

1.1.2 Description of courses

CBE Years 1 to 4

CBE Year 1

CH1002 Engineering Physics

AUs: 4, Prerequisites: NIL, Semester 2

Electricity and magnetism. Geometrical and physical optics. Modern physics, covering photons, electrons and atoms, quantum mechanics and nuclear structure.

CH1004 Materials and Energy Balance

AUs: 3, Prerequisites: NIL, Semester 1

Unit conversion and process variables. Materials balance. Material balance for single and multi-component systems. Energy balances. Energy balance on reactive/transient processes. Computer-aided balance calculations.

CH1006 Mathematics for Engineers A

AUs: 3, Prerequisites: NIL, Semester 1

Partial differentiation. Sequences and series. First order differential equations. Second order differential equations. Laplace transforms. Linear algebra.

CH1020 Physical and Analytical Chemistry

AUs: 2, Prerequisites: NIL, Semester 1

Principles of equilibrium and non-equilibrium states. Equilibrium processes in chemistry and biology. Non-equilibrium processes and chemical kinetics.

CH1031 Biomolecular Engineering I

AUs: 4, Prerequisites: NIL, Semester 1

Molecular basis of living systems. Biophysics of proteins. Principles of metabolic engineering. Cellular systems and dynamics. Genetics basis of cellular systems.

CH1701 Chemical and Biomolecular Engineering Laboratory 1

AUs: 1, Prerequisites: NIL, Semester 1

Laboratory experiments related to biomolecular engineering, physical and analytical chemistry, etc.

CH1005 Materials Science

AUs: 3, Prerequisites: NIL, Semester 1

Bonding between atoms. Building blocks of materials. Crystal defects and diffusion. Structural properties of materials. Functional properties of materials. Phases and microstructures. Applications to chemical engineering industries.

CH1007 Mathematics for Engineers B

AUs: 3, Prerequisites: NIL, Semester 2

Engineering mathematics with emphasis on analytical methods: vector integral calculus. Fourier series, integrals and transforms. Partial differential equations.

CH1011 Introduction to Programming

AUs: 1, Prerequisites: Nil, Semester 2

Self-learning course. Arithmetic operations. Logical operators and functions. Graphics. Arrays and matrices. Input and output. Modular and structured programming.

CH2002 Organic Chemistry and Spectrophotometry

AUs: 4, Prerequisites: NIL, Semester 2

Introduction to organic chemistry. Stereochemistry. Alkyl halides and reactions. Alkenes, alkynes and their reactions. Alcohols and reactions. Spectroscopy: infrared, mass and nuclear magnetic resonance. Ethers, epoxides and sulfides. Conjugated systems and ultraviolet spectroscopy. Benzene and aromaticity. Aromatic compounds and reactions. Ketones, aldehydes and carbonyl compounds. Amines and phenols.

CH2008 Thermodynamics

AUs: 3, Prerequisites: NIL, Semester 2

First law and other basic concepts. Volumetric properties of pure fluids. Second law of thermodynamics. Thermodynamic properties of pure substances. Applications of thermodynamics in flow system. Vapor-liquid equilibrium. Solution thermodynamics. Thermodynamics of mixtures. Power cycles and refrigeration. Chemical reaction equilibria.

CH1702 Chemical and Biomolecular Engineering Laboratory 2

AUs: 1, Prerequisites: NIL, Semester 2

Laboratory experiments related to biomolecular engineering, physical and analytical chemistry, material and energy balances, etc. Lectures covering principles of measurement, instrument characteristics, measurement errors, data sampling and acquisition.

HW110 Effective Communication

AUs: 2, Prerequisites: NIL, Semester 2

Communication process. Written communication. Oral presentation skills. Interpersonal skills.

CBE Year 2

CH2003 Fluids Systems

AUs: 4, Prerequisites: NIL, Semester 1

Macroscopic and microscopic fluid mechanics with emphasis on applications in chemical engineering and polymer processes. Mass, energy, and momentum balances. Fluid friction in pipes. Flow in chemical engineering equipment. Differential equations of fluid mechanics. Solution of viscous-flow problems. Laplace's equation for irrotational and porous medium flows. Boundary-layer and other nearly unidirectional flows. Turbulent flow. Bubble motion, two-phase flow, and fluidisation. Non-Newtonian fluids.

CH2005 Biomolecular Engineering II

AUs: 3, Prerequisites: NIL, Semester 1

Biophysical basis of life. Metabolic pathway analysis: carbohydrate. Metabolism and catabolism. Biochemical signal transduction. Biochemical signal transduction on extracellular matrix. Biochemical system engineering.

CH2007 Computational Methods in Chemical Engineering

AUs: 3, Prerequisites: NIL, Semester 1

Use of numerical methods to solve problems in science and engineering, with emphasis on chemical engineering and biological systems. Linear and non-linear algebraic equations. Optimisation. Least-squares regression and interpolation. Numerical differentiation and integration. Numerical solutions of ordinary differential equations and partial differential equations.

CH3003 Chemical Thermodynamics

AUs: 3, Prerequisites: NIL, Semester 1

Review of basic thermodynamics concepts. Mixture of gases. The ideal solution. The Gibbs, Helmholtz, Planck and Massieu functions. Partial and excess molar quantities. Thermodynamics of physical processes. Thermodynamics of chemical processes.

CH2701 Chemical and Biomolecular Engineering Laboratory 3

AUs: 2, Prerequisites: NIL, Semester 1

This laboratory course aims to provide appreciation and understanding of theories relating to principles in chemical and biomolecular engineering. Specifically, it provides practical demonstrations and applications in heat and mass transfer, unit operations, biomolecular engineering, etc.

HW210 Technical Communication

AUs: 2, Prerequisites: NIL, Semester 1

This course teaches the writing and presentation of effective technical reports. The focus is on writing academic reports which are requirements for your engineering course at NTU.

CH2004 Heat and Mass Transfer

AUs: 4, Prerequisites: NIL, Semester 2

Theories and applications of heat and mass transport phenomena, emphasising their analogies and contrasts. Fourier's law. Steady and unsteady thermal conduction. Heat transfer coefficients. Heat

exchangers. Condensation and boiling. Radiation, Kirchoff's law and view factors. Fick's law. Steady and unsteady diffusion. Mass transfer coefficients. Absorbers. Simultaneous heat and mass transfer.

CH3002 Chemical Reaction Engineering

AUs: 4, Prerequisites: NIL, Semester 2

Reaction rates and batch reactor. Continuous isothermal reactors - single reaction. Continuous isothermal reactors multiple reactions. Non-isothermal reactors. Multiple steady states and transients. Mass transfer and catalytic reactor. Examples in chemical and biological processing. Non-ideal reactors, bioreactors, environmental modelling. Reactions of solids, chain reactions, combustion reaction and safety. Polymerisation reactions and reactors. Multiphase reactors.

CH2040 Chemical Engineering Unit Operations I

AUs: 4, Prerequisites: NIL, Semester 2

General principles and fundamental theories of separation by equilibrium and rate processes. Applications to evaporation, distillation, absorption, adsorption, extraction, leaching, etc.

CH2702 Chemical and Biomolecular Engineering Laboratory 4

AUs: 2, Prerequisites: NIL, Semester 2

This laboratory course aims to provide appreciation and understanding of theories relating to principles in chemical and biomolecular engineering. Specifically, it provides practical demonstrations and applications in heat and mass transfer; unit operations; biomolecular engineering, etc.

CBE Year 3

CH1032 Biochemical Engineering

AUs: 4, Prerequisites: NIL, Semesters 1 and 2

This course is designed for students with an engineering background to learn the biological fundamentals of biotechnology. The course emphasizes conceptual appreciation of the molecular interplays which are the basis of 'chemical processes' in living systems. The objective of the course is to provide students with a comprehensive and concise overview of biochemical science and molecular genetics with an emphasis on quantitative, especially stoichiometric and kinetic, perspectives.

CH3001 Chemical and Biomedical Process Control

AUs: 4, Prerequisites: NIL, Semesters 1 and 2

The practice of process control and its applications in the chemical processing industry. Incentives for chemical process control. Feedback and feedforward control configurations. Design of controllers. Mathematical modelling of dynamic processes. Linearisation of nonlinear systems. Laplace transforms. Solution of linear ordinary differential equations using Laplace transforms. Response of open-loop systems. First-order systems, second-order systems, higher-order systems, time delays, inverse response systems, transfer functions. Components of a control loop. Closed-loop transfer functions. Transient response of simple closed-loop control systems. Types of controllers. Stability of controller operation. Frequency response methods. Nyquist stability theorem. Feedback control. Feedforward control. Cascade Control. Multivariable control systems.

CH3010 Modelling Chemical and Biological Systems

AUs: 3, Prerequisites: NIL, Semesters 1 and 2

Introduction to process modelling. Process modelling principles. Conservation laws and constitutive relations. Dynamic lumped parameter systems. Approximation of dynamic models: linearisation. Laplace transforms. Development of empirical models. Software issues.

CH3702 Chemical and Biomolecular Engineering Laboratory 5

AUs: 4-3, Prerequisites: Nil, Semesters 1 and 2

This laboratory course aims to provide appreciation and understanding of theories relating to chemical processes. It also aims to provide practical demonstrations and applications to reinforce theories and concepts taught in Thermodynamics, Heat and Mass Transfer, Transport Processes, Chemical Reaction Engineering and Chemical Engineering Unit Operations.

CH3720 Industrial Attachment

AUs: 10, Prerequisites: NIL, Semesters 1 and 2

TBA

CH3041 Chemical Engineering Unit Operations II

AUs: 3, Prerequisites: NIL, Semesters 1 and 2

General principles of separation, particle technology and their applications. Crystallisation, membrane processes, filtration and particle and particle / collad technologies. Recovery of products from pharma - and bio - processes.

CBE Year 4

YEAR 4 CH4002 Design Project I

AUs: 4, Prerequisites: NIL, Semester 1

Students are introduced to the application of chemical and biomolecular engineering principles in chemical design. The projects will include feasibility study, chemical engineering calculations, simulation and modelling of chemical unit operations, process flow chart. Topics include: Introduction to chemical product design; Projects in chemical product design; Introduction to chemical process design; Molecular structure design; Process creation and synthesis; Development of base-case and flow diagrams; Introduction to simulation software; Heuristics for process synthesis; Reactor design; Synthesis of separation trains; Heat and power integration; Pinch analysis; Projects in process synthesis. The emphasis is in motivating students to learn, undertake and manage projects as a team to its successful completion and to write good technical reports.

CH4001 Chemical, Biological and Plant Safety

AUs: 3, Prerequisites: NIL, Semester 1

Toxicology, Toxicants release, control and response from biological organisms, industrial hygiene, risk assessment and investigation, case studies, etc.

CH4701 Final Year Project

AUs: 10, Prerequisities: Nil, Semesters 1 and 2

Independent research project

CH4003 Design Project II

AUs: 4, Prerequisites: NIL, Semester 2

This capstone course is concerned with how the fundamentals of chemical engineering (material balances, energy balances, transport phenomena, thermodynamics, kinetics, separations, unit operations, and safety) are utilized in the design and operation of chemical plants. It introduces concepts and methods of plant design and economic evaluation: planning, cost estimation, fixed capital investments, working capital, production costs, depreciation, rate of return, profitability analysis, discounted cash flow analysis. The course raises awareness of the students to the concepts of supply and demand of raw materials, commodity, and specialty chemicals. It introduces students to the available computational tools for process flow design and economic evaluation, and stresses the importance of professional ethics, honesty and integrity.

CH4902 Human Resource Management

Strategic human resource management. Human resource planning. Job analysis, job design and quality of work life. Recruiting human resource. Employee selection. Appraising and managing performance. Human resource development/career planning and development. Employee compensation and benefits. Industrial relations. Employee health and safety. International human resource management.

HW310 Professional Communication

AUs: 2, Prerequisities: Nil, Semester 1

Interpersonal communication in professional settings. Intercultural communication. Negotiating skills. Job search skills. Professional oral presentations. Working effectively in a team.

CH4901 Engineers and Society

AUs: 3, Prerequisites: NIL, Semester 1

The course comprises four main topics: Evolution of Modern Singapore; Technology & Society: Ethics and Professionalism and The Environment. Students are made aware of current issues at the time of their study.

BIE Years 1 to 4

BIE Year 1

BG1001 Engineering Physics

AUs: 4, Prerequisites: NIL, Semester 2

Electricity and magnetism. Geometrical and physical optics. Modern physics, covering photons, electrons and atoms, quantum mechanics and nuclear structure.

BG1003 Chemistry for Engineers

AUs: 4, Prerequisites: NIL, Semester 1

This course is an introduction to chemistry for students in bioengineering. Concepts of atoms, molecules and ions. Physical chemistry. Reaction kinetics. Chemical equilibrium. Ionic equilibrium. Electrochemistry. Inorganic Chemistry. Organic chemistry. Nomenclature and reactions. Polymers and polymerisation.

BG1006 Mathematics for Engineers A

AUs: 3, Prerequisites: NIL, Semester 1

First order differential equations. Second order differential equations. Sequences and series. Laplace transforms. Linear algebra. Matrix algebra. Partial differentiation.

BG1031 Biomolecular Engineering I

AUs: 4, Prerequisites: NIL, Semester 1

Molecular basis of living systems. Biophysics of proteins. Principles of metabolic engineering. Cellular systems and dynamics. Genetics basis of cellular systems.

BG1701 Bioengineering Lab 1A

AUs: 1, Prerequisites: NIL, Semester 1

This laboratory course aims to provide practical demonstrations and applications to reinforce theories and concepts taught in the first year of Bioengineering: Physics, Biomolecular Engineering I and Chemistry.

HW110 Effective Communication

AUs: 2, Prerequisites: NIL, Semester 1

Communication process. Written communication. Oral presentation skills. Interpersonal skills.

BG1002 Bioengineering Physics

AUs: 4, Prerequisites: NIL, Semester 1

Physical quantities and vectors. Motion of particles and rigid bodies. Work and energy. Elasticity. Fluids. Temperature, heat and ideal gases. Laws of thermodynamics.

BG1005 Materials Science

AUs: 3, Prerequisites: NIL, Semester 2

Bonding between atoms. Building blocks of materials. Crystal defects and diffusion. Structural properties of materials. Functional properties of materials. Phases and microstructures. Applications to chemical engineering and bioengineering industries.

BG1007 Mathematics for Engineers B

AUs: 3, Prerequisites: NIL, Semester 2

Engineering mathematics with emphasis on analytical methods: partial differentiation, multiple integrals, vector integral calculus. Fourier series, integrals and transforms. Partial differential equations.

BG1008 Organic Chemistry and Spectrophotometry

AUs: 4, Prerequisites: NIL, Semester 2

Introduction to organic chemistry. Stereochemistry. Alkyl halides and reactions. Alkenes, alkynes and their reactions. Alcohols and reactions. Spectroscopy: infrared, mass and nuclear magnetic resonance. Ethers, epoxides and sulfides. Conjugated systems and ultraviolet spectroscopy. Benzene and aromaticity. Aromatic compounds and reactions. Ketones, aldehydes and carbonyl compounds. Amines and phenols. Spectroscopy: Structure determination.

BG1009 Anatomy and Physiology

AUs: 4, Prerequisites: NIL, Semester 2

Bones and Joints. Muscular System. Respiratory, Gastrointestinal, and Urinary System. Cardiovascular System. Basic Neuroanatomy. Structure of the Nervous System and Sensory Organs. Function of the Nervous System and Sensory Organs.

BG1702 Bioengineering Lab 1B

AUs: 1, Prerequisites: NIL, Semester 2

This laboratory course aims to provide practical demonstrations and applications to reinforce theories and concepts taught in the first year of Bioengineering: Materials Science, Physics, Biomolecular Engineering I and Chemistry.

BIE Year 2

BG2012 Biofluid Systems

AUs: 4, Prerequisites: Nil, Semester 1

Introduction, fluids and their properties, pressure and head, motion of fluid particles and streams, the momentum equation, the energy equation, two-dimensional ideal flows, flow in bound systems, boundary layer, external flow and applications to biological systems.

BG2004 Electronics for Biomedical Engineers

AUs: 4, Prerequisites: NIL, Semester 1

Introduction to Electronics. Diodes. Bipolar Junction Transistors. Field Effect Transistor. Operational Amplifiers.

BG2005 Biomolecular Engineering II

AUs: 3, Prerequisites: NIL, Semester 1

Biophysical basis of life. Metabolic pathway analysis: carbohydrate. Metabolism and catabolism. Biochemical signal transduction. Biochemical signal transduction on extracellular matrix. Biochemical system engineering.

BG2041 Mechanics of Materials

AUs: 3, Prerequisites: NIL, Semester 1

Concept of stress. Stress and strain. Axial loading. Torsional loading. Bending. Transformation of stress and strain. Deflection of beams. Energy methods. Columns. Shells.

BG2042 Biological Thermodynamics

AUs: 3; Prerequisites: Nil, Semester 2

This is an introductory course to the study of energy transformation in biological systems, the laws of thermodynamics, free energy, statistical thermodynamics, binding equilibria and reaction kinetics.

BG2701 Bioengineering Lab 2A

AUs: 1, Prerequisites: NIL, Semester 1

This laboratory course aims to provide practical demonstrations and applications to reinforce theories and concepts taught in the second year of Bioengineering: Biomolecular Engineering II, Thermodynamics, Fluid Systems, Mechanics of Materials, Organic Chemistry, Electronics and Anatomy and Physiology.

HW210 Technical Communication

AUs: 2, Prerequisites: NIL, Semester 1

This course teaches the writing and presentation of effective technical reports. The focus is on writing academic reports which are requirements for your engineering course at NTU.

BG2009 Biomechanics

AUs: 4, Prerequisites: NIL, Semester 2

Body segment parameters, External forces and moments. Kinematics. Muscle and joint mechanics. Mechanics of anatomical Structures and tissues. Rheology. Cardiovascular mechanics. Bioheat and mass transfer. Artificial organs.

BG2011 Computational Methods in Biomedical Engineering

AUs: 4, Prerequisites: NIL, Semester 2

Use of numerical methods to solve problems in science and engineering, with emphasis on biomedical engineering. Linear and non-linear algebraic equations. Optimisation. Least-squares regression and interpolation. Numerical differentiation and integration. Numerical solutions of ordinary differential equations. Applications to statistical analysis. Applications to design of experiments.

BG2010 Bioelectricity

AUs: 4 Prerequisites: NIL, Semester 2

Introduction to bioelectricity. Basics of electrical circuit analysis. Cell membrane. Ion channels and gating kinetics. Patch clamp techniques, electronics and noises. Action Potential and Hodgkin-Huxley Model. Nerve impulse and neural electrophysiology. Physiological roles of ion channels in cardioelectrophysiology, neuromuscular junction, vision and hearing.

BG2031 Biomaterials

AUs: 3, Prerequisites: NIL, Semester 2

Biomaterials. Ceramics, Metals and Polymers. Important Medical Applications of each Class. Implants. Biocompatibility. In-vitro and In-vivo Testing. Degradation in Biological Environment.

BG2702 Bioengineering Lab 2B

AUs: 1, Prerequisites: NIL, Semester 2

This laboratory course aims to provide appreciation and understanding of theories relating to principles in the second year of Bioengineering: Biomaterials, Bioelectricity and Biomechanics.

BIE Year 3

BG3002 Control in Biosystems

AUs: 4, Prerequisites: NIL, Semester 1

Introduction to biomedical control systems. Biomedical control system models. Analysis of biomedical control systems. Time domain analysis of biomedical control systems. Frequency domain analysis of biomedical control systems. Stability analysis of biomedical control systems. Control of biomedical systems.

BG3003 Signal Processing in Biosystems

AUs: 4, Prerequisites: NIL, Semester 1

Nature of biomedical signals. Correlation. Impulse response. Frequency response. Continuous-time signal modelling. Discrete-time signal modelling. Noise removal and signal compensation. Stochastic signals modelling.

BG3004 Biomedical Imaging

AUs: 3, Prerequisites: NIL, Semester 1

Fundamentals of image and signal processing. Medical image processing techniques. X-Ray imaging. Magnetic resonance imaging. Ultrasounds and ultrasonic imaging. Nuclear Imaging. Medical Radiology.

BG3005 Biomedical Instrumentation

AUs: 3, Prerequisites: NIL, Semester 1

Basic concepts of medical instrumentation. Quantities of measurements. Basic sensors and principles. Amplifiers and signal processing. Data acquisition and conversion. Measuring instruments. Blood pressure measurement.

BG3006 Advanced Biocomputational Methods

AUs: 4, Prerequisites: NIL, Semester 1

Molecular mechanics. Molecular dynamics. Monte Carlo techniques. Application to molecules. Application to drug designs. Introduction to density function theory.

BG3701 Bioengineering Lab 3

AUs: 1, Prerequisites: NIL, Semester 1

This laboratory course aims to provide practical demonstrations and applications to reinforce theories and concepts taught in third year of Bioengineering: Control, Signal Processing, Biomedical Instrumentation and Biomedical Imaging.

BG3720 Industrial Attachment

AUs: 10, Prerequisites: Nil, Semester 2

To gain first hand knowledge of the day-to-day operation in the Bioengineering profession. To apply the acquired knowledge and skills in actual planning, design, production, construction and/or operation/maintenance practices. To become knowledgeable in field problems and requirements of the biomedical industry.

BIE Year 4

BG4215 Biomedical Nanotechnology

AUs: 3, Prerequisites: NIL, Semester 2

This course will explore the world of micro/nanotechnology for applications in biomedical engineering. Topics that will be covered are prospects of nanomedicine and its importance in medical diagnostics, pathways to molecular manufacturing, molecular transport, and nano-sensor for medical applications.

BG4230 Drug Delivery and Tissue Engineering

AUs: 3, Prerequisites: NIL, Semester 2

Drug delivery. Controlled Release Principles. Targeted Delivery. Gene Delivery. Tissue Engineering Principles. Substrates for Tissue Engineering.

BG 4214 Biomedical Optics

AUs: 3, Prerequisites: NIL, Semester 2

This course aims to provide a deep understanding of the fundamental principles underlying the core technology of Microelectromechanical Systems (MEMS) and biosensors for under graduate students, and build up their ability in MEMS/ biosensor design, fabrication and packaging.

BG4226 Nuclear and Radiation Medical Engineering

AUs: 3, Prerequisites: NIL, Semester 1

The purpose of this course is to discuss the nature of the radiation and its use in biomedical engineering. The student will be introduced to radiation and radioactive sources and how radiation interacts with matter, detector properties and operations of some detectors for radiation measurement, radiation hazards/protection, radiobiology and clinical applications, namely radiation therapy, X-ray imaging and nuclear medicine imaging. This course does not cover clinical practices. It is intended to prepare bioengineering graduates for the Singapore job market, particularly in areas ranging from personnel protection, management of radiation accidents, understanding radiation equipment, to the engineering of radiation devices for clinical application.

BG4234 Stem Cell Fundamentals

AUs: 3, Prerequisites: NIL, Semester 1

“Stemness” Definitions, Criteria, and standards; Stem cell R & D related regulations and ethics; Fundamental embryonic/fetal/adult stem cell biology; and Applications and application perspectives of stem cells.

BG4235 Orthopaedic Implant Engineering and Artificial Organs

AUs: 3, Prerequisites: NIL, Semester 1

Introduction to Orthopaedic Implantology. Introduction to patents, regulations, and certification. Basic mechanics of artificial joints. Hip replacement. Knee replacement. Other joint and ligament replacement. Fracture repair. Spinal implants. Introduction to artificial organs. Blood contacting biomaterials. Long-term vascular implants. Extracorporeal devices. Implantable artificial organs.

BG4236 Sport Engineering

AUs: 3, Prerequisites: NIL, Semester 1

Introduction to sports engineering, sports disciplines, sports technology, design of sports equipment, sports shoes, basic concepts of instrumented sports equipment, pervasive computing and smart sport devices, devices for muscle training, safety issues in sport, structural properties of sports equipment, aerodynamics and fluid dynamics in sport, specific equipment design, mechanics and analysis, sports biomechanics, sports medicine.

BG4232 Biomedical Devices

AUs: 3, Prerequisites: NIL, Semester 2

Classification of devices. Diagnostic, therapeutic and pharmaceutical devices. Cardiovascular, ophthalmologic and wound closure devices. Practical aspects of device use and qualification. Role of materials.

BG4901 Engineers and Society

AUs: 3, Prerequisites: NIL, Semester 2

The course comprises four main topics: Evolution of Modern Singapore; Technology & Society: Ethics and Professionalism and The Environment. Students are made aware of current issues at the time of their study.

BG4902 Human Resource Management

AUs: 3, Prerequisites: NIL, Semester 1

Strategic human resource management. Human resource planning. Job analysis, job design and quality of work life. Recruiting human resource. Employee selection. Appraising and managing performance. Human resource development/career planning and development. Employee compensation and benefits. Industrial relations. Employee health and safety. International human resource management.