Final Examination Subjects
BSc in Electrical Engineering – full-time and part-time
Curriculum F

Under Curriculum F of the Electrical Engineering BSc programme, the final examination consists of the presentation and defence of the thesis and an examination on topics related to the specialisation.

Calculation of the final examination grade:

$$Z = (SZD + T1 + (T2_1 + T2_2)/2) / 3$$

SZD: thesis grade,
T1: grade for the topic drawn from the subject chosen by the student,
$T2_1$ and $T2_2$: grades for the topics drawn from the other two subjects.

The final examination topics cover the three subjects common to the specialisation. Ten topics are specified for each subject. During the final examination, students draw one topic from their chosen subject and one topic from each of the other two subjects.

The topics are specified in advance and made publicly available to students. The assessment is based primarily on the student's subject knowledge in the chosen subject, while performance in the other two subjects also contributes to the overall assessment.

Thesis presentation

The final examination includes the presentation and defence of the thesis. Students present the topic, objectives, methods and main findings of their thesis and answer questions from the final examination board.

As a common academic standard, the Faculty considers a slide presentation the preferred and recommended format. This enables students to present their work orally in a structured manner and defend their technical findings before the board.

The specific presentation format may vary by specialisation. Students must therefore always consult the detailed final examination information and requirements published by their specialisation.

Power Engineering Specialisation

KVXVF1EBNF/ KVXVF1EBLF Electricity Consuming Equipment

1. State and briefly explain the fundamental requirements of power system protections (Selectivity, Speed, Sensitivity, Reliability and Security)
2. Explain the operating principle of overcurrent protection. Compare definitive-time and inverse-time operating characteristics, including their typical applications
3. Explain how selectivity is achieved using time-current grading in a radial distribution network. Illustrate the concept of the grading margin between upstream and downstream relays.
4. Describe the operating principle of unit differential protection. Why is percentage bias (restraint) necessary, and what sources of false differential current does it compensate for (e.g., CT saturation, tap changer operation)?
5. Explain the physical construction and operating principle of a Buchholz (gas-actuated) relay in oil-immersed transformers. Differentiate between the faults that trigger the alarm stage versus the trip stage.
6. Define the phenomenon of magnetizing inrush current when energizing a power transformer. Why does it appear as an internal fault to a differential relay, and how is maloperation prevented (e.g., second-harmonic restraint)?
7. Analyze the voltage and current conditions during a single-phase-to-earth fault in a resonant-grounded (compensated) network. What is the role of the Petersen coil (arc-suppression coil) in extinguishing the fault arc?
8. Explain the impedance-measuring principle of distance protection. Why is the protection divided into multiple stepped time-distance zones (Zone 1, Zone 2, Zone 3), and how are their reach settings determined?
9. State the purpose of Automatic Reclosing (AR) on overhead transmission and distribution lines. Why is AR successful in the vast majority of faults (distinguishing between transient, semi-permanent, and permanent faults)?
10. Explain the purpose and operating principle of reverse power protection for synchronous generators. What mechanical damage to the prime mover (turbine) does it prevent during motoring conditions?

KVXVU1EBNF/ KVXVU1EBLF Electricity system plants

1. What are the primary technical criteria for sizing low-voltage (LV) cables and overhead lines? Explain how thermal ampacity, permissible voltage drop, overload protection, and short-circuit withstand capability are verified.
2. Describe the transient behavior of a synchronous machine during a symmetrical three-phase short circuit. Define the subtransient (Xd”’), transient (Xd””) and synchronous (Xd”) reactances and explain how they decaying short-circuit current components are calculated
3. Explain the mechanical calculation methodology for overhead line conductors using the sag-tension (state change) equation. How are meteorological loads—such as wind pressure, ice/rime buildup, and combined loads—factored into determining maximum conductor tension and sag?
4. Detail the selection and sizing criteria for high- and medium-voltage switchgear equipment (circuit breakers, disconnectors, current and voltage transformers) based on nominal continuous parameters and short-circuit thermal and dynamic stresses.

5. Explain the method of symmetrical components (Fortescue transformation) for analyzing unbalanced faults. Draw and explain the positive-, negative-, and zero-sequence equivalent circuits of synchronous machines, transformers (with various winding connections), and transmission lines.
6. Derive the connection of sequence networks and the mathematical formulas used to calculate fault currents and phase voltages during a single-phase-to-earth (1LG / *1FN*) short circuit.
7. Explain the methodology for sizing a transmission or distribution line fed from both ends (or a closed ring network). How do you determine the current distribution, the feeding point (minimum voltage point), maximum voltage drop, and active power losses?
8. Describe the dynamic mechanical verification of overhead lines regarding phase-to-phase clearances and tower geometry. How do you check against asynchronous conductor swinging (clashing in mid-span), wind-induced swing toward grounded tower structures, and conductor jump caused by sudden ice shedding?
9. Define series (open-conductor) faults in power networks (e.g., single- or two-phase open circuit) and explain how symmetrical components are applied to calculate the resulting unbalanced currents and voltages.
10. Outline the procedure for sizing rigid and flexible substation busbars. Include the verification of continuous thermal rating (ampacity), short-time thermal withstand during faults, electrodynamic forces between phase conductors, and mechanical resonance.

KVXEG1EBNF/KVXEG1EBLF Energy management

1. Explain the technical and economic reasons for reactive power compensation (power factor correction). Compare central, group, and individual compensation methods, and describe how capacitor banks or active compensators are sized.
2. How are daily and annual load profiles and load-duration curves analyzed? Define key metrics such as peak demand, load factor, utilization time of peak load, and coincidence/diversity factors.
3. Explain the conditions, load-sharing principles, and efficiency optimisation for operating power system equipment—specifically power transformers or generating units—in parallel to minimise total system losses.
4. Identify the main sources and effects of voltage and current harmonics in power systems. How do parallel and series resonances occur between network inductance and power factor correction capacitors, and how are they mitigated (detuned/tuned filters)?
5. Summarise the scope and key parameters of the EN 50160 standard regarding voltage characteristics in public distribution networks (frequency variations, voltage magnitude, flicker, voltage dips/swells, unbalance, and THD limits).
6. Define Demand-Side Management (DSM) and Demand Response (DR). Explain the strategies used to influence consumer load profiles, such as peak shaving, valley filling, load shifting, and ripple control / smart metering tariffs.
7. Explain the structure of a deregulated (liberalized) electricity market, including the unbundling of generation, transmission (TSO), distribution (DSO), and retail. Define the role of the Power Exchange (PX) and the concept of a Balancing Group and Balancing Responsible Party (BRP).
8. Describe the mechanisms of electricity trading across different market timeframes: bilateral OTC contracts, Day-Ahead Markets (DAM), Intraday Markets (IDM), and ancillary services / balancing energy markets.
9. What is the purpose and legal/technical framework of an industrial or building energy audit?

Describe the main phases of an audit: data collection, baseline energy balance, identifying energy efficiency measures, and financial payback analysis.

10. Compare the methods used for electrical load estimation in network planning (using diversity/simultaneity factors for new developments) and short-, medium-, and long-term load forecasting in power system operation.