Information about the exam

Exam

Course code and name	Date	Time	Hall
<u>First option:</u> **ELEC-E8427 Power Transmission Systems**	19.4.2024	13:00-16:00	TU5 - 1194-1195, Maarintie 8
Another option: ELEC-E8427 Power Transmission Systems	13.5.2024	16:30-19:30	Informed later

- **Exam materials: Material is all “theory” lectures (given by Janne Seppänen) + calculation exercises. No guest lectures, no materials labelled as “extra”.**
- **Exam will be a normal lecture hall exam (not remote)**
- **The most complicated equations (such as ABCD constants of long transmission lines, swing equation, symmetrical components) will be given in the exam material, if they are needed**
- **Calculator is needed and allowed in the exam**
- **Use of materials/books/computer and internet are not allowed**

Grading

- **Home calculations (non mandatory): max 6 extra points in total**
- **Exam: max 30 points**
- **Total maximum points if all home calculations have been done: 30 + 6 = 36**
- **Grade limits:**
    - 27 or higher -> 5
    - 24-26 -> 4
    - 21-23 -> 3
    - 18-20 -> 2
    - 15-17 -> 1
    - 0-14 -> 0

Exam, core topics

- Power flow
- Transmission lines (natural power, behavior of line in different loading conditions etc)
- Faults: three phase short circuit and one phase ground fault
- Voltage stability & angle stability, stability of generators after a fault
- Transfer capacity

Example of given equations

- These equations (at least) will be given in the exam
- This is a standard set of equations given in the exams of the previous versions of the Power Transmission Systems course, and <u>these equations cannot and should not be used to determine which types of questions will be included in the exam.</u>

Equations (this is a standard set of equations given at every exam):

$$\cosh(\alpha + \mathrm{j}\beta) = \frac{1}{2}\left(e^{\alpha+\mathrm{j}\beta} + e^{-\alpha-\mathrm{j}\beta}\right) = \frac{1}{2}\left(e^{\alpha}\cdot e^{\mathrm{j}\beta} + e^{-\alpha}\cdot e^{-\mathrm{j}\beta}\right) = \frac{e^{\alpha}}{2}\angle\beta + \frac{e^{-\alpha}}{2}\angle-\beta$$

$$\sinh(\alpha + \mathrm{j}\beta) = \frac{1}{2}\left(e^{\alpha+\mathrm{j}\beta} - e^{-\alpha-\mathrm{j}\beta}\right) = \frac{1}{2}\left(e^{\alpha}\cdot e^{\mathrm{j}\beta} - e^{-\alpha}\cdot e^{-\mathrm{j}\beta}\right) = \frac{e^{\alpha}}{2}\angle\beta - \frac{e^{-\alpha}}{2}\angle-\beta$$

$$\underline{A} = \cosh\underline{\gamma}s \qquad \underline{B} = \underline{Z}_0\sinh\underline{\gamma}s \qquad \underline{C} = \frac{\sinh\underline{\gamma}s}{\underline{Z}_0}$$

Swing equation as pu values:

$$\frac{2H}{\omega_s}\omega_{pu}(t)\frac{d^2\delta}{dt^2} = p_m(t) - p_e(t)$$

Reactive power consumed by a line:

$$Q_1 + Q_2 = \frac{U_1^2}{X} + \frac{U_2^2}{X} - 2\frac{U_1U_2}{X}\cos\delta - \frac{BU_1^2}{2} - \frac{BU_2^2}{2} \approx 2\frac{U^2}{X}(1-\cos\delta) - BU^2$$

Line receiving end voltage u when the sending end voltage is e = 1 pu

$$u = \sqrt{\frac{(1-2xp\tan\phi) \pm \sqrt{1-4xp\tan\phi - 4x^2p^2}}{2}}$$

Symmetrical components:

$$\begin{bmatrix}\underline{U}_A\\ \underline{U}_B\\ \underline{U}_C\end{bmatrix} = \begin{bmatrix}1 & 1 & 1\\ 1 & \underline{a}^2 & \underline{a}\\ 1 & \underline{a} & \underline{a}^2\end{bmatrix}\begin{bmatrix}\underline{U}_{A0}\\ \underline{U}_{A1}\\ \underline{U}_{A2}\end{bmatrix}$$ (similar equation also applies for currents)

$$\begin{bmatrix}\underline{U}_{A0}\\ \underline{U}_{A1}\\ \underline{U}_{A2}\end{bmatrix} = \frac{1}{3}\begin{bmatrix}1 & 1 & 1\\ 1 & \underline{a} & \underline{a}^2\\ 1 & \underline{a}^2 & \underline{a}\end{bmatrix}\begin{bmatrix}\underline{U}_A\\ \underline{U}_B\\ \underline{U}_C\end{bmatrix}$$ (similar equation also applies for currents)

$$\underline{U}_{A1} = \underline{E}_A - \underline{Z}_1\underline{I}_{A1}$$
$$\underline{U}_{2A} = -\underline{Z}_2\underline{I}_{A2}$$
$$\underline{U}_{0A} = -\underline{Z}_0\underline{I}_{A0}$$