses and strains, material properties. Axial, torsion, bending, transverse and combined loadings. Stress at a point; stress transformations and Mohr's circle for stress. Beams and beam deflections, thin-wall pressure vessels, columns and buckling, fatigue principles, impact loading.

INTRODUCTION TO ROBOTICS Overview and introduction to the science and engineering of intelligent mobile robotics and robotic manipulators. Covers guidance and force sensing, perception of the environment around a mobile vehicle, reasoning about the environment to identify obstacles and guidance path features and adaptively controlling and monitoring the vehicle health. A lesser emphasis is placed on robot manipulator kinematics, dynamics, and force and tactile sensing. Surveys manipulator and intelligent mobile robotics research and development. Introduces principles and concepts of guidance, position, and force sensing; vision data processing; basic path and trajectory

EPICS (Engineering Practices Introductory Course Sequence) EPICS is a two-semester sequence of courses for freshmen and sophomores, designed to prepare students for their upper-division courses and to develop some of the key skills of the professional engineer: the ability to solve complex, open-ended problems; the ability to self-educate; and the ability to communicate effectively. An award-winning program, EPICS replaces the traditional core courses in introductory computing skills, graphics, and technical communication. Whenever possible, instruction in these subjects is "hands-on" and experiential, with the instructor serving primarily as mentor rather than lecturer. Problem-solving skills are developed through "projects," open-ended problems, which the students solve in teams. Starting with simple case studies, the projects grow in length and complexity to a final, full-semester project submitted by an external client. The projects require extensive library research and self-education in appropriate technical areas; they also require students to consider non-technical constraints (economic, ethical, political, societal) in arriving at their solutions. Written and oral communications are studied and practiced as an integral part of the project work. Graphics and computing skills are integrated with projects wherever possible. Among the topics studied by students in EPICS are: use of the computer as a problem-solving tool, and the use of word processing, graphics, spreadsheet and CAD packages; 3-D visualization; audience analysis and the preparation of a variety of technical documents; oral communication in the staff format; interpersonal skills in group work; project management.

DESCRIPTION OF LIBERAL ARTS COURSEWORK

NATURE AND HUMAN VALUES (NHV) Nature and Human Values will focus on diverse views and critical questions concerning traditional and contemporary issues linking the quality of human life and Nature, and their interdependence. The course will examine various disciplinary and interdisciplinary approaches regarding two major questions: 1) How has Nature affected the quality of human life and the formulation of human values and ethics? (2) How have human actions, values, and ethics affected Nature? These issues will use cases and examples taken from across time and cultures. Themes will include but are not limited to population, natural resources, stewardship of the Earth, and the future of human society. This is a writing-intensive course that will provide instruction and practice in expository writing, using the disciplines and perspectives of the Humanities and Social Sciences.

HUMAN SYSTEMS Human Systems is an interdisciplinary historical examination of key systems created by humans—namely, political, economic, social, and cultural institutions—as they have evolved worldwide from the inception of the modern era (ca. 1500) to the present. This course embodies an elaboration of these human systems as introduced in their environmental context in Nature and Human Values and will reference themes and issues explored therein. It also demonstrates the cross-disciplinary applicability of the 'systems' concept. Assignments will give students continued practice in writing.

INTERNATIONAL POLITICAL ECONOMY OF ASIA A broad survey of the interrelationship between the state and economy in East and Southeast Asia as seen through an examination of critical contemporary and historical issues that shape polity, economy, and society. Special emphasis will be given to the dynamics of interstate relationships between the developed North and the developing South.

JAPANESE V An independent study of the continuation of the Japanese Language from high school. Main focus was Japanese History written in Japanese.