MONGOLIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY
POWER ENGINEERING SCHOOL
DEPARTMENT OF ELECTRICAL POWER SUPPLY

Module Descriptions

Bachelor’s Programme in Electrical Power Supply

Programme index 071310
Degree Bachelor of Engineering (B.Eng.)
Scope 134 MUST credits (≈ 240 ECTS) · 7 semesters (3.5 years)

Edition: October 2026 · Curriculum 2024

About this document

This document contains the module descriptions of the Bachelor's programme in Electrical Power Supply of the Power Engineering School, Mongolian University of Science and Technology (MUST). It covers the compulsory courses of the approved 2024 curriculum, the courses of the Transport Power Supply track, elective courses, the industrial internships and the Bachelor's diploma project.

Programme	Electrical Power Supply (Bachelor)
Programme index	071310
Degree	Bachelor of Engineering (B.Eng.)
Level	Bachelor (EQF level 6)
Duration and mode	7 semesters (3.5 years), full-time
Credits	134 MUST credits (≈ 240 ECTS)
Tracks	Electrical Power Supply; Transport Power Supply
Language of instruction	Mongolian; since the 2025–2026 academic year the programme is also delivered in English for a separately admitted cohort
Responsible unit	Department of Electrical Power Supply, Power Engineering School, MUST

Sources

Course designation, credits, module and semester follow the approved 2024 curriculum of the programme. Aims, content, teaching methods, workload, assessment, literature and learning outcomes are taken from the course syllabi and course standards of the teaching units concerned (2023 edition), which are held in the university's academic information system UNIMIS; weekly lecture, seminar and laboratory topics are summarised. For the elective courses I.EEB312, I.EEM307, I.EEM309, I.EEM310, I.ETM209, I.ETM210 and I.TEM209 the aim, content and learning outcomes are derived from the lecture topic plans of the courses in UNIMIS. For the internships (I.EEB360, I.EEB361) and the Bachelor's diploma project (I.EEB370) the content is described by the course aim and the learning outcomes.

Credits and workload

One MUST credit corresponds to 48 hours of total student workload (contact hours and independent study) and to 1.8 ECTS credits. The workload of each course is given in hours; where the course standard states it, the breakdown into lectures, seminars, laboratory work and independent study is shown.

Course types

Compulsory courses are taken by all students. Courses marked "Electrical Power Supply track" or "Transport Power Supply track" are compulsory within the respective track. Elective courses are chosen from three blocks of the curriculum: general-education electives (C.1, 6 credits), major core electives (C.2, 6 credits) and major electives (C.3, 10 credits).

Learning outcomes

The course learning outcomes (CLO) are mapped to the programme learning outcomes (PLO) listed on the following page. The column "Bloom" reproduces the level stated in the course syllabus (K = knowledge, S = skills, A = attitude).

Programme learning outcomes

The Bachelor’s programme has 17 programme learning outcomes in four areas: A — Knowledge, B — Skills, C — Communication, D — Design.

PLO	Area	Programme learning outcome
A.1	Knowledge	Possess broad knowledge by integrating and relating the knowledge acquired from courses in the natural sciences, the humanities, the arts, and the social sciences.
A.2	Knowledge	Be able to define and explain the fundamental concepts of the energy sector, its structure and organisation, and the theoretical and practical problems of electrical machines and electrical engineering using professional terminology, methods, technologies, and tools.
A.3	Knowledge	Be familiar with the main pressing issues of the energy sector and be able to identify them; explain their effects within the generation, transmission, distribution, and consumption of electrical energy; and know how to apply learned theory and methodology to address them.
B.1	Skills	Be able to prepare projects, scientific presentations, and reports for research work in the energy sector using new methods, techniques, and technologies.
B.2	Skills	Be able to identify and resolve complex problems in the energy sector, conduct experimental research, design and construct solutions, and apply theoretical and practical knowledge as well as technical-technological skills to investigate problems creatively, individually or in a team.
B.3	Skills	Be able to systematically resolve research tasks and stated problems using the theory and methodology of the energy sector and related fields.
B.4	Skills	Be able to jointly discuss approaches to social, personal, and ethical issues and reach a common solution.
B.5	Skills	Have acquired high professional competence in the generation, transmission, distribution, and consumption of electrical energy, with the maturity needed to ensure the normal, steady, and reliable operation of the sector in the future.
C.1	Communication	Be able to present one's own and others' ideas, articulate one's own problem-solving strategy, and gain the support of others.
C.2	Communication	Be able to prepare and present projects, reports, and presentations of the acquired knowledge and skills in professional and social contexts.
C.3	Communication	Be able to find, correctly use, and cite various sources of information — including foreign-language sources and different media — in projects and reports.
D.1	Design	Have the ability to understand how engineering solutions affect the external environment and society, and be able to explain this in relation to other points of view.
D.2	Design	Be able to identify how engineering solutions affect industry and business and to explain this through different media.
D.3	Design	Have the skills to propose new ideas, justify their grounds, express one's own opinion, and explain differences and disagreements.
D.4	Design	Be able to conceive new ideas that should be addressed in the field of power supply, to plan the engineering design, and to produce calculations and models.
D.5	Design	Be able to implement the designs and models developed in practice.
D.6	Design	Be able to process the data of the conceived and modelled solutions and to provide an evaluation and conclusions on the results.

Curriculum overview

Credit structure

Part of the curriculum	Credits
Compulsory courses — general education	34
Compulsory courses — major core	33
Compulsory courses — major (including the course project, 2 credits; the industrial internships, 4 credits; and the Bachelor's diploma project, 5 credits)	45
General-education electives (C.1)	6
Major core electives (C.2)	6
Major electives (C.3)	10
Total	**134**

Recommended study plan

Semester	Courses (credits)	Credits
Semester I (autumn)	S.MTM131 Mathematics 1C (3) · S.PHM101 Physics I (3) · I.EEB101 Introduction to the Profession (1) · S.CEM101 Communicative English (3) · S.MHM101 History of Mongolia (3) · S.DGM101 Descriptive Geometry (3) · S.GCM101 General Chemistry (3) · S.PTM101 Physical Training (2, general-education elective)	21
Semester II (spring)	S.MTM132 Mathematics 2C (3) · S.PHM102 Physics II (3) · S.EEM101 Engineering Economics (3) · S.CFM101 Algorithms and Programming (3) · S.MLM101 Speech and Language Culture (3) · I.EEM201 Theory of Electrical Engineering I (3) · S.TDM201 Technical Drawing (2) · S.CDM101 Civil Protection Management (1, general-education elective)	21
Semester III (autumn)	I.EEM202 Theory of Electrical Engineering II (3) · I.EEM204 Electrical Machines I (3) · I.EEM209 Electrical Engineering Materials (2) · S.AMM201 Applied Mechanics I (3) · I.ECM201 Electronics (3) · S.IMM200 Fundamentals of Mathematical Calculations (3) · Elective course (3)	20
Semester IV (spring)	I.EEM205 Electrical Machines II (3) · I.EEM210 High-Voltage Engineering (3) · S.NAM201 Computational Mathematics (3) · I.EEB303 Renewable Energy and Hybrid Systems (3) · I.EEM203 Theory of Electrical Engineering III (2) · I.EEB360 Industrial Internship 1 (2) · S.EPM301 English for Specific Purposes (2) · Major core elective course (2)	20
Semester V (autumn)	I.EEB302 Electrical Transmission and Distribution Networks (3) · I.EEB325 Electromagnetic and Mechanical Transient Processes (2) · I.EEB310 Fundamentals of Electric Lighting (2) · Major core elective courses (4) · Major elective courses (7)	18
Semester VI (spring)	I.EEB301 Equipment for Transmission and Distribution (3) · I.ETM315 Relay Protection and Automation of Power Supply (3) · I.EEB304 Industrial Power Supply (3) · I.EEB305 Electric Drives (3) · I.EEB318 Engineering Design I (3) · I.EEB361 Industrial Internship 2 (2) · Major elective courses (3)	20
Semester VII (autumn)	I.EEB307 Motor Control (3) · I.EEB308 Safety of Electrical Equipment (2) · I.EEB309 Urban Power Supply (2) · I.EEB351 Power Supply Course Project (2) · I.EEB370 Bachelor's Diploma Project (5)	14
Total		**134**

Transport Power Supply track. Students of the Transport Power Supply track take the five track courses (13 credits) in semesters V–VII in place of the five courses of the Electrical Power Supply track (13 credits). The semester totals are the same in both tracks.

Semester	Transport Power Supply track (credits)	in place of (credits)
Semester V	I.EEB320 Electric Transport (2)	I.EEB310 Fundamentals of Electric Lighting (2)
Semester VI	I.EEB321 Theory of Electric Traction (3) · I.EEB324 Mathematical Modelling of Electric Transport (3)	I.EEB304 Industrial Power Supply (3) · I.EEB305 Electric Drives (3)
Semester VII	I.EEB323 Theory of Electric Transport Control Systems (3) · I.EEB322 Electrical Equipment of Vehicles (2)	I.EEB307 Motor Control (3) · I.EEB309 Urban Power Supply (2)

Internships. The industrial internships I.EEB360 and I.EEB361 are carried out in the summer after semesters IV and VI; their credits are included in the semester totals of the recommended study plan.

Contents

Code	Course	Credits	Semester	Page
M1 — General Foundation Module — Compulsory courses				
S.CEM101	Communicative English	3	I (autumn)	8
S.GCM101	General Chemistry	3	I (autumn)	9
S.PHM101	Physics I	3	I (autumn)	10
S.MHM101	History of Mongolia	3	I (autumn)	11
S.DGM101	Descriptive Geometry	3	I (autumn)	12
S.MTM131	Mathematics 1C	3	I (autumn)	13
I.EEB101	Introduction to the Profession	1	I (autumn)	14
S.PHM102	Physics II	3	II (spring)	15
S.CFM101	Algorithms and Programming	3	II (spring)	16
S.MTM132	Mathematics 2C	3	II (spring)	17
S.EEM101	Engineering Economics	3	II (spring)	18
S.MLM101	Speech and Language Culture	3	II (spring)	19
M1 — General Foundation Module — General-education electives (C.1)				
S.CDM101	Civil Protection Management	1	Any	20
S.PTM101	Physical Training	2	Any	21
M2 — Professional Core Module — Compulsory courses				
S.TDM201	Technical Drawing	2	II (spring)	22
I.EEM201	Theory of Electrical Engineering I	3	II (spring)	23
S.AMM201	Applied Mechanics I	3	III (autumn)	24
I.EEM202	Theory of Electrical Engineering II	3	III (autumn)	25
I.EEM204	Electrical Machines I	3	III (autumn)	26
I.ECM201	Electronics	3	III (autumn)	27
I.EEM209	Electrical Engineering Materials	2	III (autumn)	28
S.IMM200	Fundamentals of Mathematical Calculations	3	III (autumn)	29
S.NAM201	Computational Mathematics	3	IV (spring)	30
I.EEM203	Theory of Electrical Engineering III	2	IV (spring)	31
I.EEM205	Electrical Machines II	3	IV (spring)	32
I.EEM210	High-Voltage Engineering	3	IV (spring)	33
M2 — Professional Core Module — Major core electives (C.2)				
I.EEB202	Low Voltage Electrical Equipment and Controls	3	Any	34
I.EEB203	Standardization and the Basis of Innovation	2	Any	35
I.EEB205	Electric Drive and Control Techniques	2	Spring	35
I.EEM207	Fundamental of Programming of Electrical Power System	2	Any	36
I.EEM216	Management and Marketing in the Electrical Industry	3	Any	37
I.ETM209	Electrical Power Conversion Technique	3	Any	38
I.ETM210	Electrical Measurement Techniques	2	Any	39
I.TEM209	Thermal Power Equipment	3	Any	39

Code	Course	Credits	Semester	Page
M3 — Power Supply Specialisation Module — Compulsory courses				
I.EEB303	Renewable Energy and Hybrid Systems	3	IV (spring)	41
S.EPM301	English for Specific Purposes	2	IV (spring)	42
I.EEB302	Electrical Transmission and Distribution Networks	3	V (autumn)	43
I.EEB310	Fundamentals of Electric Lighting	2	V (autumn)	44
I.EEB325	Electromagnetic and Mechanical Transient Processes	2	V (autumn)	45
I.EEB301	Equipment for Transmission and Distribution	3	VI (spring)	46
I.EEB304	Industrial Power Supply	3	VI (spring)	47
I.EEB305	Electric Drives	3	VI (spring)	48
I.EEB318	Engineering Design I	3	VI (spring)	49
I.ETM315	Relay Protection and Automation of Power Supply	3	VI (spring)	50
I.EEB307	Motor Control	3	VII (autumn)	51
I.EEB308	Safety of Electrical Equipment	2	VII (autumn)	52
I.EEB309	Urban Power Supply	2	VII (autumn)	53
I.EEB351	Power Supply Course Project	2	VII (autumn)	54
M3 — Power Supply Specialisation Module — Transport Power Supply track				
I.EEB320	Electric Transport	2	V (autumn)	55
I.EEB321	Theory of Electric Traction	3	VI (spring)	56
I.EEB324	Mathematical Modelling of Electric Transport	3	VI (spring)	57
I.EEB322	Electrical Equipment of Vehicles	2	VII (autumn)	58
I.EEB323	Theory of Electric Transport Control Systems	3	VII (autumn)	59
M3 — Power Supply Specialisation Module — Major electives (C.3)				
I.EEB306	High-Voltage Testing and Adjustment	3	Autumn	60
I.EEB311	Installation and Operation of Electrical Equipment	3	Autumn / Spring	61
I.EEB312	Electrical Connections of Buildings	2	Any	61
I.EEB313	Automation of Power Supply Design	3	Autumn / Spring	62
I.EEB314	Special Course on Electrical Lines and Networks	2	Autumn / Spring	63
I.EEB315	Calculation and Software	2	Any	64
I.EEB316	Electrical Technology Methods	3	Any	65
I.EEB317	Transportation Power Supply	3	Autumn / Spring	66
I.EEB319	Reliability, Quality Indicators and Efficiency of Power Supply	2	Autumn	67
I.EEM307	Electrical System Analysis	2	Any	68
I.EEM309	Power Microgrid Planning and Modelling	3	Any	68
I.EEM310	Energy System Policy and Planning	3	Any	69
M3 — Power Supply Specialisation Module — Practical training				
I.EEB360	Industrial Internship 1	2	Summer after IV	70
I.EEB361	Industrial Internship 2	2	Summer after VI	70
M4 — Final Qualification Project				
I.EEB370	Bachelor's Diploma Project	5	VII (autumn)	72

M1 — General Foundation Module

Compulsory courses

S.CEM101 — Communicative English

Module	M1 — General Foundation Module
Course type	Compulsory
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: practice 96 h, independent study 48 h
Recommended semester	Semester I (autumn)
Prerequisite	—
Responsible unit	Department of English Language
Teaching formats (hours per week)	Practice 6
Teaching methods	Problem-based learning; project-based learning; experiment-based (laboratory) learning.
Assessment	Attendance; activity and participation 15% · Homework; independent work 30% · Progress quizzes 25% · Final examination 30%

Course aim

To develop intermediate-level English skills in reading, writing, listening, and speaking across a range of general topics.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Reading: read and understand English texts on general scientific topics, apply grammar rules in practice, and build vocabulary.	C.3	K2
2	Writing: write various text types — instructions, advice, commentary, reviews and essays — planning the text and organising information and notes.	C.2	S2
3	Speaking: express one's own opinions and give presentations at intermediate level using vocabulary and grammar.	C.1	S2
4	Listening: develop comprehension of spoken English on general topics and infer the meaning of unfamiliar expressions from context.	C.3	K2
5	Other skills: express one's own views freely and gain experience of oral and written translation within the scope of the course.	C.1	A2

Content

Present simple (active and passive voice); technical terminology; comparatives and superlatives; zero and first conditionals, cause and effect; past simple (active and passive), describing events; present perfect, describing faults and repairs; numbers and trends (increase, decrease); modal verbs (must, have to, need to; should, could) for rules and safety procedures; adjectives and adverbs, shapes and dimensions; materials and their properties, classifying equipment; prepositions of place and direction; countable and uncountable nouns; project planning.

Reading list and tools

Main: MUST, School of Foreign Languages, "Communicative English", MUST Press, 2022.

Additional: Tech Talk (pre-intermediate) by Vicki Hollett and John Sydes (Oxford University press) 2010 — Cho D, 2012 Hackers TOEIC reading, Korea Young Taek 2010, Max TOEIC Korea. — Unlimited English (pre-intermediate) by Theresa Clementson, Alex Tilbury, Leslie Anne Hendra, David Rea, Adrian Doff, Ben Goldstein (Cambridge University Press) 2011. — www.elllo.org (ELLLO= English Listening Lesson Library Online) https://www.britishcouncil.org/

Software and tools: Moodle; Smart board, CD player (speaker), laptop

S.GCM101 — General Chemistry

Module	M1 — General Foundation Module
Course type	Compulsory
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: lecture 32 h, seminar 32 h, independent study 80 h
Recommended semester	Semester I (autumn)
Prerequisite	—
Responsible unit	Division of Chemical Engineering
Teaching formats (hours per week)	Lecture 2 · Seminar 2 · Independent work 5
Teaching methods	Lecture-based teaching; flipped classroom; experiment-based (laboratory) learning.
Assessment	Attendance; activity and participation 10% · Homework; independent work 20% · Progress quizzes 24% · Laboratory reports 16% · Final examination 30%

Course aim

To provide knowledge of matter, its transformations, the fundamental laws of chemistry, and their applications, enabling students to apply chemical methods in their profession.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Understand the general concepts and principal laws of chemistry.	A.1	K1 S3 A2
2	Acquire knowledge of chemical transformations, the structure of atoms, molecules and compounds, chemical bonding, the properties of solutions, and electrochemistry.	A.1	K3 S4 A3
3	Acquire the practice of using chemical methods in analysis and research and relate chemical knowledge to one's own profession.	B.2	K3 S4 A3
4	Apply theoretical knowledge of chemistry in practice and work with chemical substances, reagent solutions, glassware and laboratory equipment.	B.2	K2 S3 A2
5	Prepare and present a report on the results of laboratory work.	B.1	S3

Content

Basic concepts and laws of chemistry; atomic structure and nuclear reactions; quantum numbers and atomic orbitals; periodic law and the periodic system; chemical bonding; thermodynamics and heat of reaction; chemical kinetics and equilibrium; solutions and solubility; electrolytic dissociation, weak and strong electrolytes, pH and hydrolysis; redox reactions and electrolysis; s-, p- and d-elements, their compounds and applications. Laboratory: safety rules; equivalent mass; relative atomic mass of oxygen; heat of dissolution; reaction rate and equilibrium; preparation of solutions of given concentration; properties of electrolyte and non-electrolyte solutions.

Reading list and tools

Main: P. Munkhbaatar, B. Byambagar et al., "General Chemistry", Ulaanbaatar, 2017 (in Mongolian) — J. Nadmid, I. Sukhbaatar et al., "General Chemistry Laboratory Workbook", Ulaanbaatar, 2017 (in Mongolian) — Yu. Ganchimeg, O. Otgontuul, Ch. Gunchin, R. Dolgorjav, S. Myagmarsuren, "Problem and Exercise Collection in General Chemistry", Ulaanbaatar, 2017 (in Mongolian)

Additional: John H. Nelson, Kenneth C. Kemp, "Chemistry", NJ, 1991. — S. Dondog, D. Dorj, "General and Inorganic Chemistry", Ulaanbaatar, 1987 (in Mongolian) — B. Baatarsukh, J. Budsuren et al., "General and Inorganic Chemistry", Ulaanbaatar, 2006 (in Mongolian) — O. Otgontuul et al., "Problems, Exercises and Tests in General and Inorganic Chemistry", Ulaanbaatar, 2011 (in Mongolian)

Software and tools: MS teams and MS office programs Aspen plus Chemdraw Smart board

S.PHM101 — Physics I

Module	M1 — General Foundation Module
Course type	Compulsory
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: lecture 32 h, seminar 16 h, laboratory 16 h, independent study 80 h
Recommended semester	Semester I (autumn)
Prerequisite	—
Responsible unit	Department of Physics
Teaching formats (hours per week)	Lecture 2 · Seminar 1 · Laboratory 1
Teaching methods	Problem-based learning; experiment-based (laboratory) learning.
Assessment	Attendance; activity and participation 5% · Homework; independent work 10% · Progress quizzes 20% · Laboratory reports 15% · Course work; project 20% · Final examination 30%

Course aim

To provide fundamental knowledge of physics in mechanics, molecular physics, and electricity, and the ability to apply the laws of kinematics, dynamics, thermodynamics, and electrostatics and analyse phenomena.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Explain the fundamental concepts of kinematics and dynamics, write equations of motion, and solve problems of mechanics.	A.1	K2 S3 A3
2	Write the differential equations of oscillations and waves and determine their solutions.	A.1	K3 S3 A4
3	Study reference frames, perform calculations in inertial and non-inertial frames, and explain the application of the Lorentz transformation.	A.1	K2 S3 A5
4	Explain and analyse phenomena using molecular-kinetic theory and the fundamental laws of thermodynamics.	A.1	K3 S4 A5
5	Apply the laws of the electric field, electric polarisation and direct current in simple calculations and in practice.	A.1	K3 S4 A5
6	Verify theoretical knowledge of mechanics and molecular physics by experiment and carry out measurements with laboratory instruments.	B.2	K3 S4 A4
7	Work with laboratory instruments, master measurement techniques, and analyse the measurement results.	B.2	K4 S4 A5
8	Compare experimental results with theoretical values, calculate measurement errors, and analyse them.	B.2	K3 S5 A5
9	Prepare and present a report on the results of laboratory work.	B.1	S3

Content

SI units and reference frames; kinematics of a point; rotational motion; dynamics: momentum, Newton's laws, conservation of momentum, bodies of variable mass; work and energy, conservation of energy, rotation of rigid bodies, torque; non-inertial frames, inertial and Coriolis forces; special relativity (Galilean and Lorentz transformations); harmonic, damped and forced oscillations; kinetic theory of ideal gases, Boltzmann and Maxwell distributions, mean free path; first and second laws of thermodynamics, Carnot cycle; transport phenomena, real gases, phase transitions; electrostatics.

Reading list and tools

Main: G. Zorigt, N. Nasanbat et al., "General Physics 1", 2018 (in Mongolian)

Additional: B. Bazarragchaa, D. Ganbaatar, N. Damdinjav, B. Dorjsuren, "Physics 1", 2009 (in Mongolian) — G. Zorigt et al., "Physics 1 — Course Manual", 2022 (in Mongolian) — Lecturers of the Department of Physics, "Laboratory Instructions 1–2", 2022 (in Mongolian) — Halliday, Resnick, Walker " Fundamentals physics " 2003

S.MHM101 — History of Mongolia

Module	M1 — General Foundation Module
Course type	Compulsory
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: lecture 32 h, seminar 32 h, independent study 80 h
Recommended semester	Semester I (autumn)
Prerequisite	—
Responsible unit	Department of Humanities
Teaching formats (hours per week)	Lecture 2 · Seminar 2
Teaching methods	Problem-based learning; knowledge-construction methods and game-based learning; case method and team-based learning.
Assessment	Attendance; activity and participation 15% · Homework; independent work 30% · Progress quizzes 25% · Final examination 30%

Course aim

To provide systematic, multifaceted knowledge of the process of Mongolian historical development and to foster a sound national consciousness that values language, culture, and national interests.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Acquire foundational knowledge of history and society and of the methods, methodology and theory of historical research.	A.1	K1 A2
2	Study in depth the history of the Mongols, who left a profound mark on world history.	A.1	K2 A3
3	Combine the values of nomadic and settled civilisations and preserve the essential characteristics of the nation, its history and its older generations.	B.4	K3 S1 A4
4	Develop the attitude of disseminating, valuing and further developing the cultural heritage created by the people.	C.2	A4
5	Study the contribution of the Mongols to the development of world culture, the economy and statehood.	A.1	K5 S4 A4
6	Use historical knowledge as a criterion of truth and a source of experience, and interpret contemporary social phenomena and events from a historical perspective.	D.1	K6 S5 A5

Content

Periodisation and sources of Mongolian history; prehistoric Mongolia; ancient Mongolian states; khanates of the 6th–9th centuries; Khitan and Mongol tribes of the 10th–12th centuries; the Great Mongol Empire; Mongolia in the 14th–18th centuries; Mongolia in the 18th–early 20th centuries; the national liberation revolution of 1911; the revolution of 1921 and the development of the country; the Mongolian People's Republic 1936–1964 and the socialist period; transition to a democratic society. Assignments: essay, reading report, museum visit reports, family genealogy.

Reading list and tools

Main: MUST core textbook: Sh. Luvsandorj, N. Galiimaa et al., "History of Mongolia", Ulaanbaatar, 2019 (in Mongolian) — Sh. Luvsandorj, N. Galiimaa et al., "History of Mongolia II", textbook, Ulaanbaatar, 2018, ISBN 978-99973-0-909-9 (in Mongolian) — Sh. Luvsandorj, N. Galiimaa et al., "History of Mongolia I", textbook, Ulaanbaatar, 2016, ISBN 978-99973-0-909-9 (in Mongolian)

S.DGM101 — Descriptive Geometry

Module	M1 — General Foundation Module
Course type	Compulsory
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: lecture 32 h, practice 32 h, independent study 80 h
Recommended semester	Semester I (autumn)
Prerequisite	—
Responsible unit	Department of Engineering Graphics
Teaching formats (hours per week)	Lecture 2 · Practice 2
Teaching methods	Flipped classroom and lecture-based teaching; problem-based learning.
Assessment	Attendance; activity and participation 10% · Homework; independent work 40% · Progress quizzes 20% · Final examination 30%

Course aim

To provide theoretical and practical knowledge of solving positional and metric problems of geometric figures by orthographic projection and axonometry.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Recognise and apply the methods of representing spatial geometric figures on a plane.	A.1	K3
2	Represent spatial geometric figures in orthographic and axonometric projection.	A.1	S3
3	Determine and explain the relative positions of geometric figures.	A.1	A2
4	Determine the dimensions of geometric figures and analyse them.	A.1	K3
5	Solve and analyse problems relating to geometric figures.	B.3	S3
6	Master and perform the methods of geometric construction for positional and metric problems.	B.3	A2
7	Determine and analyse the relative positions of geometric figures in orthographic projection.	B.3	K3
8	Determine the dimensions of geometric figures in orthographic projection and apply them in practice.	B.3	S3

Content

Projection methods (central, parallel, orthogonal); projections of points, lines and planes; relative position of lines and planes, perpendicularity; transformation of projections (change of projection planes, rotation, parallel translation); curves and their projections; surfaces: polyhedral, ruled, surfaces of revolution, helicoids and quadrics; intersection of surfaces with planes and lines; intersection of two surfaces (auxiliary-sphere method).

Reading list and tools

Main: D. Battogtokh, Kh. Damchaasuren, B. Jigjid, "Descriptive Geometry", Ulaanbaatar, 2019 (in Mongolian) — Kh. Tamir, N. Dorjbaldan, U. Lkhagvadorj, "Descriptive Geometry", Ulaanbaatar, 2007 (in Mongolian) — R. O. Loving, I. L. Hill, R. C. Pare. Descriptive Geometry. 1996 — Solomon Woolf. An Elementary Course in Descriptive Geometry. 2022

Additional: Ch. Myagmarjav, D. Battogtokh, Ch. Oyunjargal, "Manual for Independent Work", 2022 (in Mongolian) — D. Battogtokh, "Geometric Construction", Ulaanbaatar, 2014 (in Mongolian) — G. Sukhbaatar et al., "Problem Collection in Descriptive Geometry", Ulaanbaatar, 2005 (in Mongolian) — V. O. Gordon, Yu. B. Ivanov, T. E. Solntseva, "Problem Collection for the Course of Descriptive Geometry", Moscow, 2005 (in Russian)

Software and tools: GeoGebra, Socrative, Classroom, CAD (AutoCAD, SolidWorks)

S.MTM131 — Mathematics 1C

Module	M1 — General Foundation Module
Course type	Compulsory
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: lecture 32 h, seminar 16 h, laboratory 16 h, independent study 80 h
Recommended semester	Semester I (autumn)
Prerequisite	—
Responsible unit	Department of Mathematics
Teaching formats (hours per week)	Lecture 2 · Seminar 1 · Laboratory 1
Teaching methods	Problem-based learning.
Assessment	Attendance; activity and participation 10% · Homework; independent work 30% · Progress quizzes 30% · Final examination 30%

Course aim

To master techniques for solving matrices, vectors, and systems of linear equations, and to acquire knowledge of single-variable functions, their limits, derivatives, and integrals, with engineering applications.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Master the techniques for computing matrices, systems of linear equations, function limits, derivatives and integrals.	A.1	K2 S1 A1
2	Apply knowledge of linear systems, limits and derivatives to engineering and technological problems.	B.3	K3 S2 A2
3	Solve selected engineering and technological problems using knowledge of matrices, linear systems, functions, derivatives and integrals.	B.3	K4 S3 A3
4	Work independently and in a team.	B.4	K6 S4 A4

Content

Matrices and matrix operations, determinants, minors and cofactors; inverse matrix and rank; systems of linear equations (Gaussian elimination, inverse matrix, Cramer's rule); homogeneous systems, eigenvalues and eigenvectors; vectors, linear dependence, vector products; equations of lines and planes; functions, limits and continuity; derivatives and differentials; curve sketching, extrema and engineering applications of derivatives; indefinite integrals (substitution, integration by parts, rational and trigonometric functions); definite and improper integrals and their applications.

Reading list and tools

Main: Bernard Kolman, David R. Hill, Introductory Linear Algebra: An Applied First Course, 2005, ISBN: 01-2005-3091 — George B. Thomas, Jr., Maurice D. Weir, Joel Hass, Thomas' Calculus, 2002, ISBN: 01-2003-8317 — T. Gereltuya, G. Battsetseg, Kh. Otgondorj, L. Burmaa, "Mathematics 1", manual, 2022, ISBN 978-9919-506-53-7 (in Mongolian)

I.EEB101 — Introduction to the Profession

Module	M1 — General Foundation Module
Course type	Compulsory
Credits	1 MUST credits (1.8 ECTS)
Workload	48 h: lecture 16 h, independent study 32 h
Recommended semester	Semester I (autumn)
Prerequisite	—
Responsible unit	Department of Electrical Power Supply
Teaching formats (hours per week)	Lecture 1
Teaching methods	Problem-based learning; example-based learning; challenge-based learning.
Assessment	Attendance; activity and participation 10% · Homework; independent work 20% · Progress quizzes 20% · Final examination 30%

Course aim

To study the structure and interconnection of the power system and electrical networks, to acquire a general understanding of transmission and distribution equipment, and to provide professional orientation.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Know the basic concepts of the power system, electrical networks, and the equipment for transmission and distribution of electrical energy.	A.2	K2
2	Know the basic concepts of renewable energy sources.	A.3	K2
3	Explain the structure of the power supply system.	A.2	K3
4	Collect and use information on safety and the environment in the energy sector.	C.3	K3

Content

The energy system; energy sources; renewable energy sources; structure and classification of electrical lines, networks and systems; power-supply systems; equipment for the transmission and distribution of electrical energy; relay protection and automation of networks and power-supply systems; safety in the energy sector and the environment. Independent work: an essay with presentation on the energy system, energy sources and renewable energy, and an independent assignment with presentation on electrical lines, networks, systems and their equipment.

Reading list and tools

Main: Kh. Tsagaan, M. Khuyagdorj, "Transmission and Distribution of Electrical Energy", Ulaanbaatar, 2017, ISBN 978-99978-57-09-5 (in Mongolian) — Z. Tserendorj, Ts. Erdenetuya, "Fundamentals of Power Supply and Distribution 1", Ulaanbaatar, 2017, ISBN 978-99978-0-681-9 (in Mongolian) — Z. Tserendorj, Ts. Erdenetuya, "Fundamentals of Power Supply and Distribution 2", Ulaanbaatar, 2022 (in Mongolian)

S.PHM102 — Physics II

Module	M1 — General Foundation Module
Course type	Compulsory
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: lecture 32 h, seminar 16 h, laboratory 16 h, independent study 80 h
Recommended semester	Semester II (spring)
Prerequisite	S.PHM101
Responsible unit	Department of Physics
Teaching formats (hours per week)	Lecture 2 · Seminar 1 · Laboratory 1
Teaching methods	Problem-based learning; experiment-based (laboratory) learning.
Assessment	Attendance; activity and participation 5% · Homework; independent work 10% · Progress quizzes 20% · Laboratory reports 15% · Course work; project 20% · Final examination 30%

Course aim

To provide fundamental knowledge of physics in electromagnetism, optics, and atomic and nuclear physics, and the ability to apply the relevant theories and analyse phenomena.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Study the properties of the magnetic field and apply Maxwell's equations.	A.1	K3 S3 A3
2	Study the physical basis of alternating-current circuits and perform calculations for simple circuits.	A.1	K3 S3 A4
3	Study geometrical optics and total internal reflection and explain their applications.	A.1	K4 S4 A4
4	Explain and analyse phenomena using the wave and particle theories of light.	A.1	K3 S3 A4
5	Explain the fundamentals of quantum physics, the concept of the micro-world, and the physical basis of nanotechnology.	A.1	K2 S3 A3
6	Verify theoretical knowledge of magnetism, optics and atomic and nuclear physics by experiment and carry out measurements with laboratory instruments.	B.2	K4 S4 A3
7	Work with electromagnetic and optical instruments, master measurement techniques, and analyse the measurement results.	B.2	K4 S4 A4
8	Compare experimental results with theoretical values, calculate measurement errors, and analyse them.	B.2	K5 S5 A5
9	Prepare and present a report on the results of laboratory work.	B.1	S3

Content

Magnetic field of currents, Lorentz force and motion of charged particles; Biot–Savart–Laplace law and magnetic flux; magnetic properties of matter; electromagnetic induction (Faraday–Lenz law), self- and mutual induction, eddy currents; transformers, generators and motors, alternating current; displacement current and Maxwell's equations; electromagnetic waves and their energy, oscillating circuits; geometrical optics (reflection, refraction, total internal reflection); interference, diffraction and polarisation of light; Compton effect, light pressure and the photoelectric effect.

Reading list and tools

Main: G. Zorigt, N. Nasanbat et al., "General Physics 1", 2018 (in Mongolian)

Additional: B. Bazarragchaa, D. Ganbaatar, N. Damdinjav, B. Dorjsuren, "Physics 2", 2009 (in Mongolian) — G. Zorigt et al., "Physics 1 — Course Manual", 2023 (in Mongolian) — Lecturers of the Department of Physics, "Laboratory Instructions 3–4", 2023 (in Mongolian) — Halliday, Resnick, Walker " Fundamentals physics " 2003

S.CFM101 — Algorithms and Programming

Module	M1 — General Foundation Module
Course type	Compulsory
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: lecture 32 h, laboratory 32 h, independent study 80 h
Recommended semester	Semester II (spring)
Prerequisite	—
Responsible unit	Department of Information Technology
Teaching methods	Problem-based learning; experiment-based (laboratory) learning.
Assessment	Attendance; activity and participation 10% · Homework; independent work 12% · Progress quizzes 20% · Laboratory reports 28% · Final examination 30%

Course aim

To provide foundational knowledge and skills in designing algorithms, writing Python programs with conditionals and loops, defining functions, using lists, tuples, and dictionaries, working with files, modules, and classes, and performing data analysis with NumPy and Pandas.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Define the fundamentals of information theory, distinguish units of information, and explain operations on binary numbers.	A.1	K1 S1 A1
2	List the properties of algorithms, describe their structure, define variables, and explain the basic algorithmic operations.	A.1	K1 S1 A1
3	Explain conditional and loop statements in Python, including the break and continue statements.	A.1	K1 S1 A1
4	Write functions and compare and explain the list, tuple and dictionary types.	A.1	K1 S1 A1
5	Explain file handling, module import, class creation, and data analysis and pre-processing techniques.	A.1	K1 S1 A1
6	Convert between number systems and perform arithmetic, logical and shift operations on bits.	B.2	K2 S2 A2
7	Construct algorithms for conditional and iterative problems in Flowgorithm.	B.2	K2 S2 A2
8	Write simple Python programs using for and while loops together with break and continue.	B.2	K2 S2 A2
9	Create and use functions, strings, lists, tuples and dictionaries.	B.2	K2 S2 A2
10	Handle files, create and import modules and classes, import data sets, and pre-process missing data.	B.2	K2 S2 A2

Content

Fundamentals of information theory; arithmetic, logical and shift operations on bits; representation and structure of algorithms; Python data types, input/output and operators; conditional statements; loops (while, for, break, continue); user-defined functions; lists and strings; file input and output; tuples and dictionaries; standard and user-defined modules and packages; data processing with NumPy; data analysis and pre-processing with Pandas; classes and object-oriented programming; image processing with PIL. Laboratory: number systems and bit operations; flowcharts in Flowgorithm; Python exercises on the topics above.

Reading list and tools

Main: H. Bhasin. Python Basics Starting out with Python, 4th Edition, Tony Gaddis — Practical-programming-third-edition P1.0. Paul Gries, Jennifer Campbell — Ts. Battsetseg, "Algorithms and Programming — Course Manual" (in Mongolian)

Additional: Introduction to Computation and Programming Using Python: With Application to Understanding Data, 2nd Edition by Guttag, John Practice of Computing Using Python, 3rd Edition by William Punch & Richard Enbody Python

Programming_ An Introduction to Computer Science (PDFDrive)

Software and tools: https://www.python.org/about/
https://www.anaconda.com/blog/anaconda-individual-edition-2022-05

S.MTM132 — Mathematics 2C

Module	M1 — General Foundation Module
Course type	Compulsory
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: lecture 32 h, seminar 16 h, laboratory 16 h, independent study 80 h
Recommended semester	Semester II (spring)
Prerequisite	S.MTM131
Responsible unit	Department of Mathematics
Teaching formats (hours per week)	Lecture 2 · Seminar 1 · Laboratory 1
Teaching methods	Problem-based learning; project-based learning.
Assessment	Attendance; activity and participation 10% · Homework; independent work 30% · Progress quizzes 30% · Final examination 30%

Course aim

To master the concepts of multivariable functions, ordinary differential equations, double and triple integrals, line and surface integrals, and series, and to apply them to engineering problems.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Master the techniques for solving ordinary differential equations, double integrals, line and surface integrals, and series.	A.1	K2 S1 A1
2	Apply knowledge of differential equations, multiple integrals, line and surface integrals and series to engineering and technological problems.	B.3	K3 S2 A2
3	Solve selected engineering and technological problems using this knowledge.	B.3	K4 S3 A3
4	Work independently and in a team.	B.4	K6 S4 A4

Content

Functions of several variables: level lines and surfaces, second-order surfaces; limits, continuity, partial derivatives and total differential; implicit and composite functions, tangent plane and normal line, directional derivative and gradient; higher-order partial derivatives, extrema and conditional extrema; double integrals (properties, change of variables, polar coordinates); triple integrals in Cartesian, cylindrical and spherical coordinates; applications of multiple integrals (volume, area, static moments, centre of gravity, moments of inertia); vector fields, divergence and curl, line and surface integrals.

Reading list and tools

Main: George B. Thomas, Jr., Maurice D. Weir, Joel Hass, Thomas' Calculus, 2002, ISBN: 01-2003-8317 — Ts. Baljinnyam, "Mathematical Analysis 2", 2021 (in Mongolian)

S.EEM101 — Engineering Economics

Module	M1 — General Foundation Module
Course type	Compulsory
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: lecture 32 h, seminar 32 h, independent study 80 h
Recommended semester	Semester II (spring)
Prerequisite	—
Responsible unit	Division of Technology Management
Teaching formats (hours per week)	Lecture 2 · Seminar 2
Teaching methods	Problem-based learning; project-based learning.
Assessment	Attendance; activity and participation 10% · Seminar assignments 10% · Independent work (project) 30% · Progress quizzes 20% · Final examination 30%

Course aim

To provide knowledge of systematically evaluating competitive engineering, technology, and design alternatives from an economic perspective and making optimal choices, and the ability to apply this in practice.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Acquire the fundamental concepts and knowledge of engineering economics and apply them in decision-making.	A.1	K1-K3
2	Apply software in the development of engineering projects.	B.3	S1-S3
3	Carry out economic efficiency analysis of engineering projects and take decisions.	D.2	K1-K4
4	Develop professional ethics, creative thinking and the ability to work in a team.	B.4	A1-A4
5	Analyse the social, economic, environmental and business impact and significance of engineering projects.	D.1	A1-A4

Content

Basic concepts of engineering economics; production planning and its preliminary studies; production and operating costs, revenue and profit; depreciation of capital and its calculation; value engineering and cost analysis; inventory management and purchasing decisions; time value of money; short-term financial planning; fundamentals of investment; methods of evaluating the economic efficiency of projects; investment project analysis; replacement and maintenance analysis; project management tools; business valuation; innovation and technology transfer. Team project: business idea, market and resource studies, production planning and costing.

S.MLM101 — Speech and Language Culture

Module	M1 — General Foundation Module
Course type	Compulsory
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: lecture 32 h, seminar 32 h, independent study 80 h
Recommended semester	Semester II (spring)
Prerequisite	—
Responsible unit	Division of Asian Studies
Teaching formats (hours per week)	Lecture 2 · Seminar 2
Teaching methods	Problem-based learning; case-based learning; challenge-based learning.
Assessment	Attendance; activity and participation 15% · Homework; independent work 30% · Progress quizzes 25% · Final examination 30%

Course aim

To improve the knowledge, habits, and skills of speaking and writing correctly in accordance with the norms of the literary language across all areas of communication.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Apply the stylistic devices of the written literary language.	A.1	K1-K6
2	Know the forms and methods of spoken style and oratory.	A.1	K1-K6
3	Know the types of official documents and their distinguishing features.	A.1	K1-K6
4	Know the types and characteristics of scientific works.	A.1	K1-K6
5	Apply the stylistic devices of the written literary language in practice.	C.2	S1-S5
6	Apply spoken style, presentation skills and methods of debate.	C.1	S1-S5
7	Apply the types of official documents and the methods of preparing them.	C.2	S1-S5
8	Use scientific works.	C.3	S1-S5
9	Acquire the ability to write well in the mother tongue with the right attitude.	C.2	A1-A5
10	Speak correctly and coherently in the mother tongue and express one's views freely.	C.1	A1-A5
11	Develop the ethics and conduct required for teamwork.	B.4	A1-A5
12	Develop the ability to carry out analysis.	B.3	A1-A5
13	Speak in public and deliver information.	C.1	S1-S5
14	Improve diction, tone, rhythm, tempo and expressive reading.	C.1	S1-S5
15	Write an essay on a given topic.	C.2	S1-S5
16	Analyse a presentation.	C.1	S1-S5
17	Prepare commonly used official documents.	C.2	S1-S5
18	Identify, extract and explain terminology from scientific works.	C.3	S1-S5

Content

Language, its functions and norms; state language policy and the mother tongue; written culture and the history of Mongolian scripts; Mongolian communication culture (forms of greeting, respect and gratitude); style of spoken language; public speaking (origins and types, preparation and planning of a speech, principles for speakers); stylistics and writing skills, stylistic errors; the essay (structure and enrichment of content); style of official documents (standards, organisational and reference documents, common document types); language and style of scientific writing, scientific papers and articles; style of the diploma thesis.

Reading list and tools

Main: G. Tomtogtokh, D. Enkhchimeg, N. Munkhjargal et al., "Language and Speech Culture", MUST core textbook, 2019, ISBN 978-99962-1-332-8 (in Mongolian) — N. Munkhjargal, B. Sonintsetseg, B. Delgermaa et al., "Exercises and Practice — Manual", 2022, ISBN 978-99962-64-43-6 (in Mongolian)

Software and tools: Teams Moodle LMS

General-education electives (C.1)

S.CDM101 — Civil Protection Management

Module	M1 — General Foundation Module
Course type	General-education elective (C.1)
Credits	1 MUST credits (1.8 ECTS)
Workload	48 h
Recommended semester	Any semester
Prerequisite	—
Responsible unit	Department of Physics, School of Applied Sciences
Teaching methods	Problem-based learning.
Assessment	Attendance and participation 40% · homework and independent work 30% · final examination 30%

Course aim

To provide knowledge of natural and human-induced disaster hazards, of hazardous substances and of preparedness, prevention and response measures.

Course learning outcomes

No	Course learning outcome
1	Acquire an understanding of disaster hazards.
2	Explain hazardous substances, recognise their labels and handle and store them safely.
3	Explain how hazardous substances affect human health and the environment.
4	Explain to others the measures for disaster prevention and for action during and after a disaster.
5	Prepare a family disaster-preparedness plan.

Content

Natural disasters: floods, drought and dzud; forest and steppe fires and lightning; earthquakes. Human-induced disasters: fire hazards. Infectious diseases of humans and animals and their prevention. Hazardous substances: labelling, safe handling and storage, effects on health and the environment. Disaster preparedness planning.

Reading list and tools

Sh. Palamdorj, P. Tsedev, N. Gereltsolmon, Sh. Olzvoi, D. Oyunbaatar, "Methodology of Disaster Risk Assessment", 2010, ISBN 978-99929-4-529-X — D. Serjmyadag, D. Altangerel, P. Dash, P. Chimedtseren, "Disaster Protection Policy and Strategy", 2020, ISBN 978-9919-24-577-1 (both in Mongolian).

S.PTM101 — Physical Training

Module	M1 — General Foundation Module
Course type	General-education elective (C.1)
Credits	2 MUST credits (3.6 ECTS)
Workload	96 h: practical training 64 h, independent study 32 h
Recommended semester	Any semester
Prerequisite	—
Responsible unit	Department of Physical Education and Sport
Teaching formats (hours per week)	Practical training 4
Teaching methods	Whole-group, team and individual training; practical exercises performed by the students.
Assessment	Attendance and participation 10% · two progress tests 10% each · independent work 20% · practice (walking) 20% · final examination 30%

Course aim

In accordance with the MUST regulation on sport credits, sports such as basketball, volleyball and skating develop students' physical fitness and technical skills and train endurance and teamwork; physical education enables students to pursue regular physical activity independently.

Course learning outcomes

No	Course learning outcome
1	Explain how to prevent physical inactivity and how to live and work healthily.
2	Communicate with others and work independently and in a team.
3	Develop physical fitness and prevent physical inactivity.
4	Practise sport independently throughout life.
5	Develop skills in a team sport (e.g. basketball).
6	Use daily walking as a basis for lifelong individual physical activity.
7	Calculate the daily calorie requirement according to WHO norms and monitor body-mass index.

Content

Basketball, volleyball, skating and other sports offered under the MUST sport-credit regulation; daily walking; daily calorie requirement and body-mass index.

Reading list and tools

FIBA Official Basketball Rules (2019, 2023) — FIVB Official Volleyball Rules (2022) — M. Bat-Ochir, Ch. Nyam, "Volleyball", handbook and textbook, 2013 (in Mongolian).

M2 — Professional Core Module

Compulsory courses

S.TDM201 — Technical Drawing

Module	M2 — Professional Core Module
Course type	Compulsory
Credits	2 MUST credits (3.6 ECTS)
Workload	96 h: practice 64 h, independent study 32 h
Recommended semester	Semester II (spring)
Prerequisite	S.DGM101
Responsible unit	Department of Engineering Graphics
Teaching formats (hours per week)	Practice 4
Teaching methods	Problem-based learning; flipped classroom.
Assessment	Attendance; activity and participation 10% · Homework; independent work 40% · Progress quizzes 20% · Final examination 30%

Course aim

To provide the knowledge and skills to produce, read, and use the fundamental engineering design documents in accordance with MNS-ISO standards.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Study, recognise and apply the purpose of engineering drawings, the rules of execution, simplifications, conventions and graphic symbols.	A.1	K3
2	Represent parts, products and geometric bodies in orthographic projection using standard views, sections and cuts.	D.4	S3
3	Study the types of axonometric representation and master and perform the methods of constructing them.	A.1	A2
4	Become familiar with the types of connections used in engineering and their simplified and conventional symbols, and represent and apply them.	A.1	K3
5	Learn the purpose, content, sequence and technique of sketches and working drawings.	D.4	S3
6	Become familiar with the purpose and structure of equipment assembly drawings and the technique of producing them.	D.4	A2
7	Distinguish the types of schematic drawings and master and perform their application.	A.1	A2

Content

Orthogonal projection system and views; sections and cuts; axonometric projection, simplifications and conventions; projection exercises; threaded joints (representation, parameters and types of threads); bolted and stud connections; permanent joints (riveted, welded, soldered, bonded); types of design documentation; detail working drawings and sketches; dimensioning and sketching procedure; tolerances of size and form, surface finish and coatings; assembly drawings.

Reading list and tools

Main: J. Tsevegsuren, "Technical Drawing", Ulaanbaatar, 1986 (in Mongolian) — J. Tsevegsuren, "Engineering Drawing", Ulaanbaatar, 1999 (in Mongolian) — D. Altansukh, Sh. Tseveendorj, "Fundamentals of Design Drawing", Ulaanbaatar, 2001 (in Mongolian)

Additional: G. Usnikh, D. Battogtokh, "Projection Drawing", Ulaanbaatar, 2013 (in Mongolian) — D. Battogtokh, N. Chuluunbaatar, "Connection of Machine Parts", Ulaanbaatar, 2020 (in Mongolian) — O. Altangerel, "Working Drawings of

Machine Parts", Ulaanbaatar, 2010 (in Mongolian)

Software and tools: Socrative, Classroom, CAD (AutoCAD, SolidWorks)

I.EEM201 — Theory of Electrical Engineering I

Module	M2 — Professional Core Module
Course type	Compulsory
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: lecture 32 h, seminar 16 h, laboratory 16 h, independent study 80 h
Recommended semester	Semester II (spring)
Prerequisite	S.PHM101
Responsible unit	Department of Electrical Power Supply
Teaching formats (hours per week)	Lecture 2 · Seminar 1 · Laboratory 1
Teaching methods	Problem-based learning; project-based learning; experiment-based (laboratory) learning.
Assessment	Attendance; activity and participation 10% · Homework; independent work 20% · Progress quizzes 20% · Laboratory reports 20% · Final examination 30%

Course aim

To study the fundamental laws of electrical circuits, their fundamental elements, the calculation methods of direct- and alternating-current circuits, and circuit processes and phenomena.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Know the fundamental concepts of electrical engineering theory.	A.2	K2
2	Perform calculations of direct-current circuits.	B.3	
3	Perform calculations of single-phase alternating-current circuits.	B.3	K2
4	Construct vector diagrams.	B.3	K3
5	Carry out measurements and experiments on direct-current circuits.	B.2	K3
6	Carry out measurements and experiments on single-phase alternating-current circuits.	B.2	K3
7	Draw conclusions and perform analysis from measurement and experiment results.	D.6	S2
8	Prepare and present a report on the results of laboratory work.	B.1	S3

Content

Electrical circuits: classification, basic elements and quantities; independent and dependent sources; basic laws of electrical circuits; methods of analysing DC circuits (node-potential method, superposition); single-phase AC circuits; R, L and C elements and RL, RC and RLC circuits; power in AC circuits; symbolic (complex) method; circuit transformations; resonance; mutual inductance; two-port networks: classification, basic equations, equivalent circuits, circle diagram; filters. Laboratory: current–voltage characteristics of linear and nonlinear elements; potential diagram; Kirchhoff's laws; DC and AC circuit calculations.

Reading list and tools

Main: Kh. Sukhbaatar, S. Byambaa, S. Munkhjargal, "Theory of Electrical Circuits: the Duality Principle", Ulaanbaatar, 2005, ISBN 99929-5-363-2 (in Mongolian) — Sh. Angar, D. Otgonjargal, "Fundamentals of the Theory of Electrical Engineering", Ulaanbaatar, 2011, ISBN 978-99962-53-65-2 (in Mongolian) — L. A. Bessonov, "Theoretical Foundations of Electrical Engineering", 1991 (in Russian)

Additional: P. A. Ionkin (ed.), "Theoretical Foundations of Electrical Engineering", 1984 (in Russian) — Sh. Angar, N. Dashnyam, "General Electrical Engineering", Ulaanbaatar, 1999 (in Mongolian) — S. Lyankhtsetseg, "Fundamentals of Electrical Engineering", Ulaanbaatar, 2016 (in Mongolian)

Software and tools: Virtual laboratory

S.AMM201 — Applied Mechanics I

Module	M2 — Professional Core Module
Course type	Compulsory
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: lecture 32 h, laboratory 32 h, independent study 80 h
Recommended semester	Semester III (autumn)
Prerequisite	S.PHM101
Responsible unit	Department of Technical Mechanics
Teaching formats (hours per week)	Lecture 2 · Laboratory 2
Teaching methods	Problem-based learning; experiment-based (laboratory) learning.
Assessment	Attendance; activity and participation 10% · Homework; independent work 28% · Progress quizzes 20% · Laboratory reports 12% · Final examination 30%

Course aim

To provide a general understanding of the structure, equilibrium, kinematics, and kinetics of machines, mechanisms, and engineering structures, and the methodology of applying the general laws of mechanics in technical calculations.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Master the equilibrium conditions of bodies, the kinematic parameters of points and systems, the laws of dynamics, and the structure, kinematics and dynamics of mechanisms.	A.1	K3
2	Perform calculations of engineering structures, select mechanical transmissions, carry out kinematic calculations, calculate the strength of components, and analyse the characteristics of mechanisms.	B.3	S3
3	Recognise, measure, test, calculate and represent the structure, kinematics and dynamics of mechanisms, process the results and analyse them.	B.2	K3 S3
4	Prepare and present a report on the results of laboratory work.	B.1	S3

Content

Subject and basic concepts of applied mechanics; engineering structures, machines, mechanisms and mechanical drives; types of constraints and constraint reactions; forces and force systems; equilibrium conditions of force systems; statically determinate and indeterminate problems, equilibrium of systems of bodies; plane trusses; kinematics of a point; translational and rotational motion of rigid bodies; plane motion of rigid bodies and kinematic analysis of plane linkages; transmission of rotation and gear ratios; gear mechanisms and their kinematic analysis.

Reading list and tools

Main: N. Tumurbaatar, G. Chimed-Ochir, A. Gulguu et al., "Applied Mechanics II", Ulaanbaatar, 2007, ISBN 99929-0-206-X (in Mongolian) — G. Chimed-Ochir, T. Namnan, P. Ulziisaikhan, D. Ganbat, Kh. Gangerel, "Machine Elements", Ulaanbaatar, 2019, ISBN 999294437-4 (in Mongolian) — N. Tumurbaatar, G. Chimed-Ochir, A. Gulguu et al., "Strength of Materials", Ulaanbaatar, 2007 (in Mongolian)

I.EEM202 — Theory of Electrical Engineering II

Module	M2 — Professional Core Module
Course type	Compulsory
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: lecture 32 h, seminar 16 h, laboratory 16 h, independent study 80 h
Recommended semester	Semester III (autumn)
Prerequisite	I.EEM201
Responsible unit	Department of Electrical Power Supply
Teaching formats (hours per week)	Lecture 2 · Seminar 1 · Laboratory 1
Teaching methods	Problem-based learning; project-based learning; experiment-based (laboratory) learning.
Assessment	Attendance; activity and participation 10% · Homework; independent work 20% · Progress quizzes 20% · Laboratory reports 20% · Final examination 30%

Course aim

To study the fundamental laws and elements of alternating-current circuits, three-phase circuits, nonlinear and non-sinusoidal circuits, magnetic circuits, and their calculation methods.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Perform calculations of alternating-current circuits.	A.2	K2
2	Perform calculations of nonlinear circuits.	B.3	K2
3	Perform calculations of magnetic circuits.	B.3	K3
4	Carry out measurements and experiments on star- and delta-connected circuits.	B.2	K3
5	Draw conclusions from measurement and experiment results.	D.6	S1
6	Determine further actions on the basis of experiment results.	D.6	S2
7	Prepare and present a report on the results of laboratory work.	B.1	S3

Content

Three-phase circuits, generators and the rotating magnetic field; star and delta connections; analysis of symmetrical and asymmetrical three-phase circuits; three-phase power and its measurement; symmetrical components and their application; non-sinusoidal circuits and their analysis, non-sinusoidal regimes in symmetrical polyphase circuits; nonlinear DC and AC circuits; synthesis of electrical circuits; magnetic circuits and their analysis. Laboratory: star–star three- and four-wire circuits; delta–delta circuits; power measurement; symmetrical and asymmetrical three-phase circuits.

Reading list and tools

Main: Kh. Sukhbaatar, S. Byambaa, S. Munkhjargal, "Theory of Electrical Circuits: the Duality Principle", Ulaanbaatar, 2005, ISBN 99929-5-363-2 (in Mongolian) — Sh. Angar, D. Otgonjargal, "Fundamentals of the Theory of Electrical Engineering", Ulaanbaatar, 2011, ISBN 978-99962-53-65-2 (in Mongolian) — L. A. Bessonov, "Theoretical Foundations of Electrical Engineering", 1991 (in Russian)

Additional: P. A. Ionkin (ed.), "Theoretical Foundations of Electrical Engineering", 1984 (in Russian) — Sh. Angar, N. Dashnyam, "General Electrical Engineering", Ulaanbaatar, 1999 (in Mongolian) — S. Lyankhtsetseg, "Fundamentals of Electrical Engineering", Ulaanbaatar, 2016 (in Mongolian)

Software and tools: Virtual laboratory

I.EEM204 — Electrical Machines I

Module	M2 — Professional Core Module
Course type	Compulsory
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: lecture 32 h, seminar 16 h, laboratory 16 h, independent study 80 h
Recommended semester	Semester III (autumn)
Prerequisite	I.EEM201
Responsible unit	Department of Electrical Power Supply
Teaching formats (hours per week)	Lecture 2 · Seminar 1 · Laboratory 1
Teaching methods	Problem-based learning; project-based learning; experiment-based (laboratory) learning.
Assessment	Attendance; activity and participation 10% · Homework; independent work 20% · Progress quizzes 20% · Laboratory reports 20% · Final examination 30%

Course aim

To acquire foundational theoretical and practical knowledge of electrical machines, the fundamentals of electromechanics, focusing on transformers and asynchronous machines.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Perform calculations for the various operating regimes of transformers and asynchronous machines.	A.2	K2
2	Obtain new information on transformers and asynchronous machines.	C.3	K2
3	Identify and repair faults of transformers and asynchronous machines.	B.2	K3
4	Operate transformers and asynchronous machines.	B.5	S1
5	Test transformers and asynchronous machines in various operating regimes.	B.2	S3
6	Prepare and present a report on the results of laboratory work.	B.1	S3

Content

Basic concepts, purpose and classification of electrical machines; materials used in electrical machines; transformers: construction, operating principle and basic equations; referred parameters and equivalent circuit, experimental determination of its parameters; load operation and vector diagrams; secondary voltage change and external characteristic; three-phase transformers and winding connection groups; parallel operation, losses and efficiency; special transformers (instrument, multi-winding) and autotransformers; general theory of AC machines: construction, classification and principles of polyphase windings.

Reading list and tools

Main: D. Ulzii-Orshikh, "Electrical Machines and Micromachines", Ulaanbaatar, 2022, ISBN 978-99973-827-3-3 (in Mongolian) — D. Ulzii-Orshikh, "Special-Purpose and Micro Electrical Machines", Ulaanbaatar, 2014 (in Mongolian) — N. Dashnyam, D. Enkhtuvshin, "Electrical Machines", Ulaanbaatar, 2012 (in Mongolian) — D. E. Bruskin, A. E. Zorokhovich, V. S. Khvostov, "Electrical Machines", parts 1–2, 1990 (in Russian)

Additional: D. Ulzii-Orshikh, N. Dashnyam, "Laboratory Manuals for Electrical Machines", Ulaanbaatar, 2012 (in Mongolian) — D. Ulzii-Orshikh, N. Dashnyam, "Calculation of Transformers", Ulaanbaatar, 2004 (in Mongolian) — D. Ulzii-Orshikh, "Calculation of Windings of Alternating-Current Machines", Ulaanbaatar, 2017 (in Mongolian)

Software and tools: Virtual laboratory

I.ECM201 — Electronics

Module	M2 — Professional Core Module
Course type	Compulsory
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: lecture 32 h, seminar 16 h, laboratory 16 h, independent study 80 h
Recommended semester	Semester III (autumn)
Prerequisite	I.EEM201
Responsible unit	Department of Electrical Power Supply
Teaching formats (hours per week)	Lecture 2 · Seminar 1 · Laboratory 1
Teaching methods	Problem-based learning; project-based learning; experiment-based (laboratory) learning.
Assessment	Attendance 10% · Activity and participation 5% · Progress quizzes 20% · Laboratory reports 15% · Independent work 20% · Final examination 30%

Course aim

To provide the fundamentals of analogue and digital electronics, to understand the physical fundamentals of semiconductor elements, and to know the basic operating structure of electronic devices.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Acquire theoretical knowledge of the operating principles of semiconductor devices, the physical basis of digital devices, and electronic components.	A.2	K3
2	Read and explain circuit diagrams and connect, test, adjust and repair simple electronic circuits.	B.2	S3
3	Assemble basic analogue rectifier circuits, work with transistors and digital logic, and assemble and operate an electronic device as an individual assignment.	D.5	A2
4	Acquire knowledge of basic electronic components and circuits.	A.2	1,2
5	Understand the fundamentals of diode and transistor circuits.	A.2	4
6	Understand the operation of selected IC-based circuits.	A.2	3
7	Study logic gates in digital circuits and their applications.	A.2	2
8	Acquire knowledge of power-electronic devices and converters used in electrical power engineering.	A.3	3
9	Verify circuits and use basic test and measuring instruments in order to understand the operation of various electronic circuits.	B.2	4 3
10	Prepare and present a report on the results of laboratory work.	B.1	S3

Content

Basic concepts of electronics and electrical conduction in semiconductors; the p–n junction and the structure and operation of diodes; bipolar transistors; field-effect transistors; thyristors; single-phase and three-phase rectifiers; amplifiers: general concepts, structure, classification, main quantities and signal distortion; single-stage common-emitter amplifier with a bipolar transistor; fundamentals of microelectronics: integrated circuits, basic logic elements and their base circuits; flip-flops; encoders and counters; multiplexers, demultiplexers and adders; analogue-to-digital and digital-to-analogue converters. Seminars: calculation of semiconductor and Zener diodes, bipolar and field-effect transistors and power semiconductor devices; number systems; analysis of logic circuits; simplification of Boolean expressions and Karnaugh maps. Laboratory work: semiconductor diodes; single-phase rectifier; Zener-diode voltage stabiliser; bipolar-transistor circuits. Independent work: study, calculation, element selection, assembly on a board and testing of an electronic device assigned to each student, with a written report and defence.

Reading list and tools

Additional: B. Bat-Otgon, "Fundamentals of Electronics", 2017 (in Mongolian)

Software and tools: Multisim

I.EEM209 — Electrical Engineering Materials

Module	M2 — Professional Core Module
Course type	Compulsory
Credits	2 MUST credits (3.6 ECTS)
Workload	96 h: lecture 24 h, laboratory 16 h, independent study 56 h
Recommended semester	Semester III (autumn)
Prerequisite	S.PHM102
Responsible unit	Department of Electrical Power Supply
Teaching methods	Problem-based learning; project-based learning; experiment-based (laboratory) learning.
Assessment	Attendance; activity and participation 10% · Homework; independent work 15% · Progress quizzes 20% · Laboratory reports 25% · Final examination 30%

Course aim

To provide electrical engineering students with systematic theoretical and practical knowledge of the materials widely used in electrical engineering — including conductors, semi-conductors, insulating and magnetic materials — enabling students to select, apply, and maintain electrical equipment in power engineering practice.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Know the theory and mechanisms of polarisation, dielectric losses, electrical conduction and breakdown occurring in insulating materials under electric and magnetic fields.	A.2	K1 A1
2	Evaluate the practical significance of conducting, semi-conducting, magnetic, optical, micro- and quantum-electronic materials on the basis of their classification, technological development and modern applications, including superconductivity.	A.2	
3	Select and use electro-technical materials correctly for specific applications in the energy sector.	B.5	S1 A1
4	Determine and measure the principal parameters of electro-technical materials, carry out standard tests in accordance with safety regulations, and read and use the electrical schematics of protective equipment.	B.2	S1 A1
5	Develop creative professional activity by applying knowledge of technological know-how and advances in electro-technical materials in order to understand and use power equipment.	D.3	S1
6	Consolidate theoretical knowledge, study the principal schemes used in testing and measuring electro-technical materials, and become familiar with diagnostic methods for high-voltage insulating materials.	B.2	K1 S1
7	Master safety techniques for work on high- and low-voltage equipment.	B.5	S1
8	Carry out measurements and experiments in a team and draw conclusions from the results.	B.4	S1 A2
9	Prepare and present a report on the results of laboratory work.	B.1	S3

Content

Classification of electrical engineering materials; dielectrics: permittivity of gaseous, liquid and solid insulation, types of polarisation; dielectric losses and their measurement; conductivity of solid, liquid and gaseous insulation and breakdown theory; conductor materials: physical basis of conductivity, electrical alloys; superconductivity, its current and prospective applications in the energy sector; elementary and compound semiconductor materials and their electrical applications; optoelectronic semiconductor devices.

Topic outline

1. Classification of electro-technical materials: conductors, semi-conductors, insulators, magnetic materials.

2. Insulating materials: solid, liquid, and gaseous insulators; dielectric polarisation; dielectric losses; breakdown strength.
3. Conducting materials: metals and alloys used in electrical engineering; resistance and temperature coefficients.
4. Semi-conducting materials: intrinsic and doped semiconductors; p-n junction; applications in power devices.
5. Magnetic materials: hard and soft magnetic materials; hysteresis loop; core losses; applications in transformers and machines.
6. Composite and special-purpose materials: heat-resistant, fire-resistant, and nano-structured materials.

Reading list and tools

Main: G. Bekhbat, Ts. Erdenetuya, "Materials of Electrical Engineering and Electronics: Theory and Application", 2018, ISBN 978-99962-1-579-7 (in Mongolian)

S.IMM200 — Fundamentals of Mathematical Calculations

Module	M2 — Professional Core Module
Course type	Compulsory
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: lecture 32 h, laboratory 32 h, independent study 80 h
Recommended semester	Semester III (autumn)
Prerequisite	S.MTM132
Responsible unit	Department of Mathematics, School of Applied Sciences
Teaching formats (hours per week)	Lecture 2 · Laboratory 2
Teaching methods	Problem-based learning; experiment-based (laboratory) learning.
Assessment	Attendance and participation · homework and independent work · progress tests · laboratory reports · final examination

Course aim

To give students a basic understanding of engineering and technological modelling, computational experiments, statistical processing and analysis.

Course learning outcomes

No	Course learning outcome
1	Become familiar with the basic concepts of the MATLAB computing software.
2	Create and use user-defined functions and files.
3	Solve selected mathematical problems using symbolic mathematics.
4	Acquire the basic concepts of statistical data processing.
5	Become familiar with the basic concepts of modelling and carry out simulation experiments.

Content

Fundamentals of MATLAB; creating vectors and matrices and operating on them; user-defined functions and files; programming in MATLAB; two- and three-dimensional plots; numerical characteristics of samples; systems of linear equations; symbolic mathematics; differential equations; numerical methods (algebraic equations in one variable, integration, differential equations); interpolation and polynomial approximation; mathematical programming problems; fundamentals and applications of Simulink.

Reading list and tools

B. Uuganbayar, D. Ariun-Erdene, M. Enkhtsetseg, U. Uyanga, "Fundamentals of Mathematical Calculations", Ulaanbaatar, 2018 (in Mongolian) — S. T. Karris, "Introduction to Simulink with Engineering Applications", 2006 — A. F. Dashchenko, V. Kh. Kirillov, "MATLAB in Engineering and Scientific Calculations", 2003 (in Russian). Software: MATLAB, Simulink.

S.NAM201 — Computational Mathematics

Module	M2 — Professional Core Module
Course type	Compulsory
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: lecture 32 h, laboratory 32 h, independent study 80 h
Recommended semester	Semester IV (spring)
Prerequisite	S.MTM132
Responsible unit	Department of Mathematics
Teaching formats (hours per week)	Lecture 2 · Laboratory 2
Teaching methods	Problem-based learning; project-based learning.
Assessment	Attendance; activity and participation 10% · Homework; independent work 20% · Progress quizzes 20% · Course work; project 20% · Final examination 30%

Course aim

To study and master the methods of computational mathematics and to apply them in solving theoretical and practical problems of one's own profession.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Approximate nonlinear equations, systems of linear and nonlinear equations, integrals and derivatives using numerical methods.	A.1	K3 S4 A5
2	Construct function approximations and perform interpolation.	B.3	K4 S5 A5
3	Build simple mathematical models and write and debug their algorithms and programs.	D.4	K4 S5 A5
4	Master the methods of computational mathematics and solve simple theoretical and practical problems in one's own field.	B.3	K3 S4 A5
5	Work independently and in a team.	B.4	K6 S4 A4

Content

Types of error in approximate values and their estimation; requirements for numerical computation and stability; separation of roots and solution of nonlinear equations (bisection, simple iteration, chord method); Newton's method and its extensions; Gaussian elimination with pivoting and LU decomposition; Jacobi and Gauss–Seidel iterative methods; tridiagonal systems (sweep method); numerical computation of eigenvalues and eigenvectors; systems of nonlinear equations (simple iteration, Newton's method); approximation and interpolation of functions (Lagrange and Newton polynomials), least-squares method.

Reading list and tools

Main: T. Zhanlav, L. Uvgun, R. Rinchinbazar, "Computational Mathematics I", Ulaanbaatar, 2006 (in Mongolian) — John H. Mathews, Kurtis D. Fink "Numerical methods using MATLAB", 2010 — Kendall E. Atkinson "An introduction to numerical analysis", 1989 — Richard L. Burden, J. Douglas Faires, "Numerical analysis", 2010

Software and tools: MATLAB MS Excel

I.EEM203 — Theory of Electrical Engineering III

Module	M2 — Professional Core Module
Course type	Compulsory
Credits	2 MUST credits (3.6 ECTS)
Workload	96 h: lecture 16 h, seminar 16 h, laboratory 16 h, independent study 48 h
Recommended semester	Semester IV (spring)
Prerequisite	I.EEM202
Responsible unit	Department of Electrical Power Supply
Teaching formats (hours per week)	Lecture 1 · Seminar 1 · Laboratory 1
Teaching methods	Problem-based learning; project-based learning; experiment-based (laboratory) learning.
Assessment	Attendance; activity and participation 10% · Homework; independent work 20% · Progress quizzes 20% · Laboratory reports 20% · Final examination 30%

Course aim

To study transient processes in electrical circuits, lines with distributed parameters, and the fundamentals of electromagnetic field theory, and to master the relevant calculation methods.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Study the first law of commutation.	A.2	K2
2	Study the second law of commutation.	A.2	K2
3	Carry out experiments on the first and second laws of commutation.	B.2	K3
4	Study and draw conclusions on the difference between the first and second laws of commutation.	D.6	S1
5	Prepare and present a report on the results of laboratory work.	B.1	S3

Content

Transient processes in electrical circuits and the laws of commutation; transients in DC and AC circuits; classical method, operator method and Duhamel's integral; lines with distributed parameters: primary and secondary parameters, calculation of currents and voltages; electromagnetic field and its calculation. Laboratory: transients in series and parallel RL, RC and RLC circuits.

Reading list and tools

Main: Kh. Sukhbaatar, S. Byambaa, S. Munkhjargal, "Theory of Electrical Circuits: the Duality Principle", Ulaanbaatar, 2005, ISBN 99929-5-363-2 (in Mongolian) — Sh. Angar, D. Otgonjargal, "Fundamentals of the Theory of Electrical Engineering", Ulaanbaatar, 2011, ISBN 978-99962-53-65-2 (in Mongolian) — L. A. Bessonov, "Theoretical Foundations of Electrical Engineering", 1991 (in Russian)

Additional: P. A. Ionkin (ed.), "Theoretical Foundations of Electrical Engineering", 1984 (in Russian) — Sh. Angar, N. Dashnyam, "General Electrical Engineering", Ulaanbaatar, 1999 (in Mongolian) — S. Lyankhtsetseg, "Fundamentals of Electrical Engineering", Ulaanbaatar, 2016 (in Mongolian)

Software and tools: Virtual laboratory

I.EEM205 — Electrical Machines II

Module	M2 — Professional Core Module
Course type	Compulsory
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: lecture 32 h, seminar 16 h, laboratory 16 h, independent study 80 h
Recommended semester	Semester IV (spring)
Prerequisite	I.EEM204
Responsible unit	Department of Electrical Power Supply
Teaching formats (hours per week)	Lecture 2 · Seminar 1 · Laboratory 1
Teaching methods	Problem-based learning; project-based learning; experiment-based (laboratory) learning.
Assessment	Attendance; activity and participation 10% · Homework; independent work 20% · Progress quizzes 20% · Laboratory reports 20% · Final examination 30%

Course aim

To acquire foundational theoretical and practical knowledge of electrical machines, focusing on synchronous and direct-current machines.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Perform calculations for the various operating regimes of synchronous and direct-current machines.	A.2	K2
2	Obtain new information on synchronous and direct-current machines.	C.3	K2
3	Identify and repair faults of synchronous and direct-current machines.	B.2	K3
4	Operate synchronous and direct-current machines.	B.5	S1
5	Test synchronous and direct-current machines in various operating regimes.	B.2	S3
6	Prepare and present a report on the results of laboratory work.	B.1	S3

Content

Synchronous machines: construction, operating principle and excitation systems; magnetic field and no-load operation of salient- and non-salient-pole machines; load operation and armature reaction; vector diagrams (Blondel and Potier diagrams); characteristics of synchronous machines; parallel operation and conditions for synchronisation; control of active and reactive power; power–angle characteristic, electromagnetic torque and static stability; synchronous motors, starting, synchronous compensators; DC machines: classification, construction, operating principle and basic equations; magnetic field and armature reaction and its reduction.

Reading list and tools

Main: D. Ulzii-Orshikh, "Electrical Machines and Micromachines", Ulaanbaatar, 2022, ISBN 978-99973-827-3-3 (in Mongolian) — D. Ulzii-Orshikh, "Special-Purpose and Micro Electrical Machines", Ulaanbaatar, 2014 (in Mongolian) — N. Dashnyam, D. Enkhtuvshin, "Electrical Machines", Ulaanbaatar, 2012 (in Mongolian) — D. E. Bruskin, A. E. Zorokhovich, V. S. Khvostov, "Electrical Machines", parts 1–2, 1990 (in Russian)

Additional: D. Ulzii-Orshikh, N. Dashnyam, "Laboratory Manuals for Electrical Machines", Ulaanbaatar, 2012 (in Mongolian) — D. Ulzii-Orshikh, N. Dashnyam, "Calculation of Transformers", Ulaanbaatar, 2004 (in Mongolian) — D. Ulzii-Orshikh, "Calculation of Windings of Alternating-Current Machines", Ulaanbaatar, 2017 (in Mongolian)

Software and tools: Virtual laboratory

I.EEM210 — High-Voltage Engineering

Module	M2 — Professional Core Module
Course type	Compulsory
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: lecture 32 h, laboratory 64 h, independent study 48 h
Recommended semester	Semester IV (spring)
Prerequisite	I.EEM209
Responsible unit	Department of Electrical Power Supply
Teaching formats (hours per week)	Lecture 2 · Laboratory 4
Teaching methods	Problem-based learning; project-based learning; experiment-based (laboratory) learning.
Assessment	Attendance; activity and participation 15% · Homework; independent work 15% · Progress quizzes 15% · Laboratory reports 25% · Final examination 30%

Course aim

To provide students with understanding of the physical processes occurring in high-voltage insulation systems, the causes and mechanisms of insulation failure, and the principles and methods for ensuring reliable operation of high-voltage electrical equipment.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Evaluate the hazardous factors acting on insulation structures and assess their reliable operating condition.	A.3	K2
2	Carry out preventive measurements and tests of external and internal high-voltage insulation on the basis of the underlying physical phenomena and master their diagnostics.	B.2	S2
3	Organise work safely in accordance with safety regulations, work in a team when carrying out standard tests, and design and connect the electrical schemes of automatic signalling for protective equipment.	B.4	S2 A3
4	Perform probability calculations of lightning overvoltage on high-voltage overhead lines and calculate lightning-protection and earthing devices.	D.4	S2
5	Consolidate theoretical knowledge, study the principal measurement schemes, and determine the ageing and fault level of high-voltage equipment.	B.2	K2
6	Master safety techniques for work on high-voltage and network equipment.	B.5	S2
7	Diagnose equipment condition on the basis of measurement and test results.	D.6	A2
8	Prepare and present a report on the results of laboratory work.	B.1	S3

Content

Types and classification of applied voltages, electrical stresses, principles of insulation design and selection; external insulation: gas discharge characteristics, types of discharge, collision ionisation; electron avalanches, conditions for self-sustained discharge, streamer theory; breakdown voltage, Paschen's law, breakdown in non-uniform fields, barrier effect, discharge time and volt–second characteristic; surface and sliding discharges, flashover of wet and polluted surfaces, pollution zones; corona on DC and AC lines and its reduction, calculation of corona losses; internal insulation and methods of field grading.

Topic outline

1. Introduction: types and classification of voltages; electric field in insulating structures; design principles.
2. External insulation: gas insulation breakdown; Paschen law; corona discharge; contamination and humidity effects.
3. Internal insulation: liquid insulation breakdown; solid insulation; thermal and electrical ageing.
4. Atmospheric overvoltages: lightning discharges; lightning protection; lightning arresters; coordination of insulation.

5. Internal overvoltages: switching overvoltages in transmission lines and transformers.
6. High-voltage testing: test equipment; impulse generators; measurement of high voltages.
7. Central Energy System of Mongolia: 110/220 kV line insulation design and maintenance.

Reading list and tools

Z. Tserendorj, Ts. Erdenebat. "High Voltage Engineering — 1: External Insulation." 2004 (in Mongolian). Z. Tserendorj, Ts. Erdenetuya. "High Voltage Engineering — 2: Internal Insulation." 2006 (in Mongolian). E. Kuffel, W. S. Zaengl, J. Kuffel. "High Voltage Engineering Fundamentals." Oxford: Butterworth-Heinemann, 2000.

Additional: G. Bekhbat, Ts. Erdenetuya, "High-Voltage Laboratory Manual", 2015 (in Mongolian) — F. A. M. Rizk, G. N. Trinh, "High Voltage Engineering", 2014 — E. Kuffel, W. S. Zaengl, "High Voltage Engineering: Fundamentals", 2000

Major core electives (C.2)

I.EEB202 — Low Voltage Electrical Equipment and Controls

Module	M2 — Professional Core Module
Course type	Major core elective (C.2)
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: lecture 32 h, seminar 32 h, independent study 80 h
Recommended semester	Any semester
Prerequisite	I.EEM201
Responsible unit	Electrical Engineering Division, Power Engineering School
Teaching formats (hours per week)	Lecture 2 · Seminar 2
Teaching methods	Problem-based learning; project-based learning; example-based (peer) learning.
Assessment	Attendance and participation · homework and independent work · progress tests · final examination

Course aim

To learn the operating principles of the power electrical equipment of industrial enterprises and of public and residential buildings, to read the control circuits of the low-voltage equipment in these installations, and to use them in maintenance.

Course learning outcomes

No	Course learning outcome
1	Know the types of low-voltage electrical equipment.
2	Perform selection calculations for low-voltage electrical equipment.
3	Develop the scheme of a smart substation.

Content

Reversing control of induction motors with magnetic starters; selection of magnetic starters, contactors and thermal relays; local and remote control circuits; 0.4 kV four-wire and five-wire systems; selection of distribution boards, cables and self-supporting insulated conductors; energy-loss calculation in 0.4 kV networks; measurement and analysis of current, voltage and power; supply-reliability indices (SAIDI, SAIFI, CAIDI); smart meters for 220/380 V; electric heating of smart residential buildings; PowerFactory exercises; smart-grid project.

Reading list and tools

Kh. Tsagaan, M. Khuyagdorj, "Transmission and Distribution of Electrical Energy", Ulaanbaatar, 2017, ISBN 978-99978-57-09-5 (in Mongolian) — B. Yu. Lipkin, "Power Supply of Industrial Enterprises and Installations", 2000 (in Russian).

I.EEB203 — Standardization and the Basis of Innovation

Module	M2 — Professional Core Module
Course type	Major core elective (C.2)
Credits	2 MUST credits (3.6 ECTS)
Workload	96 h: lecture 24 h, seminar 16 h, independent study 56 h
Recommended semester	Any semester
Prerequisite	—
Responsible unit	Electrical Engineering Division, Power Engineering School
Teaching formats (hours per week)	Lecture 1.5 · Seminar 1
Teaching methods	Problem-based learning; project-based learning; example-based (peer) learning.
Assessment	Attendance and participation 10% · homework and independent work 30% · progress tests 30% · final examination 30%

Course aim

To introduce the basic concepts of innovation, intellectual property, technology transfer and standardisation, together with international trends in innovation and the current situation in Mongolia.

Course learning outcomes

No	Course learning outcome
1	Know the standards for electrical equipment.
2	Register intellectual property.
3	Know the sequence and the rules for bringing an innovative product to market.

Content

Standards: basic concepts, the law on standardisation in force in Mongolia, standards for electrical equipment. Start-up companies: basic concepts and the rules for establishing a start-up. Intellectual property: basic concepts, the intellectual-property law in force in Mongolia, copyright, patents for inventions and utility models, trademarks.

Reading list and tools

B. Ochirbat, T. Namnan, B. Sergelen, "Experience and Impact of Implementing Innovation", Ulaanbaatar, 2019 — L. Oyuntsetseg, "Management of Productivity, Quality and Innovation", 2020, ISBN 978-9919-506-09-4 (both in Mongolian).

I.EEB205 — Electric Drive and Control Techniques

Module	M2 — Professional Core Module
Course type	Major core elective (C.2)
Credits	2 MUST credits (3.6 ECTS)
Workload	96 h: lecture 24 h, laboratory 16 h, independent study 56 h
Recommended semester	Spring
Prerequisite	I.EEM201
Responsible unit	Department of Electrical Power Supply
Teaching methods	Problem-based learning; project-based learning; experiment-based (laboratory) learning.
Assessment	Attendance; activity and participation 10% · Homework; independent work 20% · Progress quizzes 20% · Laboratory reports 20% · Final examination 30%

Course aim

To study power-semiconductor conversion techniques and their application in electric drives.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Acquire a basic understanding of power-electronic conversion techniques.	A.2	K2
2	Understand the effects of semiconductor converters on the power system.	A.3	K2
3	Locate a faulty semiconductor device within a complex circuit.	B.2	K3
4	Develop and use the circuits of simple semiconductor converters.	D.4	S3
5	Test power-converter circuits in simulation software.	B.2	S4
6	Prepare and present a report on the results of laboratory work.	B.1	S3

Content

Basic concepts of electric drives and control technology; power semiconductor devices: ratings, purpose and characteristics; frequency converters, their control and operation; single-phase half- and full-bridge inverters, PWM control; matrix converters; harmonics and semiconductor-based compensation devices; single- and three-phase AC controllers; three-phase inverters, V/f and vector control; grid inverters, power control and thermal management of semiconductor devices; cycloconverters and protection of power semiconductors. Laboratory: half- and full-wave rectifiers; one- and four-quadrant DC converters.

Reading list and tools

Main: G. Enkhbayar, "Power Conversion Technique", Ulaanbaatar, 2014, 628 pp., ISBN 978-99973-969-4-5 (in Mongolian) — B. Sergelen, "Laboratory Manual for Electric Drives", Ulaanbaatar, 2010 (in Mongolian) — M. H. Rashid, "Power Electronics"

Additional: A. Kloss, "A Basic Guide to Power Electronics", John Wiley & Sons, 1984 — R. Shaffer, "Fundamentals of Power Electronics with MATLAB", Charles River Media — M. Barnes, "Practical Variable Speed Drives and Power Electronics", 2003 — A. Mahdy, "Ultimate Power Electronics and Electrical Protection Course" (udemy.com)

Software and tools: Texas Instruments resource explorer (controlSUITE); Lucas-Nülle power-electronics equipment and software

I.EEM207 — Fundamental of Programming of Electrical Power System

Module	M2 — Professional Core Module
Course type	Major core elective (C.2)
Credits	2 MUST credits (3.6 ECTS)
Workload	96 h: lecture 24 h, laboratory 16 h, independent study 56 h
Recommended semester	Any semester
Prerequisite	—
Responsible unit	Electrical Engineering Division, Power Engineering School
Teaching formats (hours per week)	Lecture 1.5 · Laboratory 1
Teaching methods	Problem-based learning; project-based learning; experiment-based (laboratory) learning.
Assessment	Attendance and participation 5% · homework and independent work 10% · progress tests 20% · laboratory reports 15% · course project 20% · final examination 30%

Course aim

To develop the ability to design algorithms and write programs for various power-system calculations, and to use the MATLAB package in power calculations.

Course learning outcomes

No	Course learning outcome
1	Apply algorithm design to the optimal selection of conductor cross-sections.
2	Develop programs that determine line parameters according to an algorithm.
3	Carry out regime calculations using the programming methods acquired.
4	Use written and oral skills in writing and defending independent work and project reports.
5	Use software to determine the equivalent-circuit parameters of lines and transformers.

Content

Logic and logical thinking; algorithms and calculation methods of power systems; fundamentals of programming and programming languages; programmed analysis of load curves; fundamentals of MATLAB; programming the determination of the equivalent-circuit parameters of lines; programming classical and modern methods of regime calculation; algorithms for determining the loss time and for energy-loss calculation.

Reading list and tools

B. Uuganbayar, D. Ariun-Erdene, "MATLAB and Its Applications", 2018, ISBN 978-99962-72-56-7 — P. Ariunbolor, "MATLAB Programming for Engineering", 2020, ISBN 978-9919-21-802-7 (both in Mongolian).

I.EEM216 — Management and Marketing in the Electrical Industry

Module	M2 — Professional Core Module
Course type	Major core elective (C.2)
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: lecture 32 h, seminar 32 h, independent study 80 h
Recommended semester	Any semester
Prerequisite	—
Responsible unit	Electrical Engineering Division, Power Engineering School
Teaching formats (hours per week)	Lecture 2 · Seminar 2
Teaching methods	Problem-based learning; project-based learning (team assignments).
Assessment	Attendance and participation 10% · homework and independent work 30% · progress tests 30% · final examination 30%

Course aim

To provide theoretical and practical knowledge of the characteristics of the energy sector and of the fundamentals of energy economics and management.

Course learning outcomes

No	Course learning outcome
1	Relate the economic and management characteristics of energy systems to the main concepts of management science.
2	Analyse the cost structure of the generation, transmission and distribution of electricity and heat.
3	Calculate the efficiency of energy enterprises, analyse the efficiency of investments and draw conclusions.
4	Calculate the power, consumption and cost of household electrical appliances and analyse energy-saving measures.
5	Apply marketing concepts to changes and market models in the energy market.
6	Use written and oral skills in completing and defending independent work.

Content

Concepts and functions of management; human-resource management in the energy sector; productivity management and labour productivity; fixed and working assets of energy enterprises; production cost of energy enterprises (thermal, combined heat-and-power and hydro plants, transmission and distribution networks); electricity prices, tariffs and tariff classes; profit and profitability; investment management and investment efficiency; energy markets and marketing.

Reading list and tools

S. Batkhuyag, Sh. Davaakhuu et al., "Economics and Finance of the Energy Sector", Ulaanbaatar, MUST Press, 2018, ISBN 978-99978-3-139-2 (in Mongolian).

I.ETM209 — Electrical Power Conversion Technique

Module	M2 — Professional Core Module
Course type	Major core elective (C.2)
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h
Recommended semester	Any semester
Prerequisite	—
Responsible unit	Power Engineering School
Assessment	Continuous assessment 70% (attendance and participation, assignments, progress quizzes) · Final examination 30% (MUST Bachelor's Studies Regulation)

Course aim

To study power semiconductor devices and power electronic converters (rectifiers, AC–DC and DC–DC converters, AC voltage controllers, inverters and cycloconverters), their control and protection.

Course learning outcomes

No	Course learning outcome
1	Explain the characteristics and application areas of power semiconductor devices and power electronic converters.
2	Analyse single- and three-phase rectifiers and AC–DC converters with different loads.
3	Analyse buck, boost and buck–boost DC–DC converters and AC voltage controllers.
4	Explain the operation and voltage control of single- and three-phase inverters and cycloconverters.
5	Select protection devices for power semiconductor switches and explain the drive of electronically commutated motors.

Content

Power electronic devices and the application areas of power electronic converters; Technical characteristics, purpose and features of power semiconductor switches; Technical characteristics of rectifiers; single-phase half-wave rectifier with R, R‖C and R–L loads; Three-phase star and bridge rectifiers; Thyristor control methods; Single-phase AC–DC converters; Three-phase AC–DC converters; DC–DC converters: buck and boost converters; Buck–boost DC–DC converters; AC voltage controllers; Single-phase half-bridge and full-bridge inverters; Three-phase inverters; Voltage control of inverters; Cycloconverters; Protection devices of power semiconductor switches; Electronically commutated electric motors.

I.ETM210 — Electrical Measurement Techniques

Module	M2 — Professional Core Module
Course type	Major core elective (C.2)
Credits	2 MUST credits (3.6 ECTS)
Workload	96 h
Recommended semester	Any semester
Prerequisite	—
Responsible unit	Power Engineering School
Teaching methods	Problem-based learning; MOOC-based learning; experiment-based (laboratory) learning (lectures, independent work, flipped classroom, MOOC, team laboratory work).
Assessment	Continuous assessment 70% (attendance and participation, assignments, progress quizzes) · Final examination 30% (MUST Bachelor's Studies Regulation)

Course aim

To study the classification and errors of measurements, electromechanical and digital measuring instruments, and the measurement of electrical and non-electrical quantities.

Course learning outcomes

No	Course learning outcome
1	Classify measurements and estimate measurement errors and accuracy.
2	Explain the operating principles of electromechanical measuring mechanisms and logometers.
3	Measure current, voltage and active and reactive power in single- and three-phase circuits using shunts, additional resistors and instrument transformers.
4	Measure resistance by compensation and bridge methods and explain the principles of digital instruments.
5	Explain methods of measuring non-electrical quantities with parametric and generator transducers.

Content

Introduction; classification and definitions of measurements; measurement errors and accuracy (weeks 1–2); Electromagnetic and electrodynamic measuring mechanisms and logometers (weeks 3–4); Measuring circuits of ammeters and voltmeters; shunts and additional resistors (weeks 5–6); Instrument transformers: current and voltage transformers; power measurement (weeks 7–8); Measurement of active and reactive power in single- and three-phase circuits (weeks 9–10); Compensation method; resistance measurement with single and double DC bridges (weeks 11– 12); Fundamentals of digital instruments and methods of digital measurement (weeks 13–14); Methods of measuring non-electrical quantities; parametric and generator transducers (weeks 15–16).

I.TEM209 — Thermal Power Equipment

Module	M2 — Professional Core Module
Course type	Major core elective (C.2)
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h
Recommended semester	Any semester
Prerequisite	—
Responsible unit	Power Engineering School
Teaching methods	Problem-based learning; experiment-based learning (lectures and seminars).
Assessment	Continuous assessment 70% (attendance and participation, assignments, progress quizzes) · Final examination 30% (MUST Bachelor's Studies Regulation)

Course aim

To study the fundamentals of technical thermodynamics and heat transfer and the main equipment and technological schemes of thermal power plants.

Course learning outcomes

No	Course learning outcome
1	Apply the first and second laws of thermodynamics to thermodynamic processes and cycles (Carnot, Otto, Diesel, Trinkler).
2	Determine the state of water vapour from steam tables and calculate the efficiency of thermal power cycles.
3	Explain heat transfer by conduction, convection and radiation.
4	Describe the classification of power plants and the technological scheme of a thermal power plant, including boilers, turbines and dust-collection systems.
5	Explain the environmental effects of thermal power generation and the role of dust-collection systems.

Content

Subject of technical thermodynamics; state parameters, gas mixtures and heat capacity; First law of thermodynamics: work, heat, enthalpy and entropy; Thermodynamic processes: polytropic, isochoric, isothermal, isobaric and isentropic; Second law of thermodynamics; cycles; direct and reverse Carnot cycles; Internal combustion engines: Otto, Diesel and Trinkler cycles; Water vapour: wet and superheated steam; steam tables; Cycles of thermal power equipment; calculation of cycle efficiency; Basic concepts of heat transfer; thermal conduction; Convective heat transfer; Radiative heat transfer; Classification of power plants; Technological scheme of a thermal power plant; Dust-collection systems; Boiler equipment and its classification; Turbine equipment; Detailed scheme of a thermal power plant.

M3 — Power Supply Specialisation Module

Compulsory courses

I.EEB303 — Renewable Energy and Hybrid Systems

Module	M3 — Power Supply Specialisation Module
Course type	Compulsory
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: lecture 32 h, seminar 32 h, independent study 80 h
Recommended semester	Semester IV (spring)
Prerequisite	I.EEM202
Responsible unit	Department of Electrical Power Supply
Teaching methods	Problem-based learning; project-based learning; example-based learning.
Assessment	Attendance; activity and participation 10% · Homework; independent work 30% · Progress quizzes 30% · Final examination 30%

Course aim

To study the operating principles and economical use of solar, wind, water, biomass, and stationary diesel power sources used for remote areas and critical facilities away from the power system.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Know the technologies and operation of non-conventional energy sources.	A.3	K2
2	Perform calculations for renewable-energy generating units.	B.3	K2
3	Develop the design of a renewable-energy generating unit.	D.4	K3
4	Elaborate the design of a renewable-energy generating unit.	D.4	
5	Calculate the carbon-emission savings achieved by using renewable-energy sources.	D.1	K3
6	Evaluate the results obtained from installing a renewable-energy generating unit.	D.6	S1

Content

Thermodynamic state parameters, ideal-gas laws and gas mixtures; heat capacity and basic thermodynamic processes; internal combustion engines: classification, operating principle and construction, working cycles, indicated and effective power; diesel power plants: generators, excitation and automatic protection; semiconductor materials and the p–n junction; photovoltaic generation of electricity; DC and induction generators driven by rotating mechanical energy (wind); fuel gasification; fuel cells and energy storage. Individual project: site data (latitude and longitude), load growth, monthly solar irradiation, and sizing of a PV system to meet a given demand.

Reading list and tools

Main: Z. Tserendorj, Ts. Erdenetuya, "Use of Renewable Energy and Energy Storage", Ulaanbaatar, 2015 (in Mongolian) — V. P. Alekseev, "Internal Combustion Engines", Mashgiz, 1982 (in Russian)

Additional: I. A. Budzko (ed.), "Practical Course on Rural Power Supply", Moscow, Kolos, 1982 (in Russian) — Alternative power sources

S.EPM301 — English for Specific Purposes

Module	M3 — Power Supply Specialisation Module
Course type	Compulsory
Credits	2 MUST credits (3.6 ECTS)
Workload	96 h: practical classes 64 h, independent study 32 h
Recommended semester	Semester IV (spring)
Prerequisite	S.CEM101
Responsible unit	Department of English Language
Teaching formats (hours per week)	Practical classes 4
Teaching methods	Problem-based learning; project-based learning; experiment-based learning.
Assessment	Attendance and participation 15% · homework and independent work 30% · progress tests 25% · final examination 30%

Course aim

To develop students' reading, writing, listening and speaking skills in English for professional purposes, so that they understand the terminology of the sector, acquire the relevant theoretical knowledge of English, and read, write and translate professional texts independently.

Course learning outcomes

No	Course learning outcome
1	Reading: read and understand professional texts, process descriptions, essays, e-mails, official letters and project documents in English.
2	Writing: collect information, plan, draft and revise texts on professional topics using professional English vocabulary and appropriate grammar.
3	Speaking and listening: prepare for and take part in job interviews, give short presentations and conduct professional conversations in the workplace.
4	Translation: translate texts related to the profession from English into Mongolian and from Mongolian into English.
5	Soft skills: work in teams and in pairs, give presentations, take part in discussions and debates.

Content

Introduction to the professional field; trends in the sector and in the profession; professional topics of the energy sector studied through reading, speaking, writing and listening; translation of professional texts; progress tests.

Reading list and tools

S. Campbell, "Energy Industry" (Oxford Career English), 2018, ISBN 978-0-19-457921-6 — N. Altanzul, A. Amarzaya, "English for Power Engineering", 2016.

I.EEB302 — Electrical Transmission and Distribution Networks

Module	M3 — Power Supply Specialisation Module
Course type	Compulsory
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: lecture 32 h, seminar 32 h, independent study 80 h
Recommended semester	Semester V (autumn)
Prerequisite	I.EEM203
Responsible unit	Department of Electrical Power Supply
Teaching formats (hours per week)	Lecture 2 · Seminar 2
Teaching methods	Problem-based learning; project-based learning; experiment-based (laboratory) learning.
Assessment	Attendance; activity and participation 10% · Homework; independent work 20% · Progress quizzes 30% · Final examination 30%

Course aim

To study the operating regimes of electrical networks, their features, and the fundamental parameters of electrical networks, and to acquire knowledge for evaluating, concluding, and solving technical problems.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Know the basic concepts of electrical networks.	A.3	K2
2	Calculate the parameters of electrical networks.	B.3	
3	Perform operating-regime calculations for electrical networks.	B.3	S2
4	Prepare a design project for an electrical network.	D.4	A2
5	Introduce new information into the electrical network design project.	D.3	A3

Content

Basic concepts of electrical systems and of medium- and low-voltage lines and networks; main parameters, classification and design of lines; operating modes of 6, 10 and 35 kV networks; power and energy losses and their determination, losses in 0.4 kV networks; main equipment and schemes of 6–10 kV networks; natural power and choice of voltage; distribution networks and their calculation; calculation of radial networks (iteration method); ring lines and lines supplied from both ends; complex networks (simple transformation method); voltage regulation methods; selection of compensation devices; lines with distributed parameters; methods of increasing transmission capacity.

Reading list and tools

Main: Kh. Tsagaan, M. Khuyagdorj, "Transmission and Distribution of Electrical Energy", Ulaanbaatar, 2017, ISBN 978-99978-57-09-5 (in Mongolian)

Additional: Z. Tserendorj, Ts. Erdenetuya, "Fundamentals of Power Supply and Distribution", Ulaanbaatar, 2017, ISBN 978-99978-0-681-9 (in Mongolian)

I.EEB310 — Fundamentals of Electric Lighting

Module	M3 — Power Supply Specialisation Module
Course type	Compulsory (Electrical Power Supply track); open elective for other programmes
Credits	2 MUST credits (3.6 ECTS)
Workload	96 h: lecture 24 h, seminar 16 h, independent study 56 h
Recommended semester	Semester V (autumn)
Prerequisite	I.EEM202
Responsible unit	Department of Electrical Power Supply
Teaching methods	Problem-based learning; project-based learning; example-based learning.
Assessment	Attendance; activity and participation 10% · Homework; independent work 30% · Progress quizzes 30% · Final examination 30%

Course aim

To select the number and capacity of electric-lighting devices required to ensure people's normal activity in conditions of insufficient or absent natural light, to position them correctly, and to build and operate lighting networks using the technically and economically optimal option.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Know the basic concepts of daylight and lighting engineering.	A.3	K2
2	Know the methods of converting electrical energy into light energy.	A.2	K2
3	Perform calculations for the selection of luminaires.	B.3	K3
4	Study methods of reducing the electricity consumption of luminaires.	D.1	K3
5	Position and draw luminaires correctly.	D.4	S1

Content

Luminous flux and luminous intensity; illuminance on horizontal and vertical surfaces and luminance; colour of light, reflected, transmitted and absorbed light; wavelength and electromagnetic radiation; luminous efficacy; utilisation-factor method; specific-power and point methods of lighting calculation; types and operating principles of luminaires and lamp technologies; cross-sections of lighting circuits; room index, room geometry and luminaire layout; lighting circuits, power and lighting distribution boards, emergency lighting; industrial, urban and road lighting, earthing and neutral conductors.

Reading list and tools

Main: Kh. Tsagaan, M. Khuyagdorj, "Transmission and Distribution of Electrical Energy", Ulaanbaatar, 2017, ISBN 978-99978-57-09-5 (in Mongolian) — Z. Tserendorj, Ts. Erdenetuya, "Fundamentals of Power Supply and Distribution 1", Ulaanbaatar, 2017, ISBN 978-99978-0-681-9 (in Mongolian)

Additional: Z. Tserendorj, Ts. Erdenetuya, "Fundamentals of Power Supply and Distribution 2", Ulaanbaatar, 2022 (in Mongolian) — DIALux evo – new calculation method

Software and tools: DIALux evo

I.EEB325 — Electromagnetic and Mechanical Transient Processes

Module	M3 — Power Supply Specialisation Module
Course type	Compulsory
Credits	2 MUST credits (3.6 ECTS)
Workload	96 h: lecture 32 h, seminar 16 h, independent study 48 h
Recommended semester	Semester V (autumn)
Prerequisite	I.EEM202
Responsible unit	Department of Electrical Power Supply
Teaching formats (hours per week)	Lecture 2 · Seminar 1
Assessment	Attendance; activity and participation 15% · Progress quizzes 25% · Course work; project 30% · Final examination 30%

Course aim

To master the analytical theory of electromagnetic transient processes in electrical systems, to study magnetic processes, and to master the methods of calculating symmetric and asymmetric short circuits.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Apply knowledge of transient processes in evaluating the severity of short circuits occurring in the power system.	A.3	K3
2	Perform calculations of short circuits occurring in the power system.	B.3	K4
3	Use Mongolian and foreign-language literature on electromagnetic transient processes.	C.3	S3
4	Apply written and oral skills in writing and defending an individual assignment.	C.2	S3

Reading list and tools

Main: D. Sodnomdorj, B. Purevsuren, "Electromagnetic Transient Processes in Electrical Systems", Ulaanbaatar, 2018, ISBN 99929-6-299-2 (in Mongolian)

Additional: D. Sodnomdorj, B. Purevsuren, "Problem Collection on Electromagnetic Transient Processes", Ulaanbaatar, 2010, ISBN 978-99929-4-392-0 (in Mongolian) — D. Sodnomdorj, "Transient Processes in Electrical Power Systems — Laboratory Manual", Ulaanbaatar, 2008 (in Mongolian) — O. Tsogbayar, P. Erkhemtur, E. Enkhsaikhan, "Course-Work Manual on Electromagnetic Transient Processes", Ulaanbaatar, 2022, ISBN 978-9919-27-770-3 (in Mongolian) — N. Jigjidsuren, O. Tsogbayar, G. Munkhtuul, "Laboratory Manual on Electromagnetic Transient Processes", Ulaanbaatar, 2018 (in Mongolian)

Software and tools: GPM-1.0 virtual short-circuit stand

I.EEB301 — Equipment for Transmission and Distribution

Module	M3 — Power Supply Specialisation Module
Course type	Compulsory
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: lecture 32 h, seminar 16 h, laboratory 16 h, independent study 80 h
Recommended semester	Semester VI (spring)
Prerequisite	I.EEM205
Responsible unit	Department of Electrical Power Supply
Teaching formats (hours per week)	Lecture 2 · Seminar 1 · Laboratory 1
Teaching methods	Problem-based learning; project-based learning; experiment-based (laboratory) learning.
Assessment	Attendance; activity and participation 10% · Homework; independent work 20% · Progress quizzes 20% · Laboratory reports 20% · Final examination 30%

Course aim

To study the operating principles of equipment for the transmission and distribution of electrical energy and, on the basis of calculations, to select and verify such equipment.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Study the operating principles of high- and low-voltage electrical equipment and select and verify equipment on the basis of calculations.	A.3	K3
2	Analyse operating regimes on the basis of the operating principles of electrical equipment.	B.3	S3 A2
3	Carry out independent measurements and research on the basis of the theoretical material and apply them in practice.	B.2	S3 A2
4	Test theoretical knowledge of power-plant and substation equipment by performing experiments and measurements on a virtual stand.	B.2	K3 S4
5	Study the operating principles of electrical equipment, master measurement techniques, and analyse the results obtained.	B.2	K4 S4 A4
6	Compare experimental results with theoretical values and analyse them.	D.6	K3 S5
7	Prepare and present a report on the results of laboratory work.	B.1	S3

Content

Types and features of power plants and substations; electrical equipment of power transmission and distribution and its classification; current-carrying conductors; heating of apparatus and conductors; short circuits and calculation methods; high- and low-voltage electrical equipment; power transformers and autotransformers; substation switchgear and its connection schemes; instrument transformers and their selection; selection and checking of cables and conductors; auxiliary supply of substations; protection of equipment and substations. Laboratory: no-load transformer parameters; transformer voltage regulation equipment; switching operations in substations.

Reading list and tools

Main: Sh. Gantumur, "Power Plants and Substations", Ulaanbaatar, 2011 (in Mongolian) — Kh. Tsagaan, M. Khuyagdorj, "Transmission and Distribution of Electrical Energy", Ulaanbaatar, 2017, ISBN 978-99978-57-09-5 (in Mongolian)

Additional: L. D. Rozhkova, V. S. Kozulin, "Electrical Equipment of Power Plants and Substations", 1987 (in Russian) — D. Sodnomdorj, "Electrical Equipment of Power Plants and Substations", Ulaanbaatar, 2017, ISBN 978-99929-4-530-3 (in Mongolian) — B. N. Neklepaev et al., "The Electrical Part of Power Plants and Substations: Reference Material for Course and Diploma Design", Russia, 1987 (in Russian) — Yu. B. Guk et al., "Design of the Electrical Part of Power Plants and Substations", 1985 (in Russian)

Software and tools: Bileg-10 virtual laboratory stand

I.EEB304 — Industrial Power Supply

Module	M3 — Power Supply Specialisation Module
Course type	Compulsory (Electrical Power Supply track)
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: lecture 32 h, seminar 16 h, laboratory 16 h, independent study 80 h
Recommended semester	Semester VI (spring)
Prerequisite	I.EEB302
Responsible unit	Department of Electrical Power Supply
Teaching formats (hours per week)	Lecture 2 · Seminar 1 · Laboratory 1
Teaching methods	Problem-based learning; project-based learning; experiment-based (laboratory) learning.
Assessment	Attendance; activity and participation 10% · Homework; independent work 20% · Progress quizzes 20% · Laboratory reports 20% · Final examination 30%

Course aim

To study the reliable supply of quality energy to various industrial consumers and the appropriate construction and operation of sources, networks, distribution substations, and consumer complexes.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Know the general concepts of industrial power supply systems.	A.3	K2
2	Select power transformers, compensation devices and conductor cross-sections.	B.3	K2
3	Perform short-circuit calculations.	B.3	K3
4	Perform new load calculations for industrial power supply.	D.4	S1
5	Produce a new layout drawing for an industrial power supply system.	D.4	S2
6	Calculate the compensation devices of an industrial power supply system and compare the results.	D.6	A1
7	Measure the neutral-point regime of a medium-voltage network.	B.2	S3
8	Study lightning-protection and earthing installations.	B.2	S4
9	Prepare and present a report on the results of laboratory work.	B.1	S3

Content

Methods of determining the design load of industrial enterprises; development of power supply schemes; short-circuit calculation; selection of switching and protective apparatus; selection of conductor cross-sections; power and voltage losses; power quality indicators; technical and economic comparison of alternatives; power factor, reactive power calculation and selection of compensation devices; selection of power transformers; neutral earthing modes; transformer protection and selection of current and voltage transformers; calculation of electricity consumption; earthing and lightning protection. Seminars: load calculation for a workshop, substation location and load centre, internal power supply design of a plant.

Reading list and tools

Main: Kh. Tsagaan, M. Khuyagdorj, "Transmission and Distribution of Electrical Energy", Ulaanbaatar, 2017, ISBN 978-99978-57-09-5 (in Mongolian) — Z. Tserendorj, Ts. Erdenetuya, "Fundamentals of Power Supply and Distribution 1", Ulaanbaatar, 2017, ISBN 978-99978-0-681-9 (in Mongolian) — A. A. Fedorov, V. V. Kameneva, "Fundamentals of Power Supply of Industrial Enterprises", Moscow, Energoatomizdat, 1984 (in Russian)

Additional: Z. Tserendorj, Ts. Erdenetuya, "Fundamentals of Power Supply and Distribution 2", Ulaanbaatar, 2022 (in Mongolian)

I.EEB305 — Electric Drives

Module	M3 — Power Supply Specialisation Module
Course type	Compulsory (Electrical Power Supply track)
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: lecture 32 h, seminar 16 h, laboratory 16 h, independent study 80 h
Recommended semester	Semester VI (spring)
Prerequisite	I.EEM205
Responsible unit	Department of Electrical Power Supply
Teaching formats (hours per week)	Lecture 2 · Seminar 1 · Laboratory 1
Teaching methods	Problem-based learning; project-based learning; experiment-based (laboratory) learning.
Assessment	Attendance; activity and participation 10% · Homework; independent work 20% · Progress quizzes 20% · Laboratory reports 20% · Final examination 30%

Course aim

To study the components of electric drives — power sources, electrical apparatus, motors — that ensure the reliable and proper operation of various electric motors and the continuous operation of industrial processes.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Know the types of electric drives, load classification, mechanical characteristics and methods of motor speed control.	A.3	K2
2	Perform calculations for electric drives with various types of motor.	B.3	K2
3	Become familiar with the operation and applications of electric drives and select mechanical and power converters.	B.5	K3
4	Assemble electric drives with various types of motor.	D.5	S3
5	Test electric drives with various types of motor.	B.2	S4
6	Carry out measurements on electric drives with various types of motor.	B.2	S4
7	Calculate and evaluate the efficiency obtained after selecting mechanical and power converters.	D.6	
8	Prepare and present a report on the results of laboratory work.	B.1	S3

Content

Structure and components of electric drives, classification of electrical machines; drives with squirrel-cage induction motors; PWM control of AC converters; induction-motor drives with frequency converters; DC motor drives (separately, shunt-, series- and compound-excited) and their applications; synchronous-machine drives and applications, brushless excitation systems, soft starting and static excitation; drives of high-speed trains; linear-motor drives; drives with permanent-magnet rotors.

Reading list and tools

Main: B. Sergelen, "Laboratory Manual for Electric Drives", Ulaanbaatar, 2010 (in Mongolian) — N. F. Ilyinsky, "Fundamentals of the Electric Drive", 2010 (in Russian) — N. Dashnyam, D. Enkhtuvshin, "Electrical Machines", Ulaanbaatar, 2012 (in Mongolian)

Additional: M. G. Chilikin, A. S. Sandler, "General Course of Electric Drives", 1981 (in Russian) — M. G. Chilikin, A. S. Sandler, V. I. Klyukov, "Theory of the Automated Electric Drive", 1979 (in Russian) — D. Ulzii-Orshikh, "Electrical Machines and Micromachines", Ulaanbaatar, 2016, ISBN 978-99973-827-3-3 (in Mongolian) — D. Enkhbayar, "Power Conversion Technology", Ulaanbaatar (in Mongolian)

I.EEB318 — Engineering Design I

Module	M3 — Power Supply Specialisation Module
Course type	Compulsory
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: laboratory 64 h, independent study 80 h
Recommended semester	Semester VI (spring)
Prerequisite	—
Responsible unit	Department of Electrical Power Supply
Teaching formats (hours per week)	Laboratory 4
Teaching methods	Problem-based learning; project-based learning; experiment-based (laboratory) learning.
Assessment	Attendance; activity and participation 30% · Homework; independent work 20% · Creative work 50%

Course aim

To develop students' ability to design control, protection, and automation schemes for electrical power supply system components; to build, test, and document engineering designs in a laboratory environment; and to practise professional technical documentation and project reporting.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Acquire knowledge of engineering design for equipment problems, its operation and the design management process.	A.3	K3
2	Develop an engineering design for equipment problems and perform calculations.	D.4	K3
3	Use the control and mounting schemes of electrical equipment.	D.5	K4
4	Develop technical and safety instructions and documentation for equipment.	C.2	K5
5	Design the control and mounting schemes of electrical equipment and switchboard layouts.	D.4	S3
6	Select equipment in accordance with the designed schemes and drawings.	D.4	S4
7	Assemble electrical circuits.	D.5	A6
8	Prepare and present a report on the results of laboratory work.	B.1	S3
9	Present and justify the design solution.	C.1	S3

Content

Laboratory-based design work: operating modes of high-voltage equipment, relay protection and signalling; control and safe operation of three-phase power equipment; automatic control, metering of power equipment; control, relay protection, interlocking and signalling of single-phase and low-power equipment; design of current, voltage and magnetic-field measuring instruments; design of sensors for motor direction, rotor speed and position; design of DC motor control circuits; design of AC motor starting and control devices.

Topic outline

1. Engineering design process: problem definition, requirements specification, conceptual and detailed design.
2. Control and protection schemes: logic controllers; relay circuits; protective relay coordination.
3. Software tools for electrical design: AutoCAD Electrical; ETAP; MATLAB/Simulink.
4. Design project phases: schematic design, component selection, simulation, laboratory assembly and testing.
5. Technical documentation: engineering drawings; equipment lists; test protocols; project reports.
6. Design review and optimisation: evaluation criteria; iterative improvement; presentation of results.

Reading list and tools

Ts. Erdenetuya, Ch. Renchindorj. "Engineering Design I: Laboratory Manual." MUST, 2023 (in Mongolian). IEC 60617: Graphical Symbols for Diagrams (current edition). ETAP software user manual (current version).

Additional: Electronic Circuit Design - with Bipolar and MOS Transistors (Electrical and Electronic Engineering Design Series) (Volume 2) by Nicholas L. Pappas Ph.D.

I.ETM315 — Relay Protection and Automation of Power Supply

Module	M3 — Power Supply Specialisation Module
Course type	Compulsory
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h
Recommended semester	Semester VI (spring)
Prerequisite	—
Responsible unit	Department of Electrical Power Supply

Course aim

To provide students with knowledge of the principles, types, and settings of relay protection and automation devices used in electrical power supply systems, enabling them to design, set, and maintain protection systems for generators, transformers, transmission lines, busbars, and motors.

Course learning outcomes

No	Course learning outcome
1	Explain the fundamental requirements for relay protection (selectivity, speed, sensitivity, reliability) and describe the types of protection relays.
2	Analyse overcurrent, voltage, differential, distance, and directional protection schemes and determine their operating criteria.
3	Calculate protection settings for typical power system components (lines, transformers, motors, busbars).
4	Design a relay protection scheme for a given power supply system using current protection standards.
5	Describe automatic reclosing (AR) and automatic bus transfer (ABT) systems and explain their operation.

Contribution to PLO: B.1 (Skills) · B.2 (Skills) · B.3 (Skills)

Content

1. Fundamentals: protection requirements; relay types; instrument transformers and connections.
2. Overcurrent protection: time-overcurrent and instantaneous overcurrent; voltage-restrained overcurrent.
3. Directional overcurrent protection; distance (impedance) protection.
4. Differential protection: longitudinal differential protection for lines; transformer differential protection.
5. Motor and busbar protection.
6. Automatic reclosing (AR): single- and three-phase AR; two-source line AR.

I.EEB307 — Motor Control

Module	M3 — Power Supply Specialisation Module
Course type	Compulsory (Electrical Power Supply track)
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: lecture 32 h, laboratory 32 h, independent study 80 h
Recommended semester	Semester VII (autumn)
Prerequisite	I.EEB305
Responsible unit	Department of Electrical Power Supply
Teaching formats (hours per week)	Lecture 2 · Laboratory 2
Teaching methods	Problem-based learning; project-based learning; experiment-based (laboratory) learning.
Assessment	Attendance; activity and participation 10% · Homework; independent work 20% · Progress quizzes 20% · Laboratory reports 20% · Final examination 30%

Course aim

To study the types of motors used in industrial processes and transport, the fundamental components and equipment of their automation, operating principles, requirements, connections, and the automatic control schemes of industrial processes.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Acquire knowledge of the hardware and software of industrial automation.	A.3	K2
2	Study the selection and technical parameters of automatic control equipment.	B.3	K2
3	Define and plan the functions to be performed in an industrial automation process (motors, limit switches, push-buttons, time relays, signals).	D.4	S1
4	Draw the line diagram of a control circuit and program it on a programmable logic controller.	D.5	S2
5	Enter industrial automation circuit diagrams into computer software.	D.5	S3
6	Carry out assembly practice on automatic motor-control equipment.	B.2	A1
7	Control motors automatically using software.	B.5	A2
8	Prepare and present a report on the results of laboratory work.	B.1	S3

Content

Automatic control of production processes: main components; control objects, elements of automatic control systems and block-diagram transformation; control of electric drives with automatically controlled motors; thermal, smoke and motion sensors; inductive and capacitive sensors; magnetic and angle sensors; process-automation processors and ZAT modules; communication methods and servers; PERTINAX hardware and software and block diagrams; the ZAT-2000 control system; PERNET server; InTouch SCADA software: window commands, alarms and process visualisation.

Reading list and tools

Main: B. Sergelen, "The ZAT System of Automatic Motor Control", Ulaanbaatar, 2009 (in Mongolian) — B. Sergelen, "Use of the InTouch Automation Software", 2005 (in Mongolian) — B. Sergelen, "Use of the Pertinax Software", Ulaanbaatar, 2005 (in Mongolian)

Additional: B. Bat-Erdene, M. Battulga, "Theory of Automatic Control", Ulaanbaatar, 2021 (in Mongolian) — M. G. Chilikin, A. S. Sandler, V. I. Klyukov, "Theory of the Automated Electric Drive", 1979 (in Russian) — B. Sergelen, "Use of the InTouch Automation Software I — Laboratory Manual" (in Mongolian)

Software and tools: InTouch software

I.EEB308 — Safety of Electrical Equipment

Module	M3 — Power Supply Specialisation Module
Course type	Compulsory
Credits	2 MUST credits (3.6 ECTS)
Workload	96 h: lecture 32 h, independent study 64 h
Recommended semester	Semester VII (autumn)
Prerequisite	I.EEB301
Responsible unit	Department of Electrical Power Supply
Teaching formats (hours per week)	Lecture 2
Teaching methods	Problem-based learning; project-based learning.
Assessment	Attendance; activity and participation 5% · Homework; independent work 10% · Progress quizzes 20% · Course work; project 20% · Final examination 30%

Course aim

To study the technical, economic, organisational, and hygienic measures, laws, regulations, and norms aimed at preserving workers' ability to work and health and ensuring occupational safety.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Apply knowledge of the safety of electrical systems in engineering and technological activity.	A.3	K4
2	Carry out workplace risk assessment using the matrix method.	B.3	S4
3	Evaluate workplace risks assessed by the matrix method.	B.4	
4	Perform earthing calculations using ETAP software.	D.4	A3

Content

Occupational health and safety management systems and legislation; principles of safe work, causes and costs of accidents; workplace hazards, hazard and risk identification and control, hazard reporting; duties of workers, safety signs and markings, safety training and instructions; general safety rules, manual handling, fire and pressure-vessel safety; workplace risk management; effects of electric current on the human body, body resistance and factors affecting the severity of electric injuries; protective measures in electrical installations.

Reading list and tools

Main: J. Nandagsamba, “Electrical Safety”, Ulaanbaatar, 2017, 2021 (in Mongolian) — J. Nandagsamba, “Design and Calculation of Power Supply”, Ulaanbaatar, 2015, 2018 (in Mongolian) — J. Nandagsamba, “Design and Calculation of Earthing for Power Plants and Substations”, Ulaanbaatar, 2018 (in Mongolian) — J. Nandagsamba, “Virtual Software for Electrical Safety”, Ulaanbaatar, 2018 (in Mongolian)

Additional: P. A. Dolin, “Fundamentals of Safety Engineering in Electrical Installations”, Moscow, Energiya, 1979, 408 pp. (in Russian) — “Rules for the Operation of Electrical Equipment”, 2008 (in Mongolian) — “Safety Rules for the Operation of Electrical Installations”, 2018 (in Mongolian)

Software and tools: Digital course repository of the Power Engineering School, MUST

I.EEB309 — Urban Power Supply

Module	M3 — Power Supply Specialisation Module
Course type	Compulsory (Electrical Power Supply track)
Credits	2 MUST credits (3.6 ECTS)
Workload	96 h: lecture 24 h, seminar 16 h, independent study 56 h
Recommended semester	Semester VII (autumn)
Prerequisite	I.EEB304
Responsible unit	Department of Electrical Power Supply
Teaching methods	Problem-based learning; project-based learning; example-based learning.
Assessment	Attendance; activity and participation 15% · Progress quizzes 25% · Course work; project 30% · Final examination 30%

Course aim

To study the reliable supply of quality energy to residential, public, and agricultural consumers in urban and settled areas and the appropriate construction and operation of sources, networks, distribution substations, and consumer complexes.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Apply load-calculation methods for residential, public and agricultural consumers.	A.3	K3
2	Create the conditions for the normal operation of urban and agricultural electricity consumers.	B.5	K4
3	Construct electrical equipment in a techno-economically efficient variant.	D.4	S3
4	Perform short-circuit calculations.	B.3	K4
5	Select electrical equipment.	B.3	K5
6	Determine the correct location of a substation using a load cartogram.	D.4	S4
7	Plan electrical equipment in a techno-economically efficient variant.	D.4	S4
8	Draw and evaluate electrical equipment in a techno-economically efficient variant.	D.6	A1

Content

Structure and classification of cities and of urban electrical loads; residential consumers and their design load; consumers in public buildings and their design load; loads of distribution networks; reliability of urban power supply; schemes of 10 and 6 kV distribution networks, standard schemes of step-down substations, indoor and packaged substations; 0.4/0.23 kV network schemes, building service-entrance switchboards, risers and internal networks; utilisation time of maximum load, power and energy losses; design loads of rural settlements.

Reading list and tools

Main: Kh. Tsagaan, M. Khuyagdorj, "Transmission and Distribution of Electrical Energy", Ulaanbaatar, 2017, ISBN 978-99978-57-09-5 (in Mongolian) — Z. Tserendorj, Ts. Erdenetuya, "Fundamentals of Power Supply and Distribution", Ulaanbaatar, 2017, ISBN 978-99978-0-681-9 (in Mongolian)

Additional: A. A. Fedorov, V. V. Kameneva, "Fundamentals of Power Supply of Industrial Enterprises", Moscow, Energoatomizdat, 1984 (in Russian) — Ts. Batchimeg et al., "Electrical Technology", Ulaanbaatar, 2008 (in Mongolian) — BD 43-103-03 "Rules for Electrical Installations", Ulaanbaatar, 2003 (in Mongolian)

Software and tools: AutoCAD

I.EEB351 — Power Supply Course Project

Module	M3 — Power Supply Specialisation Module
Course type	Compulsory
Credits	2 MUST credits (3.6 ECTS)
Workload	96 h: practical work 32 h, consultation 24 h, independent study 40 h
Recommended semester	Semester VII (autumn)
Prerequisite	I.EEB304
Responsible unit	Department of Electrical Power Supply
Teaching formats (hours per week)	Practice 2 · Independent work 5
Teaching methods	Problem-based learning; project-based learning.
Assessment	Attendance; activity and participation 5% · Homework; independent work 10% · Progress quizzes 20% · Course work; project 20% · Final examination 30%

Course aim

To perform power supply calculations in accordance with the course-project guidelines and to develop a power supply design for any facility.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Apply knowledge of the power supply course project in engineering and technological activity.	A.3	K4
2	Perform the calculations of the power supply course project.	B.3	S4
3	Develop the design drawings of electrical equipment.	D.4	A3
4	Prepare the course project report.	B.1	S4
5	Present and defend the project solution.	C.1	A3

Content

Course project on the power supply of a given object, comprising: distributed generation; overhead transmission line; selection of transformers; node substation; industrial power supply; compensation devices; determination of the electrical load centre; equipment up to 1000 V; cable and overhead lines; short-circuit calculation; equipment above 1000 V; relay protection; earthing; lightning protection; solar and wind power plants.

Reading list and tools

Main: J. Nandagsamba, "Design and Calculation of Power Supply", Ulaanbaatar, 2015, 2018 (in Mongolian)

Additional: J. Nandagsamba, "Design and Calculation of Earthing for Power Plants and Substations", Ulaanbaatar, 2018 (in Mongolian) — J. Nandagsamba, "Design of Urban Power Supply", Ulaanbaatar, 2020 (in Mongolian) — J. Nandagsamba, "Design of Industrial Power Supply", Ulaanbaatar, 2020 (in Mongolian) — J. Nandagsamba, "Design of Building Power Supply", Ulaanbaatar, 2020 (in Mongolian)

Software and tools: Digital course repository of the Power Engineering School, MUST

Transport Power Supply track

I.EEB320 — Electric Transport

Module	M3 — Power Supply Specialisation Module
Course type	Compulsory (Transport Power Supply track)
Credits	2 MUST credits (3.6 ECTS)
Workload	96 h: lecture 24 h, seminar 16 h, independent study 56 h
Recommended semester	Semester V (autumn)
Prerequisite	I.EEM205
Responsible unit	Department of Electrical Power Supply
Teaching methods	Problem-based learning; project-based learning; experiment-based (laboratory) learning.
Assessment	Attendance; activity and participation 10% · Independent work 20% · Progress quizzes 20% · Laboratory reports 20% · Final examination 30%

Course aim

To give students basic proficiency in the MATLAB software and the knowledge and skills needed to model and analyse electric vehicles.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Know the types of electric vehicles.	A.3	K3
2	Know the basic concepts of modelling electric vehicles.	B.1	K4
3	Use the MATLAB software.	B.5	K5
4	Model electric vehicles.	D.4	S3

Content

Basic concepts of electric transport; types and operating principles of electric vehicles; urban electric transport; electric buses and electric trains; types and operating principles of electric cars; power supply of monorail, tram and trolleybus systems; future trends in electric transport. Practical work in MATLAB: modelling of the motor, battery and controller of an electric car, and of an electric train and an electric bus; presentation of the individual project.

Reading list and tools

Main: B. Sergelen, L. Buligirmaa, S. Enkhtaivan, "Fundamentals of Power Supply and Lighting for Industrial, Urban and Railway Systems", Ulaanbaatar, 2021, ISBN 978-9919-20-885-1 (in Mongolian) — M. Khuyagdorj, S. Enkhtaivan, L. Buligirmaa, "Railway Electrification", Ulaanbaatar, 2017, ISBN 978-99978-4-278-7 (in Mongolian) — N. Dashnyam, D. Enkhtuvshin, "Electrical Machines", Ulaanbaatar, 2012 (in Mongolian)

Additional: D. Ulzii-Orshikh, "Electrical Machines and Micromachines", Ulaanbaatar, 2016, ISBN 978-99973-827-3-3 (in Mongolian)

I.EEB321 — Theory of Electric Traction

Module	M3 — Power Supply Specialisation Module
Course type	Compulsory (Transport Power Supply track)
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: lecture 32 h, laboratory 32 h, independent study 80 h
Recommended semester	Semester VI (spring)
Prerequisite	I.EEM205
Responsible unit	Department of Electrical Power Supply
Teaching formats (hours per week)	Lecture 2 · Laboratory 2
Teaching methods	Problem-based learning; project-based learning; experiment-based (laboratory) learning.
Assessment	Attendance; activity and participation 10% · Homework; independent work 20% · Progress quizzes 20% · Laboratory reports 20% · Final examination 30%

Course aim

To study electrified railway power supply facilities, electric traction equipment, and electrical devices in order to determine the electrical power consumption and operational characteristics of electric locomotives.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Understand the theoretical principles of electric locomotives.	A.3	K3
2	Perform calculations related to the electrical power supply systems of electric locomotives.	B.1	K4
3	Apply Ansys Motor-CAD software for electric machine analysis and simulation.	B.5	S3
4	Design the main traction motor of an electric vehicle.	D.4	S4

Content

Structure and operating principle of electric locomotives; types of traction motors; power supply of electric traction; traction motors and electrical equipment of locomotives; power-electronic, switching and control equipment; auxiliary machines; operation of electric traction on railways; automatic control and monitoring systems of locomotives; features of electric locomotives in other countries. Practical work with Ansys Motor-CAD: design of an electric-car traction motor and its electromagnetic, thermal and mechanical performance.

Reading list and tools

Main: B. Sergelen, L. Buligirmaa, S. Enkhtaivan, "Fundamentals of Power Supply and Lighting for Industrial, Urban and Railway Systems", Ulaanbaatar, 2021, ISBN 978-9919-20-885-1 (in Mongolian) — M. Khuyagdorj, S. Enkhtaivan, L. Buligirmaa, "Railway Electrification", Ulaanbaatar, 2017, ISBN 978-99978-4-278-7 (in Mongolian)

Additional: N. Dashnyam, D. Enkhtuvshin, "Electrical Machines", Ulaanbaatar, 2012 (in Mongolian)

Software and tools: Ansys Motor-CAD

I.EEB324 — Mathematical Modelling of Electric Transport

Module	M3 — Power Supply Specialisation Module
Course type	Compulsory (Transport Power Supply track)
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: lecture 32 h, laboratory 32 h, independent study 80 h
Recommended semester	Semester VI (spring)
Prerequisite	—
Responsible unit	Department of Electrical Power Supply
Teaching formats (hours per week)	Lecture 2 · Laboratory 2
Teaching methods	Problem-based learning; project-based learning; experiment-based (laboratory) learning.
Assessment	Attendance; activity and participation 10% · Independent work 20% · Progress quizzes 20% · Laboratory reports 20% · Final examination 30%

Course aim

To give students basic proficiency in the MATLAB software and the knowledge and skills needed to model and analyse electric vehicles.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Know the types of electric vehicles.	A.3	K3
2	Know the basic concepts of modelling electric vehicles.	B.1	K4
3	Use the MATLAB software.	B.5	K5
4	Model electric vehicles.	D.4	S3

Content

Types of electric vehicles; MATLAB modelling of an electric car: motor, battery, controller and drive train; modelling of electric trains, monorails, trams, trolleybuses and electric buses; modelling of the supply lines and traction substations of electric transport; modelling of mechanical and braking components; introduction to MATLAB; modelling and analysis of a helicopter model; modelling of an electric-car charging station.

Reading list and tools

Main: B. Sergelen, L. Buligirmaa, S. Enkhtaivan, "Fundamentals of Power Supply and Lighting for Industrial, Urban and Railway Systems", Ulaanbaatar, 2021, ISBN 978-9919-20-885-1 (in Mongolian) — M. Khuyagdorj, S. Enkhtaivan, L. Buligirmaa, "Railway Electrification", Ulaanbaatar, 2017, ISBN 978-99978-4-278-7 (in Mongolian) — N. Dashnyam, D. Enkhtuvshin, "Electrical Machines", Ulaanbaatar, 2012 (in Mongolian)

Additional: D. Ulzii-Orshikh, "Electrical Machines and Micromachines", Ulaanbaatar, 2016, ISBN 978-99973-827-3-3 (in Mongolian)

I.EEB322 — Electrical Equipment of Vehicles

Module	M3 — Power Supply Specialisation Module
Course type	Compulsory (Transport Power Supply track)
Credits	2 MUST credits (3.6 ECTS)
Workload	96 h: lecture 24 h, seminar 16 h, independent study 56 h
Recommended semester	Semester VII (autumn)
Prerequisite	I.EEM205
Responsible unit	Department of Electrical Power Supply
Teaching methods	Problem-based learning; project-based learning; experiment-based (laboratory) learning.
Assessment	Attendance; activity and participation 10% · Homework; independent work 20% · Progress quizzes 20% · Laboratory reports 20% · Final examination 30%

Course aim

To study the operating principles of the equipment for the transmission and distribution of electrical energy and to select and verify this equipment on the basis of calculations.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Study the operating principles of high- and low-voltage electrical equipment and learn to select and verify equipment on the basis of calculation results.	A.3	K3
2	Acquire the ability to analyse operating regimes by studying the operating principles of electrical equipment.	B.1	S3 A2
3	Carry out measurements and investigations independently on the basis of the theoretical material and apply them in practice.	B.2	S3 A2
4	Test the theoretical knowledge of the equipment of power plants and substations and of its operating principles by carrying out experiments and measurements on a virtual laboratory stand.	B.2	K3 S4
5	Study the operating principles of electrical equipment, learn measurement techniques and analyse the results obtained.	B.5	K4 S4 A4
6	Learn to compare experimental results with theoretical values and to analyse them.	D.6	K3 S5

Content

Basic concepts and main types of electrical equipment of vehicles and their operating principles; principles of selecting vehicle electrical equipment; electrical equipment of electric cars, electric buses, trolleybuses, electric trains, monorails and trams. Project work: stages of designing the electrical part of a power station, main electrical scheme, short-circuit calculation and selection of apparatus, station layout, relay protection settings, earthing and lightning protection, auxiliary DC distribution.

Reading list and tools

Main: Sh. Gantumur, "Power Plants and Substations", Ulaanbaatar, 2011 (in Mongolian) — Kh. Tsagaan, M. Khuyagdorj, "Transmission and Distribution of Electrical Energy", Ulaanbaatar, 2017, ISBN 978-99978-57-09-5 (in Mongolian)

Additional: L. D. Rozhkova, V. S. Kozulin, "Electrical Equipment of Power Plants and Substations", 1987 (in Russian) — D. Sodnomdorj, "Electrical Equipment of Power Plants and Substations", Ulaanbaatar, 2017, ISBN 978-99929-4-530-3 (in Mongolian) — B. N. Neklepaev et al., "The Electrical Part of Power Plants and Substations: Reference Material for Course and Diploma Design", Russia, 1987 (in Russian) — Yu. B. Guk et al., "Design of the Electrical Part of Power Plants and Substations", 1985 (in Russian)

Software and tools: Bileg-10 virtual laboratory stand

I.EEB323 — Theory of Electric Transport Control Systems

Module	M3 — Power Supply Specialisation Module
Course type	Compulsory (Transport Power Supply track)
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: lecture 32 h, laboratory 32 h, independent study 80 h
Recommended semester	Semester VII (autumn)
Prerequisite	I.EEB320
Responsible unit	Department of Electrical Power Supply
Teaching formats (hours per week)	Lecture 2 · Laboratory 2
Teaching methods	Problem-based learning; project-based learning; experiment-based (laboratory) learning.
Assessment	Attendance; activity and participation 10% · Homework; independent work 20% · Progress quizzes 20% · Laboratory reports 20% · Final examination 30%

Course aim

To study the basic concepts of the control of electric vehicles and the control software of modern vehicles, and to learn to model them.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Know the operation of the electrical equipment of vehicles.	A.3	K3
2	Know the operation of the monitoring and control of electric vehicles.	B.1	K4
3	Use SCADA software.	B.5	S2
4	Model the monitoring and control part of an electric-vehicle charging station using a SCADA system.	D.4	S3

Content

Control systems of electric vehicles; internal structure and control systems of charging stations; monitoring and control systems of electric vehicles; basic concepts of SCADA systems. Practical work: SCADA modelling of the monitoring and control of a charging station and of the power supply of an electric-vehicle control system; presentation of the report and of the individual project.

Reading list and tools

Main: B. Sergelen, L. Buligirmaa, S. Enkhtaivan, "Fundamentals of Power Supply and Lighting for Industrial, Urban and Railway Systems", Ulaanbaatar, 2021, ISBN 978-9919-20-885-1 (in Mongolian) — M. Khuyagdorj, S. Enkhtaivan, L. Buligirmaa, "Railway Electrification", Ulaanbaatar, 2017, ISBN 978-99978-4-278-7 (in Mongolian) — N. Dashnyam, D. Enkhtuvshin, "Electrical Machines", Ulaanbaatar, 2012 (in Mongolian)

Additional: D. Ulzii-Orshikh, "Electrical Machines and Micromachines", Ulaanbaatar, 2016, ISBN 978-99973-827-3-3 (in Mongolian)

Major electives (C.3)

I.EEB306 — High-Voltage Testing and Adjustment

Module	M3 — Power Supply Specialisation Module
Course type	Major elective (C.3)
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: lecture 32 h, seminar 16 h, laboratory 16 h, independent study 80 h
Recommended semester	Autumn
Prerequisite	I.EEM210
Responsible unit	Department of Electrical Power Supply
Teaching methods	Problem-based learning; project-based learning; experiment-based (laboratory) learning.
Assessment	Attendance; activity and participation 15% · Homework; independent work 15% · Progress quizzes 20% · Laboratory reports 20% · Final examination 30%

Course aim

To provide the theoretical fundamentals and methodologies for the diagnosis of high-voltage cables and transformers.

Course learning outcomes

No	Course learning outcome
1	Know the methods for diagnosing and detecting faults and defects in the main high-voltage equipment of power systems, networks, and substations.
2	Understand the procedures, norms, standards, and techniques for insulation testing and measurement of equipment.
3	Quickly master technological advances in high-voltage testing and measurement instruments and develop creative work.
4	Master and apply safe-working techniques for high-voltage and network equipment.

Contribution to PLO: A.3 (Knowledge) · B.1 (Skills) · B.5 (Skills) · D.2 (Design) · D.6 (Design)

Content

High-voltage insulating structures and field grading in internal insulation; cable insulation, joints and terminations of high-voltage cables and their measurements; modern plastic- and rubber-insulated cables, water treeing; insulation and testing of high-voltage capacitors; transients in power transformers and internal winding protection; insulation measurements and diagnostics of power transformers; insulation and testing of current and voltage transformers; bushings and insulators, diagnostic tests; measurements and tests of high-voltage electrical machines; insulation of high-voltage circuit breakers.

Reading list and tools

Main: G. Bekhbat, Ts. Erdenetuya, "Materials of Electrical Engineering and Electronics: Theory and Application", 2018, ISBN 978-99962-1-579-7 (in Mongolian) — Z. Tserendorj, Ts. Erdenebat, "High-Voltage Engineering 1: External Insulation. Fundamentals of Theory and Practice", 2015, ISBN 99929-6-311-5 (in Mongolian) — Z. Tserendorj, Ts. Erdenetuya, "High-Voltage Engineering 2: Internal Insulation. Construction, Testing, Diagnostics", 2020 (in Mongolian) — Z. Tserendorj, Ts. Erdenetugs, "High-Voltage Engineering 3: Lightning Protection, Earthing", 2018 (in Mongolian) — Z. Tserendorj, Ts. Erdenechimeg, "High-Voltage Engineering 4: Internal Overvoltages and Insulation Measurement and Diagnostics", 2012 (in Mongolian)

Additional: G. Bekhbat, Ts. Erdenetuya, "High-Voltage Laboratory Manual", 2015 (in Mongolian) — F. A. M. Rizk, G. N. Trinh, "High Voltage Engineering", 2014 — E. Kuffel, W. S. Zaengl, "High Voltage Engineering: Fundamentals", 2000

I.EEB311 — Installation and Operation of Electrical Equipment

Module	M3 — Power Supply Specialisation Module
Course type	Major elective (C.3)
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: lecture 32 h, seminar 32 h, independent study 80 h
Recommended semester	Autumn / Spring
Prerequisite	I.EEB301
Responsible unit	Department of Electrical Power Supply
Teaching methods	Problem-based learning; project-based learning.
Assessment	Attendance; activity and participation 5% · Homework; independent work 10% · Progress quizzes 20% · Course work; project 20% · Final examination 30%

Course aim

To familiarise students with the assembly, installation and operation of electrical equipment, to develop practical skills, and to prepare students for industrial practice with the necessary theoretical knowledge.

Course learning outcomes

No	Course learning outcome
1	Apply knowledge of the installation and operation of electrical equipment in engineering practice.
2	Develop project drawings for electrical equipment.
3	Carry out the installation and assembly of electrical equipment.

Contribution to PLO: A.2 (Knowledge) · B.2 (Skills) · D.4 (Design)

Content

Generation and distribution of electrical energy; installation and operation of disconnectors, load-break switches and circuit breakers; instrument transformers and indoor and outdoor switchgear; oil and gas circuit breakers; busbars and outdoor equipment of switchgear; power transformers; protective earthing; secondary-circuit equipment; single- and three-phase meters and meter testing; safety during installation of switchgear in power plants and substations; lightning protection and earthing of substations and overhead lines; cable lines.

Reading list and tools

Main: Sh. Gantumur, "Power Plants and Substations", 2012 (in Mongolian)

Additional: J. Nandagsamba, "Design and Calculation of Power Supply", Ulaanbaatar, 2015, 2018 (in Mongolian) — J. Nandagsamba, "Design and Calculation of Earthing for Power Plants and Substations", Ulaanbaatar, 2018 (in Mongolian)

Software and tools: Digital course repository of the Power Engineering School, MUST

I.EEB312 — Electrical Connections of Buildings

Module	M3 — Power Supply Specialisation Module
Course type	Major elective (C.3)
Credits	2 MUST credits (3.6 ECTS)
Workload	96 h
Recommended semester	Any semester
Prerequisite	I.EEB302
Responsible unit	Power Engineering School
Teaching methods	Problem-based learning; project-based learning.
Assessment	Continuous assessment 70% (attendance and participation, assignments, progress quizzes) · Final examination 30% (MUST Bachelor's Studies Regulation)

Course aim

To study the internal electrical networks of residential and public buildings, their protective, metering and distribution equipment, the substations that supply buildings, and the safety, earthing and lightning-protection measures of building installations.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Apply knowledge of the internal electrical networks of buildings in engineering and technological activities.	A.2	K4
2	Perform the power supply calculations of buildings.	B.2	S4
3	Develop the power supply design of buildings.	D.4	A3

Content

Basic concepts of internal electrical networks of buildings; Low-voltage protective devices: fuses and circuit breakers; Residual-current devices and RCBOs; Current transformers, voltage stabilisers and step-down transformers; Single- and three-phase meters and smart meters; Planning and installation of electrical equipment in residential and public buildings; Cables and conductors of internal networks; Distribution boards: classification and types (main, floor and group boards); Calculation and scheme of the main distribution board; Closed-type substations; Outdoor substations; Packaged substations; Safety and protective measures in residential and public buildings; Monitoring and control systems of low-voltage distribution networks; Planning of energy-efficient green buildings; Lightning protection of buildings and structures; earthing calculation.

Reading list and tools

Main: Kh. Tsagaan, M. Khuyagdorj, "Transmission and Distribution of Electrical Energy", Ulaanbaatar, 2017, ISBN 978-99978-57-09-5 (in Mongolian)

Additional: G. N. Glushkov, "Power Supply of Construction and Installation Works" (in Russian) — I. K. Tulchin, G. I. Nudler, "Electrical Networks and Electrical Equipment of Residential and Public Buildings" (in Russian) — I. E. Tsigelman, "Power Supply of Civil Buildings and Municipal Enterprises" (in Russian)

I.EEB313 — Automation of Power Supply Design

Module	M3 — Power Supply Specialisation Module
Course type	Major elective (C.3)
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: lecture 16 h, laboratory 32 h, independent study 96 h
Recommended semester	Autumn / Spring
Prerequisite	—
Responsible unit	Department of Electrical Power Supply
Teaching methods	Problem-based learning; project-based learning; experiment-based (laboratory) learning.
Assessment	Attendance; activity and participation 10% · Homework; independent work 20% · Progress quizzes 20% · Laboratory reports 20% · Final examination 30%

Course aim

To produce internal and external power-supply project drawings in AutoCAD in accordance with current norms and rules.

Course learning outcomes

No	Course learning outcome
1	Use the functions and operations of AutoCAD.
2	Read internal and external power-supply symbols and drawings.
3	Design lighting layouts and lighting boards.
4	Design external power supply with cable and overhead lines.

Contribution to PLO: A.3 (Knowledge) · B.1 (Skills) · B.2 (Skills) · D.4 (Design)

Content

Working with AutoCAD: interface, menus, command line and toolbars; drawing settings, sheet and paper size; two-dimensional objects, layers and units; drawing aids (Snap, Osnap); basic geometric shapes; building plans (walls, doors, windows, roofs) as the basis for electrical drawings; title blocks, captions and room schedules for course and diploma projects; lighting layouts of buildings; power equipment layouts of buildings; design of distribution boards for public and residential buildings.

Reading list and tools

Main: Ch. Myagmarjav, "AutoCAD 2007/2008: Engineering Drawing Program", Ulaanbaatar, 2008, ISBN 978-99929-3-057-8 (in Mongolian) — Kh. Tsagaan, M. Khuyagdorj, "Transmission and Distribution of Electrical Energy", Ulaanbaatar, 2017, ISBN 978-99978-57-09-5 (in Mongolian)

Additional: "Planning and Installation of the Electrical Equipment of Residential and Public Buildings", Ulaanbaatar, 2007 (in Mongolian) — BD 43-102-08 "Planning and Installation of Lightning Protection and Earthing of Buildings and Structures" (in Mongolian)

Software and tools: AutoCAD

I.EEB314 — Special Course on Electrical Lines and Networks

Module	M3 — Power Supply Specialisation Module
Course type	Major elective (C.3)
Credits	2 MUST credits (3.6 ECTS)
Workload	96 h: lecture 24 h, seminar 16 h, independent study 56 h
Recommended semester	Autumn / Spring
Prerequisite	I.EEB302
Responsible unit	Department of Electrical Power Supply
Teaching methods	Problem-based learning; project-based learning; example-based learning.
Assessment	Attendance; activity and participation 10% · Homework; independent work 30% · Progress quizzes 30% · Final examination 30%

Course aim

To master the methods for calculating the mechanical part, assembly and other elements of overhead power transmission lines for use in their design and operation.

Course learning outcomes

No	Course learning outcome
1	Become familiar with the structure and construction of overhead power transmission lines.
2	Perform the electrical and mechanical calculations of transmission lines.
3	Develop a project for constructing an overhead transmission line.

Contribution to PLO: A.3 (Knowledge) · B.1 (Skills) · B.2 (Skills)

Content

Construction and main structures of overhead lines; insulators on poles and cross-arms and voltage distribution along insulator strings; mechanical loads on overhead lines; state equation of conductors; conductor tension and sag; templates and placement of poles, span calculation; calculation methods for icing, critical temperature and annual mean temperature; route selection and line clearances; corona; lightning protection and earthing of overhead lines. Individual project on the calculation of an overhead line.

Reading list and tools

Main: Kh. Tsagaan, M. Khuyagdorj, "Transmission and Distribution of Electrical Energy", Ulaanbaatar, 2017, ISBN 978-99978-57-09-5 (in Mongolian) — Z. Tserendorj, Ts. Erdenetuya, "Fundamentals of Power Supply and Distribution 1", Ulaanbaatar, 2017, ISBN 978-99978-0-681-9 (in Mongolian)

Additional: Sh. Gantumur, "Electrical Lines, Networks and Systems", Ulaanbaatar, 2014, ISBN 99929-5-724-7 (in Mongolian) — "Calculation of the Mechanical Part of Overhead Transmission Lines", 1982

Software and tools: DIALux evo

I.EEB315 — Calculation and Software

Module	M3 — Power Supply Specialisation Module
Course type	Major elective (C.3)
Credits	2 MUST credits (3.6 ECTS)
Workload	96 h: lecture 24 h, seminar 16 h, independent study 56 h
Recommended semester	Any semester
Prerequisite	I.EEB302
Responsible unit	Electrical Engineering Division, Power Engineering School
Teaching formats (hours per week)	Lecture 1.5 · Seminar 1
Teaching methods	Problem-based learning; project-based learning; example-based (peer) learning.
Assessment	Attendance and participation 10% · homework and independent work 30% · progress tests 30% · final examination 30%

Course aim

To acquire methods for calculating the operating regimes and power flows of electrical power systems.

Course learning outcomes

No	Course learning outcome
1	Know the modelling of networks, lines, cables and shunt elements and the per-unit system.
2	Form the network matrices.
3	Determine voltage levels by iterative and Gauss–Seidel methods.
4	Determine power flows by the Newton–Raphson method.

Content

Modelling of networks, lines, cables and shunt elements; the per-unit system; the nodal admittance matrix and ABCD matrices; short-circuit calculation; determination of voltage levels by iterative and Gauss–Seidel methods; power-flow calculation by the Newton–Raphson method; voltage regulation; transfer capability between power stations.

Reading list and tools

Kh. Tsagaan, M. Khuyagdorj, "Transmission and Distribution of Electrical Energy", Ulaanbaatar, 2017, ISBN 978-99978-57-09-5 — D. Sodnomdorj, "Complex Study and Mathematical Modelling of Power-System Operating Regimes", Ulaanbaatar (both in Mongolian).

I.EEB316 — Electrical Technology Methods

Module	M3 — Power Supply Specialisation Module
Course type	Major elective (C.3)
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h
Recommended semester	Any semester
Prerequisite	I.EEM205
Responsible unit	Department of Electrical Power Supply
Teaching methods	Problem-based learning; project-based learning.
Assessment	Attendance; activity and participation 5% · Homework; independent work 10% · Progress quizzes 20% · Course work; project 20% · Final examination 30%

Course aim

To become acquainted with the action of electric current and of electric and magnetic fields as the driving force of industrial technological processes and with the physical nature of the new technologies based on them, and to acquire the knowledge and practice needed to calculate and test various installations using theoretical knowledge.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Apply knowledge of electrical technology in engineering practice.	A.2	K4
2	Perform the design calculations of electric heaters.	B.2	S4
3	Develop project drawings for electrical equipment.	D.4	A3

Content

Basic concepts of electrical technology; electrothermal technology; induction heating; dielectric heating; electroflotation; electroplasmolysis; the electrohydraulic effect; electron-ion technology; laser technology; ultrasonic technology; electrodialysis technology. Independent work: calculation of the thermal insulation and of the electrical parameters of electric heating installations; calculation of electric air heaters, induction furnaces, dielectric heating, electroflotation and electroplasmolysers; calculation of farm electric heaters, electrode water heaters, electrode steam heaters, plate heaters and welding apparatus.

Reading list and tools

Main: A. M. Basov, V. G. Bykov, "Electrotechnology", 1985 (in Russian)

Additional: V. N. Gaiduk, "Practical Course in Electric Heating and Electrotechnology", 1982 (in Russian) — P. N. Rogov, "Electrophysical Methods of Food Processing", 1989 (in Russian) — A. D. Svenchanskii (ed.), "Electrotechnological Industrial Installations", Moscow, Energoizdat, 1982 (in Russian)

Software and tools: Digital course repository of the Power Engineering School, MUST

I.EEB317 — Transportation Power Supply

Module	M3 — Power Supply Specialisation Module
Course type	Major elective (C.3)
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h: lecture 32 h, seminar 16 h, independent study 96 h
Recommended semester	Autumn / Spring
Prerequisite	I.EEM204
Responsible unit	Department of Electrical Power Supply
Teaching methods	Problem-based learning; project-based learning; example-based learning.
Assessment	Attendance; activity and participation 10% · Homework; independent work 30% · Progress quizzes 30% · Final examination 30%

Course aim

To study the features of electrified transport vehicles and facilities and to acquire the ability to perform calculations on simple power-supply schemes.

Course learning outcomes

No	Course learning outcome
1	Know the types and classification of electric transport vehicles.
2	Study the prospects of the railway transport sector.
3	Assess environmental, climatic, and ecological factors.
4	Calculate the power supply of electrified railways.

Contribution to PLO: A.3 (Knowledge) · B.1 (Skills) · B.2 (Skills) · B.3 (Skills)

Content

Electrical equipment and installations used in transport; traction substations, power converters and rectifiers for electrified transport; switchgear of electrified transport; monitoring and control systems, automatic protection and signalling; contact (overhead) supply and distribution networks; transmission mechanisms and operating principles of electric traction; management of electrified-transport installations; occupational safety. Practical work: selection of the electrical equipment of a transport installation, calculation of its parameters, short-circuit calculation.

Reading list and tools

Main: B. Sergelen, L. Buligirmaa, S. Enkhtaivan, "Fundamentals of Power Supply and Lighting for Industrial, Urban and Railway Systems", Ulaanbaatar, 2021, ISBN 978-9919-20-885-1 (in Mongolian) — M. Khuyagdorj, S. Enkhtaivan, L. Buligirmaa, "Railway Electrification", Ulaanbaatar, 2017, ISBN 978-99978-4-278-7 (in Mongolian) — N. Dashnyam, D. Enkhtuvshin, "Electrical Machines", Ulaanbaatar, 2012 (in Mongolian)

Additional: D. Ulzii-Orshikh, "Electrical Machines and Micromachines", Ulaanbaatar, 2016, ISBN 978-99973-827-3-3 (in Mongolian)

I.EEB319 — Reliability, Quality Indicators and Efficiency of Power Supply

Module	M3 — Power Supply Specialisation Module
Course type	Major elective (C.3)
Credits	2 MUST credits (3.6 ECTS)
Workload	96 h: lecture 32 h, independent study 64 h
Recommended semester	Autumn
Prerequisite	I.EEM203
Responsible unit	Department of Electrical Power Supply
Teaching methods	Problem-based learning; example-based learning; challenge-based learning.
Assessment	Attendance; activity and participation 10% · Homework; independent work 20% · Progress quizzes 20% · Final examination 30%

Course aim

To study methods of regulating energy efficiency according to consumer demand in order to reduce wasteful energy consumption, and to study the difficulties and adverse effects arising during the delivery of the required power-supply parameters to consumers.

Course learning outcomes

No	Course learning outcome
1	Identify methods for assessing the quality and efficiency of power supply.
2	Understand the concept of electromagnetic compatibility in industrial power supply.
3	Apply quality and efficiency methods to industrial and building power supply.
4	Evaluate the results obtained from applying these quality and efficiency methods.

Contribution to PLO: A.3 (Knowledge) · B.1 (Skills) · B.3 (Skills) · D.1 (Design)

Content

Power quality problems in power supply; electromagnetic compatibility of power supply systems and industrial power supply; harmonics generated by power supply equipment and methods of their mitigation; reliability of lines and networks, substations and power supply equipment; reliability of transmission and distribution; energy-saving methods in urban, industrial and building power supply. Practical work: identification of power quality problems; methods of eliminating harmonics; presentation of the individual assignment.

Reading list and tools

Main: Kh. Tsagaan, M. Khuyagdorj, "Transmission and Distribution of Electrical Energy", Ulaanbaatar, 2017, ISBN 978-99978-57-09-5 (in Mongolian) — Z. Tserendorj, Ts. Erdenetuya, "Fundamentals of Power Supply and Distribution 1", Ulaanbaatar, 2017, ISBN 978-99978-0-681-9 (in Mongolian) — Z. Tserendorj, Ts. Erdenetuya, "Fundamentals of Power Supply and Distribution 2", Ulaanbaatar, 2022 (in Mongolian)

Additional: B. Sergelen, L. Buligirmaa, S. Enkhtaivan, "Fundamentals of Power Supply and Lighting for Industrial, Urban and Railway Systems", Ulaanbaatar, 2021, ISBN 978-9919-20-885-1 (in Mongolian)

I.EEM307 — Electrical System Analysis

Module	M3 — Power Supply Specialisation Module
Course type	Major elective (C.3)
Credits	2 MUST credits (3.6 ECTS)
Workload	96 h
Recommended semester	Any semester
Prerequisite	—
Responsible unit	Power Engineering School
Assessment	Continuous assessment 70% (attendance and participation, assignments, progress quizzes) · Final examination 30% (MUST Bachelor's Studies Regulation)

Course aim

To study the structure and modelling of electrical networks and systems and the calculation of their operating regimes, losses and voltage conditions with professional software.

Course learning outcomes

No	Course learning outcome
1	Explain the structure, voltage levels and principal equipment of electrical networks and systems.
2	Model overhead lines and transformers and calculate their parameters, including four-terminal parameters.
3	Calculate the operating regimes and energy losses of radial and complex networks with the Gorim software.
4	Analyse voltage regulation and reactive-power compensation in substations.
5	Interpret the results of operating-regime, short-circuit and stability calculations and report them.

Content

Basic principles of electrical networks and systems; Voltage levels of networks: role and features; Equipment of overhead transmission lines; inductance and capacitance; Modelling of electrical systems and calculation methods; Power transmission equations and the circle diagram; Natural (surge-impedance) power and features of power transmission; Basic line parameters and four-terminal parameters; Transformer modelling and calculation of parameters; Operating-regime and energy-loss calculation with the Gorim 1.0 software; Operating-regime calculation of complex networks with the Gorim 5.0 software; Voltage regulation in substations and compensation equipment; Modern software for operating-regime calculation; short-circuit and stability calculation.

I.EEM309 — Power Microgrid Planning and Modelling

Module	M3 — Power Supply Specialisation Module (also offered as an interdisciplinary course)
Course type	Major elective (C.3)
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h
Recommended semester	Any semester
Prerequisite	—
Responsible unit	Power Engineering School
Teaching methods	Problem-based learning; project-based learning; experiment-based (laboratory) learning.
Assessment	Continuous assessment 70% (attendance and participation, assignments, progress quizzes) · Final examination 30% (MUST Bachelor's Studies Regulation)

Course aim

To study energy microgrids and distributed energy sources, the policy, market and tariff framework of microgrids, and the selection, planning, investment and control of microgrid components.

Course learning outcomes and PLO mapping

No	Course learning outcome	PLO	Bloom
1	Determine and calculate the electrical and heat loads of consumers.	A.3, D.4	S2
2	Carry out a study of the resources of the available energy sources.	B.2	S3
3	Plan and model an energy microgrid suited to the consumption.	D.4	S4
4	Calculate the investment efficiency of an energy microgrid.	D.2	S3
5	Use MS Excel and other dedicated software to plan and calculate energy consumption.	C.2	S3
6	Plan a stand-alone energy system.	D.4, D.3	S3
7	Carry out the feasibility-study calculations of an energy microgrid.	D.2	S4
8	Work in a team and carry out tasks jointly.	C.2	A3

Content

Energy microgrids; Energy security; Microgrid policy and regulation; Electricity market (two weeks); Microgrids and distributed energy sources; Stand-alone heat supply systems; Electrical load; Microgrid measurement and input data; Selection and planning of microgrid components; Investment in microgrids (two weeks); Microgrid policy, regulation and market; Microgrid prices and tariffs; Demand-side management in microgrids; Microgrid integration and smart control.

Reading list and tools

Main: A. K. Giri, S. R. Arya, D. Vinnikov (eds.), "Distributed Energy Systems: Planning, Design, and Modeling", CRC Press, 2023, ISBN 978-1-003-22912-4 — C. Sharmeela, P. Sivaraman, P. Sanjeevikumar, J. B. Holm-Nielsen, "Microgrid Technologies", 2021, ISBN 9781119710790 — A. Creti, F. Fontini, "Economics of Electricity: Markets, Competition and Rules"

Additional: S. Padmanaban, K. Nithiyananthan, S. P. Karthikeyan, J. B. Holm-Nielsen, "Microgrid", 2021, ISBN 9780367612610

I.EEM310 — Energy System Policy and Planning

Module	M3 — Power Supply Specialisation Module
Course type	Major elective (C.3)
Credits	3 MUST credits (5.4 ECTS)
Workload	144 h
Recommended semester	Any semester
Prerequisite	S.EEM101
Responsible unit	Power Engineering School
Assessment	Continuous assessment 70% (attendance and participation, assignments, progress quizzes) · Final examination 30% (MUST Bachelor's Studies Regulation)

Course aim

To study energy resources and development trends, the electricity market and energy pricing, the energy sector of Mongolia, and the policy, economics, management and planning of energy systems and projects.

Course learning outcomes

No	Course learning outcome
1	Describe primary energy resources, energy development trends and the structure of Mongolia's energy sector.
2	Explain electricity market types and the principles of energy pricing.
3	Analyse energy system development policies, including the use of renewable energy and their environmental effects.
4	Apply methods of energy-system economics, investment and strategic management to an energy project.
5	Prepare and present a business plan or project proposal for an energy system.

Content

Research on primary energy resources; Trends in energy development; Electricity market and its types; Energy pricing and related issues; Mongolia's energy sector; Energy system development policy; Energy and ecology; Utilisation of renewable energy; Structure of energy sources; Economics of energy systems; Energy management systems; Strategic management in the energy sector; Investment management of energy systems; Characteristics of energy system planning; Business planning for energy systems; Characteristics of energy project development.

Practical training

I.EEB360 — Industrial Internship 1

Module	M3 — Power Supply Specialisation Module / Practical Training
Course type	Compulsory
Credits	2 MUST credits (3.6 ECTS)
Workload	96 h
Recommended semester	Summer after semester IV
Prerequisite	—
Responsible unit	Department of Electrical Power Supply

Course aim

To familiarise students with the practical operation, maintenance and safety practices of electrical power supply enterprises through structured on-site training at host companies in the energy sector.

Course learning outcomes

No	Course learning outcome
1	Describe the organisational structure, technological processes and key equipment of an electrical power supply enterprise.
2	Apply electrical safety regulations and operational procedures in a real industrial environment.
3	Document observed equipment, processes and operational issues in a structured internship report.
4	Communicate professionally with engineering and technical staff during the internship.

Contribution to PLO: A.3 (Knowledge) · B.4 (Skills) · D.1 (Design) · D.6 (Design)

I.EEB361 — Industrial Internship 2

Module	M3 — Power Supply Specialisation Module / Practical Training
Course type	Compulsory
Credits	2 MUST credits (3.6 ECTS)
Workload	96 h
Recommended semester	Summer after semester VI
Prerequisite	I.EEB360
Responsible unit	Department of Electrical Power Supply

Course aim

To deepen practical engineering competence through advanced on-site training focused on the design, operation and analysis of electrical power supply systems, and to collect data and engineering context relevant to the Bachelor's Diploma Project.

Course learning outcomes

No	Course learning outcome
1	Analyse the operation, performance parameters and reliability of selected power-supply equipment in the host enterprise.
2	Identify a real engineering problem suitable for further investigation in the Bachelor's Diploma Project.
3	Collect, organise and verify technical data and documentation needed for engineering calculations and design.
4	Write a structured engineering internship report compliant with the department's documentation requirements.

Contribution to PLO: A.3 (Knowledge) · B.4 (Skills) · B.5 (Skills) · C.2 (Communication) · D.6 (Design)

M4 — Final Qualification Project

I.EEB370 — Bachelor's Diploma Project

Module	M4 — Final Qualification Project
Course type	Compulsory
Credits	5 MUST credits (9.0 ECTS)
Workload	240 h
Recommended semester	Semester VII (autumn)
Prerequisite	—
Responsible unit	Department of Electrical Power Supply

Course aim

To enable the student to demonstrate, through an independent engineering project, the integrated application of knowledge, methods and tools acquired during the Bachelor's programme to solve a real or applied problem in electrical power supply.

Course learning outcomes

No	Course learning outcome
1	Define an engineering problem in the field of electrical power supply, formulate objectives and scope, and justify the chosen approach.
2	Carry out engineering calculations, modelling, simulation or design work appropriate to the chosen problem, using standard methods and software tools of the discipline.
3	Evaluate technical, economic, safety and environmental aspects of the proposed solution.
4	Prepare engineering documentation (calculations, drawings, schematics, specifications) in accordance with national and institutional standards.
5	Defend the project publicly before a graduation committee, responding to technical questions clearly and professionally.

Contribution to PLO: A.1 (Knowledge) · A.3 (Knowledge) · B.1 (Skills) · B.5 (Skills) · C.1 (Communication) · C.3 (Communication) · D.1 (Design) · D.6 (Design)