

**Course 090245223****Electrical Transients in Electrical Power Systems**

King Mongkut's University of Technology North Bangkok

The Sirindhorn International Thai-German Graduate School of Engineering

Electrical and Computer Engineering Program

Section 1: General Information**1. Course code and course title**090245223 **Electrical Transients in Electrical Power Systems****2. Total credits**3 credits ☐ (2-2-5) ☒ (3-0-6) ☐ (3-0-9) ☐ (2-3-7)**3. Curriculum and course category:**Curriculum: *Master of Engineering in Electrical and Software Systems Engineering*

Course category: Required Courses

☐ Core Course ☐ Specific Core Course☐ Industrial Internship ☐ Master Thesis

Elective Courses

☒ General Elective ☐ Specific Elective ☐ Other Elective**4. Course coordinator/Instructors**

Course Coordinator: Assoc. Prof. Dr.-Ing. Thanapong Suwanasri

Instructor(s): Assoc. Prof. Dr.-Ing. Thanapong Suwanasri

5. Semester/year of study☐ Semester 1 (Aug. to Dec.) ☒ Semester 2 (Jan. to May) Academic Year: **2023****6. Pre-requisite (if any)**☒ No ☐ Yes, please provide:**7. Co-requisites (if any)**☒ No ☐ Yes, please provide:**8. Venue of study**Lecture Day/Time: **Thursdays at 09.00-12.00**☒ On-site: Lecture Room No 504 Floor:.....5.....☐ TGGs, KMUTNB☐ Faculty of Engineering, CU☐ RWTH



Program: **ESSE**
Degree Level: **Master**

Faculty/College: **TGGS**

- ☒ On-line*: Teaching Media: ☒ Microsoft Teams ☐ Google Meet
☐ Zoom ☐ Webex
☐ Other (specify)

*Remark: * During COVID-19, the teaching can be on-site and/or on-line according to TGGS Policy.*

9. Information for quality assurance in education

This course shows evidence of:

- ☐ Development of implementation from previous practices, e.g. the improvement of class teaching, course content, content classification and methods used for learning assessment
- ☐ Involvement from professional bodies/ external agencies in instruction; thus Enhancing student academic and professional experiences
- ☐ Integration of research or creative activities with instruction; use of research-based learning management; knowledge management practices for learning improvement
- ☐ Integration of academic services and course implementation
- ☐ Combination of cultural heritage preservation efforts into instruction or student activities

10. Date of latest revision:

Nov 2023



Section 2: Course Description and Implementation

1. Course Description *(As written in the Official Approved Curriculum)*

Fundamental of electrical transients, Switching transients, Damping of transient oscillation, Abnormal switching transients, Transients in three-phase circuits, Transients on transmission lines, Behavior of equipment under transient conditions, lightning, Protection of systems and equipment against transient overvoltages.

2. Number of hours per semester

Lecture	Practice	Self-study
<i>45 hours/semester</i> <i>(3 hours/week*)</i>	<i>0 hours</i> <i>(0 hours/week*)</i>	<i>105 hours/semester</i> <i>(7 hours/week*)</i>

Remark: * Based on 15 weeks of lecture

Course Category: ☒ Lecture ☐ Practice ☐ Laboratory

Course Evaluation: ☒ A-F ☐ S/U ☐ P

3. Number of hours per week for academic guidance to individual students

☐ 1. Giving academic advice (minimally number hour per week) during the office hour

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

The student can arrange the time other than the office hour via telephone or email for the meeting date/time.

☒ 2. Adopting information technology-based academic advising

☒ Email: thanapong.s@tggs.kmutnb.ac.th

☒ Phone: 0816297055

(Do not distribute this mobile number without permission.)

☐ Communication Apps: Line ID:

(Please notify the lecturer when adding the line.)

☒ Meeting Online: Microsoft Team

☐ Other (specify)

☐ 3.

4. Course Learning Outcomes (CLOs): Students should be able to:

CLO 1. To understand the theoretical concepts in the followings:

- Fundamental of electrical transients,
- Switching transients,



- Damping of transient oscillation,
 - Abnormal switching transients,
 - Transients in three-phase circuits, Transients on transmission lines,
 - Behavior of equipment under transient conditions,
 - lightning,
 - Protection of systems and equipment against transient overvoltages.
- CLO 2. To build high voltage equipment database and condition assessment procedure to evaluate the condition of high voltage equipment using Microsoft Excel.
- CLO 3. To apply the aging models to analyze and understand the aging and degradation of different high voltage equipment.
- CLO 4. To apply the condition assessment models to evaluate the condition of high voltage equipment.
- CLO 5. To compare the pros and cons of various maintenance strategies applied to high voltage equipment.

Remark: 1. Guidelines according to Bloom's Taxonomy is available at [https://courses.dcs.wisc.edu/design-teaching/PlanDesign_Fall2016/2-Online-Course-Design/2_Learning-Objectives-](https://courses.dcs.wisc.edu/design-teaching/PlanDesign_Fall2016/2-Online-Course-Design/2_Learning-Objectives-Alignment/6_objectives_blooms-taxonomy.html)

[Alignment/6_objectives_blooms-taxonomy.html](https://courses.dcs.wisc.edu/design-teaching/PlanDesign_Fall2016/2-Online-Course-Design/2_Learning-Objectives-Alignment/6_objectives_blooms-taxonomy.html)

2. For the master level course, CLOs should be "apply" and "analyze" or possibly to consider the doctoral CLOs "evaluate" and "create". "Remember" and "Understand" are for the undergraduate level courses, however, they can be implemented only at the beginning of the course.

3. CLOs can be defined as many as appropriated for the course.

5. The mapping between Expected Learning Outcomes (ELOs) from the curriculum and Course Learning Outcomes (CLOs)

Table 5.1 ELOs-CLOs Consistency *(for a subject-specific course/a specific curriculum)*

ELOs/CLOs consistency	CLO 1	CLO 2	CLO 3	CLO 4	CLO 5
ELO1					
ELO2	✓		✓	✓	
ELO3					
ELO4		✓	✓	✓	
ELO5					
ELO6		✓	✓	✓	
ELO7					



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ELOs/CLOs consistency	CLO 1	CLO 2	CLO 3	CLO 4	CLO 5
ELO8	✓				✓
ELO9					

Remark: All ELOs and CLOs for the course (highlighted row) are as written in the Official Approved Curriculum.

Table 5.2 Mapping desirable characteristics of KMUTNB graduates and CLOs *(for non-specific courses designed for various curriculums)*

Consistency between desirable characteristics of KMUTNB Graduates- CLOs	CLO 1	CLO 2	CLO 3	CLO 4	CLO 5
1. Professional credentials with critical thinking skills	✓			✓	✓
2. Integrity and social responsibility					✓
3. Innovative and technopreneur mindset				✓	✓
4. Global Competence		✓	✓	✓	

**Section 3: Student Improvement in relation to Course Learning Outcomes****(CLOs)**

Organizing learning to develop skills/ knowledge; evaluation of CLOs in accordance with the ones identified in Section 2.4

Course Learning Outcomes (CLOs)	Teaching Methods compliant with CLOs	Evaluation Methods compliant with CLOs
CLO 1	<ul style="list-style-type: none">• Lecture*• In-class exercises• Individual and/or group assignment• Additional reading assignments from research and/or literature journals	<ul style="list-style-type: none">• Assignment evaluation• Exam***
CLO 2	<ul style="list-style-type: none">• Lecture• In-class exercises• Individual and/or group assignment• Group discussions	<ul style="list-style-type: none">• Assignment evaluation• Exam
CLO 3	<ul style="list-style-type: none">• Lecture• In-class exercises• Individual and/or group assignment• Group discussions	<ul style="list-style-type: none">• Assignment evaluation• Exam
CLO 4	<ul style="list-style-type: none">• Lecture• In-class exercises• Individual and/or group assignment• Group discussions	<ul style="list-style-type: none">• Assignment evaluation• Exam
CLO 5	<ul style="list-style-type: none">• Lecture• In-class exercises• Individual and/or group assignment• Group discussions	<ul style="list-style-type: none">• Assignment evaluation• Exam

*Remark: * Lecture on the concept of the topic is introduced with basic or fundamental definitions, visualization and correlations. For the complicated equation, the derivation from the basic laws can be shown to students. So, the students do not memorize the equations but understand the basic concept and basic equation. The lecturer will introduce the advanced and new concepts, technologies, and findings to students from publications such as journals and websites and from the research and industrial experiences.*



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*** Active learning by asking questions related to the topic in the lecture and encouraging the students to response to the questions. If the students cannot response with answers, then the lecturer will give some guidance until the students can response.*

**** Quiz in the closed-book format on the basic concepts and equations with simple problem solving to evaluate their learning. The solution will be given to students after grading, so they can identify their mistakes and weakness.*

***** Exam on the basic concepts and equations with simple problem solving in the closed-book format as a review, whereas the complicated integrated problem solving will be worked in the open-book format*

**Section 4: Lesson Plan and Evaluation****1. Lesson Plan**

Week	Topics/Details	CLOs	Hours	Learning and teaching activities; teaching media (if any)	Lecturer
1	Chapter 1 Fundamental of Electrical Transients 1. Introduction 2. Circuit parameter 3. Mathematical statement and physical interpretation 4. Circuit characteristics or thumbprints 5. Principle of superposition	1,5	3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Thanapong
2	Chapter 2 Laplace Transform for Solving Differential Equations 1. The concept of a transform 2. The Laplace transform 3. Example of Laplace transform in circuit problems	1,2,3,4	3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Thanapong
3	Chapter 3 Simple Switching Transients 1. Introduction 2. Circuit closing transient 3. Exercise	1	3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Thanapong
4	Chapter 3 Simple Switching Transients 1. the recovery transient initiated by the removal of a short circuit 2. double-frequency transients 3. Exercise	1,2,3,4,5	3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Thanapong
5	Chapter 4 Damping 1. The basic transform of the RLC circuit 2. The generalized damping curves 3. Exercise	1,2,3,4	3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Thanapong
6	Chapter 4 Damping	1,2,3,4,5	3.0	Lecture presentation slides	Thanapong



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Week	Topics/Details	CLOs	Hours	Learning and teaching activities; teaching media (if any)	Lecturer
	1. the series RLC circuit 2. Resistance switching 3. Load switching 4. Other forms of damping 5. Exercise			Examples & In-class exercises Homework assignment	
7	Chapter 5 Abnormal Switching Transients 1. Normal and abnormal switching transients 2. Current Suppression 3. Capacitance Switching 4. Other restriking phenomena 5. Transformer magnetizing inrush current 6. Exercise	1,2,3,4	3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Thanapong
8	Chapter 6 Transients in Three-Phase Circuits 1. Three phase capacitance switching 2. Exercise		3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Thanapong
	Midterm Exam				
9	Chapter 7 Travelling Waves and Transients on Transmission Lines 1. Circuits with distributed constants 2. The wave equation 3. Reflection and refraction of travelling waves 4. Behavior of travelling wave at line terminations	1,2,3,4,5	3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Thanapong
10	Chapter 7 Travelling Waves and Transients on Transmission Lines 1. Lattice diagrams 2. Attenuation and distortion of travelling waves 3. Switching operations involving transmission line	1,2,3,4	3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Thanapong



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Week	Topics/Details	CLOs	Hours	Learning and teaching activities; teaching media (if any)	Lecturer
	Exercise				
11	Chapter 8 Impact of surges on transformer windings 1. Impact of surges on transformer windings 2. Impact of surges on insulator strings 3. Exercise	1,2,3,4	3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Thanapong
12	Chapter 9 Lightning 1. Lightning stroke current 2. Overhead ground wire protection 3. Overvoltages 4. Computation of lightning effect on voltage rise of transmission tower 5. Exercise	1,2,3,4,5	3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Thanapong
13	Chapter 10 Insulation Coordination 1. Stress / strength 2. Concept of volt/time curve 3. Probability and risk evaluation 4. Exercise	1,2,3,4	3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Thanapong
14	Chapter 11 Protection of Systems and Equipment against Transient Overvoltages 1. Lightning protection by overhead ground wire 2. Lightning arrester 3. Exercise	1,2,3,4	3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Thanapong
	Final Exam		3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Thanapong

2. Evaluation Plan (in accordance with OBE 2 mapping framework)



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Course Learning Outcomes (CLOs)	Evaluation Methods	Week of Evaluation	Percentage of Evaluation
CLO 2, 3, 4	Exercises and assignments	Upon assignment (normally weekly)	25
CLO 1, 2, 3, 4, 5	Midterm written exam and workshop	8	35
CLO 1, 2, 3, 4, 5	Final written exam and workshop	16	45
	Attendance	1-15	5

Section 5 Teaching/Learning Resources

Textbooks and materials

1. Thanapong Suwanasri, Lecture companion, Electrical Transients in Electrical Power Systems, 2012
2. .Allan Greenwood, "Electrical Transient in Electrical Power System", John Wiley & Sons, Inc. Second Edition, 1991
3. Lou van der Sluis, "Transients in Power Systems", John Wiley & Sons, Inc. Second Edition, 2002
4. Kunio Nakanishi, "Switching Phenomena in High-Voltage Circuit Breakers", Marcel Dekker, Inc. 1991



Section 6 Course Evaluation and Improvement

1. Course evaluation by students

The students will have an opportunity to evaluate the effectiveness of the course in a form of paper survey and group interview at the end of each semester. The results of survey and interview including the grading will be reviewed by the curriculum meeting to evaluate the course's effectiveness.

2. Strategies for assessing learning management

The students will have an opportunity to evaluate the teaching of the course in a form of paper survey and group interview at the end of each semester. The results of survey and interview including the grading will be reviewed by the curriculum meeting to evaluate the teaching as well as returning to the lecturer for further improvement.

3. Improvement schemes of course implementation

The evaluation from the students including the grading will be submitted to the curriculum meeting for reviewing and brainstorming to improve teaching of each course. Comments and suggestions given by the curriculum meeting will be informed to the responsible lecturer of each course.

4. Verification of students' learning outcomes, referred to OBE 2 and 3

The grading of this course will be evaluated and reviewed by the curriculum meeting and the TGGS board meeting in order to verify its appropriateness before the final approval.

5. Course review and improvement plans

The results of the grading evaluation and student evaluation will be submitted to the curriculum meeting for reviewing and brainstorming to improve the effectiveness of the offered courses. Comments and suggestions will be informed to the responsible lecturer of each course.