

Understanding Hydraulics Les Hamill

A guide to analyzing and predicting traffic. It also covers the various problems encountered when designing traffic signal controls and highways to accommodate the varying volume.

This document presents for guidelines for assessing the credibility of modeling and simulation in computational fluid dynamics. The two main principles that are necessary for assessing credibility are verification and validation. Verification is the process of determining if a computational simulation accurately represents the conceptual model, but no claim is made of the relationship of the simulation to the real world. Validation is the process of determining if a computational simulation represents the real world. This document defines a number of key terms, discusses fundamental concepts, and specifies general procedures for conducting verification and validation of computational fluid dynamics simulations. The document's goal is to provide a foundation for the major issues and concepts in verification and validation. However, this document does not recommend standards in these areas because a number of important issues are not yet resolved. It is hoped that the guidelines will aid in the research, development, and use of computational fluid dynamics simulations by establishing common terminology and methodology for verification and validation. The terminology and methodology should also be useful in other engineering and science disciplines.

This unique and encyclopedic reference work describes the evolution of the physics of modern shock wave and detonation from the earlier and classical percussion. The history of this complex process is first reviewed in a general survey. Subsequently, the subject is treated in more detail and the book is richly illustrated in the form of a picture gallery. This book is ideal for everyone professionally interested in shock wave phenomena.

This third edition of the late R.J. Salter's successful book has been revised and updated by N.B. Hounsell. Part I covers transportation planning, incorporating new methodological approaches and models. Part II covers highway traffic analysis and design, including updated sections on link and junction design, together with new computer aided design packages. Part III concentrates in traffic signals, with new chapters on microprocessor-based signal control and modern urban traffic control systems. This new edition consolidates the book's position as a practical text of traffic theory and practice, including many worked examples, for undergraduate and postgraduate students of transport and traffic engineering.

Hydraulics of Wells

Experimental and Computational Solutions of Hydraulic Problems

Chute Spillways

History of Shock Waves, Explosions and Impact

Highway Traffic Analysis and Design

Complexities of Climate and Governance

Applications in Hydrogeology for Geoscientists presents the most recent scientific developments in the field that are accessible yet rigorous enough for industry professionals and academic researchers alike. A multi-contributed reference that features the knowledge and experience of the field's experts, the book's chapters span the full scope of hydrogeology, introducing new approaches and progress in conceptualization, simulation of groundwater flow and transport, and progressive hydro-geophysical methods. Each chapter includes examples of recent developments in hydrogeology, groundwater, and hydrology that are underscored with perspectives regarding the challenges that are facing industry professionals, researchers, and academia. Several sub-themes—including theoretical advances in conceptualization and modeling of hydro-geologic challenges—connect the chapters and weave the topics together holistically. Advances in research are aided by insights arising from observations from both field and laboratory work. Introduces new approaches and progress in hydrogeology, including conceptualization, simulated groundwater flow and transport, and cutting edge hydro-geophysical methods Features more than 100 figures, diagrams, and illustrations to highlight major themes and aid in the retention of key concepts Presents a holistic approach to advances in hydrogeology, from the most recent developments in reservoirs and hydraulics to analytic modeling of transient multi-layer flow and aquifer flow theory Integrates real life data, examples and processes, making the content practical and immediately implementable

The purpose of this text is to provide a straightforward introduction to the principles and methods of design for concrete structures. The theory and practice described are of fundamental nature and will be of use internationally.

Teaching the fundamental principles of structures via simple explanations of the theory and numerous worked examples, this text assumes little or no prior experience in the subject matter.

Bryophyte Biology provides an extensive overview of the hornworts, liverworts, and mosses; diverse groups of land plants that occupy a great variety of habitats throughout the world. This edition covers essential aspects of bryophyte biology, from morphology, physiological ecology and conservation, to speciation, and genomics. Revised classifications incorporate contributions from recent phylogenetic studies. Six new chapters complement fully updated chapters from the original book to provide a completely up-to-date resource. New chapters focus on the contributions of Physcomitrella to plant genomic research, population ecology of bryophytes, mechanisms of drought tolerance, a phylogenomic perspective on land plant evolution, and problems and progress of bryophyte speciation and conservation. Written by leaders in the field, this book offers an authoritative treatment of bryophyte biology, with rich citation of the current literature, suitable for advanced students and researchers.

Hydraulic Structures

The Rock Manual

Theory and Methods

Management and Ecology of Freshwater Plants

Bryophyte Biology

Physical Models and Laboratory Techniques in Coastal Engineering

Prepared by the Task Committee on Hydraulics of Wells of the Groundwater Hydrology Technical Committee of the Groundwater Council and Watershed Council of the Environmental and Water Resources Institute of ASCE. Hydraulics of Wells: Design Construction Testing and Maintenance of Water Well Systems provides comprehensive treatment of the engineering issues related to the development and management of economical supplies of groundwater. Groundwater is a vital resource in nearly all parts of the world. Because groundwater is typically of high quality and dependability this vital resource is used to supply drinking water in nearly all parts of the globe. Demand for groundwater is expected to increase as population expands and technology advances. Yet groundwater is not free from costs and limitations including the construction and maintenance of wells and pumping equipment as well as storage and transmission infrastructure. Threats to well capacity and water quality rise from a variety of factors such as pollution overuse and drought. This Manual of Practice codifies existing practices in the water well industry in order to improve the identification development and management of groundwater resources in the future. Topics include: fundamentals of hydrogeology; efficiency of water well systems; design of water wells; construction development and testing; corrosion; incrustation; wellhead protection; and maintenance. Appendixes include a detailed example of a system design for a water well and sample technical specifications for drilling constructing and testing of water wells. MOP 127 guides engineers and designers through the process of planning designing installing maintaining and troubleshooting water-well systems. Managers administrators and water-well operators at all levels of government as well as in the private sector will find it an indispensable reference to water wells assets.

Laboratory physical models are a valuable tool for coastal engineers. Physical models help us to understand the complex hydrodynamic processes occurring in the nearshore zone and they provide reliable and economic engineering design solutions. This book is about the art and science of physical modeling as applied in coastal engineering. The aim of the book is to consolidate and synthesize into a single text much of the knowledge about physical modeling that has been developed worldwide. This book was written to serve as a graduate-level text for a course in physical modeling or as a reference text for engineers and researchers engaged in physical modeling and laboratory experimentation. The first three chapters serve as an introduction to similitude and physical models, covering topics such as advantages and disadvantages of physical models, systems of units, dimensional analysis, types of similitude and various hydraulic similitude criteria applicable to coastal engineering models. Practical application of similitude principles to coastal engineering studies is covered in Chapter 4 (Hydrodynamic Models), Chapter 5 (Coastal Structure Models) and Chapter 6 (Sediment Transport Models). These chapters develop the appropriate similitude criteria, discuss inherent laboratory and scale effects and overview the technical literature pertaining to these types of models. The final two chapters focus on the related subjects of laboratory wave generation (Chapter 7) and measurement and analysis techniques (Chapter 8).

The Hydraulics of Open Channel Flow is a major new textbook for senior undergraduates and postgraduate students. Dr Chanson first introduces the basic principles of open channel flow hydraulics, namely the continuity, Bernoulli and momentum principles. Applications include short transitions (e.g. intake), hydraulic jumps and flow resistance. The key topics of sediment transport, hydraulic modelling and the design of hydraulic structures are then developed in turn. This innovative textbook contains numerous examples, including practical applications, and is fully illustrated with line drawings and photographs in colour and black and white. Exercises - located at the end of each chapter and as revision sections at the end of each part - form an integral part of the text. The book concludes with major assignments, which assimilate all the knowledge into a fully coherent whole. Solutions to exercises, together with the shareware software Hydroculv, are available from the Web at: Key Features: Ideal for Use by Students and Lecturers in Civil and Environmental Engineering Numerous Exercises and Examples, Including a Supporting Website, to Aid the Reader's Understanding Comprehensive Coverage of the Basic Principles and the Key Application Areas of the Hydraulics of Open Channel Flow the Reader is Taken Step by Step from the Basic Principles to the More Advanced Design Calculations

Environmental issues, vast and varied in their details, unfold at the confluence of people and place. They present complexities in their biophysical details, their scope and scale, and the dynamic character of human action and natural systems. Addressing environmental issues often invokes tensions among battling interests and competing priorities. Air and water pollution, the effects of climate change, ecosystem transformations—these and other environmental issues involve scientific, social, economic, and institutional challenges. This book analyzes why tackling many of these problems is so difficult and why sustainability involves more than adoption of greener, cleaner technologies. Sustainability, as discussed in this book, involves knowledge flows and collaborative decision processes that integrate scientific and technological methods and tools, political and governance structures

and regimes, and social and community values. The authors synthesize a holistic and adaptive approach to rethinking the framework for restoring healthy ecosystems that are the foundation for thriving communities and dynamic economies. This approach is that of collective action. Through their research and practical experiences, the authors have learned that much wisdom resides among diverse people in diverse communities. New collaborative decision-making institutions must reflect that diversity and tap into its wisdom while also strengthening linkages among scientists and decision makers. From the pre-publication reviews: "Finally, we have a book that explains how science is irrelevant without people. It's people who decide when and how to use science, not scientists. This book gives us a roadmap for how to really solve complex problems. It involves hard work, and creating new relationships between scientists and the public that don't typically exist in our society." -John M. Hagan, Ph.D. President, Manomet Center for Conservation Sciences

Water Wells and Boreholes

Water Harvesting for Groundwater Management

Restructuring and Geographic Change in the Auto Industry

Plant Electrophysiology

Proceedings of the 9th International Symposium on Aquatic Weeds, European Weed Research Society

Manual on Scour at Bridges and Other Hydraulic Structures

Hydraulics has a reputation for being a complex, even intimidating, discipline. Put simply, hydraulics is the study of how water and similar fluids behave and can be harnessed for practical use. It is one of the fundamental scientific and engineering subjects and many professions demand a working knowledge of its basic concepts, yet most hydraulics textbooks are aimed at readers with a strong engineering or mathematical background. Practical Hydraulics approaches the subject from basic principles and demonstrates how these are applied in practice. It is clearly written and includes many illustrations and examples. It will appeal to a wide range of professionals and students needing an introduction to the subject, from farmers irrigating crops to fire crews putting out fires with high-pressure water hoses. However hydraulics is not just about water. Many other fluids behave in the same way and so affect a wide range of people from doctors, needing to know how blood flows in veins, to car designers, wanting to save fuel by reducing drag.

The second edition (1997) of this text was a completely rewritten version of the original text Basic Coastal Engineering published in 1978. This third edition makes several corrections, improvements and additions to the second edition. Basic Coastal Engineering is an introductory text on wave mechanics and coastal processes along with fundamentals that underline the practice of coastal engineering. This book was written for a senior or first postgraduate course in coastal engineering. It is also suitable for self study by anyone having a basic engineering or physical science background. The level of coverage does not require a math or fluid mechanics background beyond that presented in a typical undergraduate civil or mechanical engineering curriculum. The material presented in this text is based on the author's lecture notes from a one-semester course at Virginia Polytechnic Institute, Texas A&M University, and George Washington University, and a senior elective course at Lehigh University. The text contains examples to demonstrate the various analysis techniques that are presented and each chapter (except the first and last) has a collection of problems for the reader to solve that further demonstrate and expand upon the text material. Chapter 1 briefly describes the coastal environment and introduces the relatively new field of coastal engineering. Chapter 2 describes the two-dimensional characteristics of surface waves and presents the small-amplitude wave theory to support this description.

Maintaining the microbial quality in distribution systems and connected installations remains a challenge for the water supply companies all over the world, despite many years of research. This book identifies the main concerns and knowledge gaps related to regrowth and stimulates cooperation in future research. Microbial Growth in Drinking Water Supplies provides an overview of the regrowth issue in different countries and the water quality problems related to regrowth. The book assesses the causes of regrowth in drinking water and the prevention of regrowth by water treatment and distribution.

This established textbook provides an understanding of materials' behaviour through knowledge of their chemical and physical structure. It covers the main classes of construction materials: metals, concrete, other ceramics (including bricks and masonry), polymers, fibre composites, bituminous materials, timber, and glass. It provides a clear and comprehensive perspective on the whole range of materials used in modern construction, to form a must-have for civil and structural engineering students, and those on courses such as architecture, surveying and construction. It begins with a Fundamentals section followed by a section on each of the major groups of materials. In this new edition: - The section on fibre composites FRP and FRC has been completely restructured and updated. - Typical questions with answers to any numerical examples are given at the end of each section, as well as an instructor's manual with further questions and answers. - The links in all parts have also been updated and extended, including links to free reports from The Concrete Centre, as well as other online resources and material suppliers' websites.

Their Nature and Behaviour, Fifth Edition

Converging and Diverging Tendencies

Applied Hydrometeorology

Supplementary Guide

An Introduction to Structural Mechanics

Outlines the concept and principles of water harvesting for groundwater management for an international audience, and looks at the positives and negatives surrounding water harvesting technologies This book is the first to fully outline the concept and principles of water harvesting for groundwater management for a global audience. It offers guidance to academics, students and researchers on effective water harvesting approaches for groundwater recharge, and educates them on the risks associated with managed aquifer recharge, as well as the causes of success or failure of particular management strategies, and demand management strategies and tools. The book is helpful to water managers, administrators, and professionals, to make decisions to allocate resources; developing innovative cost-effective measures and approaches to achieve demand-supply balance. The book provides readers with an overview of the historical evolution of water harvesting for groundwater recharge. It looks at the benefits and gaps in knowledge, their implementation and funding strategies, and public participation. It also assesses the strengths, weaknesses, opportunities, and threats (SWOT) of water harvesting technologies. **Water Harvesting for Groundwater Management: Issues, Perspectives, Scope and Challenges** offers chapters covering: issues on water harvesting and water security; mega-trends that impact water security; groundwater occurrence, availability, and recharge-ability;

phases of water harvesting systems; SWOT analysis of water harvesting systems; case studies and short examples of implementing water harvesting; scope of water harvesting for GWM strategies; guidelines to make water harvesting helpful and meaningful for GWM; and more. Summarizes the theories and applications of water harvesting for groundwater management for a world audience Offers guidance on effective water harvesting approaches for groundwater recharge, managed aquifer recharge, and successful water management strategies Evaluates the strengths, weaknesses, opportunities and threats (SWOT) of water harvesting technologies Part of the Challenges in Water Management series Water Harvesting for Groundwater Management: Issues, Perspectives, Scope and Challenges is an excellent resource for water management professionals working with water harvesting technologies, and will be of great interest to water managers, administrators, professionals, academics and researchers working in water management.

"Threshold Concepts in Practice brings together fifty researchers from sixteen countries and a wide variety of disciplines to analyse their teaching practice, and the learning experiences of their students, through the lens of the Threshold Concepts Framework. In any discipline, there are certain concepts – the 'jewels in the curriculum' – whose acquisition is akin to passing through a portal. Learners enter new conceptual (and often affective) territory. Previously inaccessible ways of thinking or practising come into view, without which they cannot progress, and which offer a transformed internal view of subject landscape, or even world view. These conceptual gateways are integrative, exposing the previously hidden interrelatedness of ideas, and are irreversible. However they frequently present troublesome knowledge and are often points at which students become stuck. Difficulty in understanding may leave the learner in a 'liminal' state of transition, a 'betwixt and between' space of knowing and not knowing, where understanding can approximate to a form of mimicry. Learners navigating such spaces report a sense of uncertainty, ambiguity, paradox, anxiety, even chaos. The liminal space may equally be one of awe and wonderment. Thresholds research identifies these spaces as key transformational points, crucial to the learner's development but where they can oscillate and remain for considerable periods. These spaces require not only conceptual but ontological and discursive shifts. This volume, the fourth in a tetralogy on Threshold Concepts, discusses student experiences, and the curriculum interventions of their teachers, in a range of disciplines and professional practices including medicine, law, engineering, architecture and military education. Cover image: Detail from 'Eve offering the apple to Adam in the Garden of Eden and the serpent' c.1520–25. Lucas Cranach the Elder (1472–1553). Bridgeman Images. All rights reserved.

Covering all the fundamental topics in hydraulics and hydrology, this textbook is an accessible, thorough and trusted introduction to the subject. The text builds confidence by encouraging readers to work through examples, try simple experiments and continually test their own understanding as the book progresses. This hands-on approach aims to show students just how interesting hydraulics and hydrology is, as well as providing an invaluable reference resource for practising engineers. There are numerous worked examples, self-test and revision questions to help students solve problems and avoid mistakes, and a question and answer feature to keep students thinking and engaging with the text. The text is essential reading for undergraduates from pre-degree through all undergraduate level courses and for practising engineers around the world. New to this Edition: - Updates on climate change, flood risk management, flood alleviation, design considerations when developing greenfield sites, and the design of storm water sewers - A new chapter on sustainable storm water management (referred to as sustainable drainage systems (SUDS) in the UK) including their advantages and disadvantages, the design of components such as permeable and porous pavements, swales, soakaways and detention ponds and flood routing through storage reservoirs.

This is an introductory guide to the basic principles of hydraulics with an explanation of the essential theory which should be ideal for student-centred learning. It should appeal to any student embarking on a course in fluid mechanics having no previous knowledge of the subject.

Threshold Concepts in Practice

A Chronological and Biographical Reference

Fashionable Nonsense

Reinforced Concrete Design

Microbial Growth in Drinking Water Supplies

To Eurocode 2

This publication is a summary of good practice on the use of rock in engineering works for rivers, coasts and seas. It has incorporated all the significant advances in knowledge that have occurred over the past 10-15 years.

This book offers a comprehensive look at an industry that plays a growing role in motor vehicle production in the United States.

Water is vital for life. Since the dawn of civilization, much effort has been made to harness sources of fresh water. Recent years have raised global awareness of the need for increasing demand of water worldwide, largely because of growing population, rising standard of living, higher demand for energy, and greater appreciation for environmental quality. As an example, the world population has increased threefold in the past five decades. In order to meet the rising water demand, water resources are being developed by building large dams, reservoirs, barrages and weirs across rivers worldwide. The guiding principle for water resources development has been to ensure adequate supply of water for agriculture, domestic use (including fine drinking water), waste disposal, industries, and energy production, with due attention to maintain the ecosystem functions. This development, however, depends on a holistic, cooperative and scientific approach. The basic inputs in the assessment of water resources for a given region are from hydrological data and the subject of hydrology forms the core in achieving sustainable development of water resources. Barring a few exceptions, hydrological data for most river basins are sparse and therefore it is difficult to comprehensively assess their water resources. The major source of water is rainfall which occurs as a result of condensation of atmospheric moisture governed by the science of meteorology.

This book compiles new findings in plant electrophysiology from the work of internationally renowned experts in the fields of electrophysiology, bio-electrochemistry, biophysics, signal transduction, phloem transport, tropisms, ion channels, plant electrochemistry, and membrane transport. Opening with a historical introduction, the book reviews methods in plant electrophysiology, introducing such topics as measuring membrane potentials and ion fluxes, patch-clamp technique, and electrochemical sensors. The coverage includes experimental results and their theoretical interpretation.

Principles and Practice

Environmental Hydraulic Design and Control of Multiport Diffusers

32nd International School of Hydraulics

Practical Hydraulics

Practical and Applied Hydrogeology

Construction Materials

In 1996 physicist Alan Sokal published an essay in *Social Text*--an influential academic journal of cultural studies--touting the deep similarities between quantum gravitational theory and postmodern philosophy. Soon thereafter, the essay was revealed as a brilliant parody, a catalog of nonsense written in the cutting-edge but impenetrable lingo of postmodern theorists. The event sparked a furious debate in academic circles and made the headlines of newspapers in the U.S. and abroad. Now in *Fashionable Nonsense: Postmodern Intellectuals' Abuse of Science*, Sokal and his fellow physicist Jean Bricmont expand from where the hoax left off. In a delightfully witty and clear voice, the two thoughtfully and thoroughly dismantle the pseudo-scientific writings of some of the most fashionable French and American intellectuals. More generally, they challenge the widespread notion that scientific theories are mere "narrations" or social constructions.

Water Wells and Boreholes provides the necessary scientific background together with practical advice using global case studies, in an accessible easy to use style suitable for both postgraduates/researchers and practitioners. The book begins with an introduction to the type and uses of water wells from water supply and irrigation through to groundwater remediation. It then covers well siting detailing how to source data from geophysical surveys, remote sensing etc. Well design is then summarised to ensure the well is stable and cost-effective. The book ends with three chapters covering well construction, well testing and well performance, maintenance and rehabilitation.

There is a growing need for appropriate management of aquatic plants in rivers and canals, lakes and reservoirs, and drainage channels and urban waterways. This management must be based on a sound knowledge of the ecology of freshwater plants, their distribution and the different forms of control available including chemical, physical, biological and biomanipulation. This series of papers from over 20 different countries was generated from the highly successful European Weed Research Society symposia on aquatic plant management, this being the ninth. The contributions provide a valuable insight into the complexities involved in managing aquatic systems, discuss state-of-the-art control techniques such as biomanipulation using fish and waterfowl and the use of straw, and deal with patterns of regrowth and recovery post-management. Careful consideration is given to the use of chemicals, a practice which has come under scrutiny in recent years. Underpinning the development of such control techniques is a growing body of knowledge relating to the biology and ecology of water plants, including growth responses under different trophic conditions, the impact of pollution, and aspects of photosynthesis. The authorship of the papers represents the collective wisdom of leading scientists and experts from fisheries agencies, river authorities, nature conservation agencies, the agrochemical industry and both governmental and non-governmental organisations.

Treats the subject of local scour around different kinds of marine structures, exposed to waves and/or currents.

The Hydraulics of Open Channel Flow

A Guide to the Basic Principles of Hydraulics with an Explanation of the Essential Theory

Design, Construction, Testing, and Maintenance of Water Well Systems

Coupled 3D Hydrodynamic Models for Submarine Outfalls

Civil engineering materials

Issues, Perspectives, Scope, and Challenges

A textbook for HNC/HND students of civil engineering. Covers contract administration, control and programming, safety, ground water control, excavation, foundations, retaining walls and deep basements, superstructures and road pavements.

What is the progress in hydraulic research? What are the new methods used in modeling of transport of momentum, matter and heat in both open and conduit channels? What new experimental methods, instruments, measurement techniques, and data analysis routines are used in top class laboratory and field hydro-environment studies? How to link novel findings in fundamental hydraulics with the investigations of environmental issues? The consecutive 32nd International School of Hydraulics that took place in Łochów, Poland brought together eminent modelers, theoreticians and experimentalists as well as beginners in the field of hydraulics to consider these and other questions about the recent advances in hydraulic research all over the world. This volume reports key findings of the scientists that took part in the meeting. Both state of the art papers as well as detailed reports from various recent investigations are included in the book

Now includes Worked Examples for lecturers in a companion pdf! The fourth edition of this volume presents design principles and practical guidance for key hydraulic structures. Fully revised and updated, this new edition contains enhanced texts and sections on: environmental issues and the World Commission on Dams partially saturated soils, small amenity dams, tailing dams, upstream dam face protection and the rehabilitation of embankment dams RCC dams and the upgrading of masonry and concrete dams flow over stepped spillways and scour in plunge pools cavitation, aeration and vibration of gates risk analysis and contingency planning in dam safety small hydroelectric power development and tidal and wave power wave statistics, pipeline stability, wave-structure interaction and coastal modelling

computational models in hydraulic engineering. The book's key topics are explored in two parts - dam engineering and other hydraulic structures – and the text concludes with a chapter on models in hydraulic engineering. Worked numerical examples supplement the main text and extensive lists of references conclude each chapter. Hydraulic Structures provides advanced students with a solid foundation in the subject and is a useful reference source for researchers, designers and other professionals.

This book studies the techniques of construction technology and services, and the principles of environmental and materials science and their applications. It also studies the nature and the historical development of the built environment together with the roles of people working in the construction industry. This wide range of topics is of practical use to students and practitioners studying and working in building construction, civil engineering, surveying, planning and development. The style of writing is kept simple and supported by a clear explanations, a structured layout, practical examples and diagrams. Includes definitions, checklists and keyword summaries to help students preparing for tests, examinations and assignments.

Construction 2

Understanding Hydraulics

Environment Science Materials Technology

Nordic Management-Labour Relations and Internationalization

NASA's University Program

An Introduction

Sammanfattning.

Understanding Hydraulics Bloomsbury Publishing

Water-Resources Engineering provides comprehensive coverage of hydraulics, hydrology, and water-resources planning and management. Presented from first principles, the material is rigorous, relevant to the practice of water resources engineering, and reinforced by detailed presentations of design applications. Prior knowledge of fluid mechanics and calculus (up to differential equations) is assumed.

Basic Coastal Engineering

Restoring Lands – Coordinating Science, Politics and Action

The Mechanics of Scour in the Marine Environment

Civil Engineering Construction Design and Management

Problems, Causes, Control and Research Needs

The Use of Rock in Hydraulic Engineering