Program: ECE **Faculty/College**: TGGS
Degree Level: Master

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 Computer 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: 2021

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

☑ 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**:

July 2021

Program: **ECE** **Faculty/College**: **TGGS**
Degree Level: **Master**

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, Insulation coordination, Protection of systems and equipment against transient overvoltages.

2. Number of hours per semester

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

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. Explain 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,
- Insulation coordination,
- Protection of systems and equipment against transient overvoltages

CLO 2. Create electrical system simulation models using EMTP/ATP software (freeware)

CLO 3. Apply the electrical system simulation models to analyze and understand different electrical transient phenomena due to various switching operations in electrical system.

CLO 4. Apply the electrical system simulation models to simulate and implement the preventive measures to minimize the severity of electrical transients to high voltage equipment.

CLO 5. Compare the pros and cons of various alternatives to minimize electrical transients.

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-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					
ELO8	□				□
ELO9					

Program: **ECE** **Faculty/College**: **TGGS**
Degree Level: **Master**

ELOs/CLOs consistency	CLO 1	CLO 2	CLO 3	CLO 4	CLO 5
ELO10					

Remark: *All ELOs and ELOs 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**		□	□	□	

Program: **ECE** **Faculty/College**: **TGGS**
Degree Level: **Master**

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	• Lecture* • In-class exercises • Individual and/or group assignment • Additional reading assignments from research and/or literature journals	• Assignment evaluation • Exam****
CLO 2	• Lecture • In-class exercises • Individual and/or group assignment • Group discussions	• Assignment evaluation • Exam
CLO 3	• Lecture • In-class exercises • Individual and/or group assignment • Group discussions	• Assignment evaluation • Exam
CLO 4	• Lecture • In-class exercises • Individual and/or group assignment • Group discussions	• Assignment evaluation • Exam
CLO 5	• Lecture • In-class exercises • Individual and/or group assignment • Group discussions	• 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.*

*** 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.*

Program: **ECE** **Faculty/College**: **TGGS**
Degree Level: **Master**

***** 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.*

Program: **ECE** **Faculty/College**: **TGGS**
Degree Level: **Master**

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 parameters 3. Mathematical statement and physical interpretation 4. Circuit characteristics and 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. 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 of RLC circuit	1,2,3,4	3.0	Lecture presentation slides Examples & In-class exercises	Thanapong

Program: **ECE** **Faculty/College**: **TGGS**
Degree Level: **Master**

Week	Topics/Details	CLOs	Hours	Learning and teaching activities; teaching media (if any)	Lecturer
	2. The generalized damping curves 3. Exercise			Homework assignment	
6	Chapter 4 Damping 1. The series RLC circuit 2. Resistance switching 3. Load switching 4. Other forms of damping 5. Exercise	1,2,3,4, 5	3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Thanapong
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
9	Midterm Exam		3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Thanapong
10	Chapter 7 Travelling Waves and Transients on Transmission Lines 1. Circuit with distributed constants 2. The wave equation 3. Reflection and refraction of travelling waves	1,2,3,4	3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Thanapong

Program: **ECE** **Faculty/College**: **TGGS**
Degree Level: **Master**

Week	Topics/Details	CLOs	Hours	Learning and teaching activities; teaching media (if any)	Lecturer
	4. Behavior of travelling wave at the line terminations				
11	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 4. Exercse	1,2,3,4	3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Thanapong
12	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, 5	3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Thanapong
13	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	3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Thanapong
14	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
15	Chapter 11 Protection of Systems and Equipment against Transient Overvoltages	1,2,3,4, 5	3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Thanapong

Program: **ECE** **Faculty/College**: **TGGS**
Degree Level: **Master**

Week	Topics/Details	CLOs	Hours	Learning and teaching activities; teaching media (if any)	Lecturer
	1. Lightning protection by overhead ground wire 2. Lightning arrester 3. Exercise				
16	Final Exam		3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Thanapong

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

Course Learning Outcomes (CLOs)	Evaluation Methods	Week of Evaluation	Percentage of Evaluation
CLO 2, 3, 4	Exercises and assignments	Upon assignment (normally weekly)	20
CLO 1, 2, 3, 4, 5	Midterm written exam and workshop	8	40
CLO 1, 2, 3, 4, 5	Final written exam and workshop	16	40

Program: **ECE** **Faculty/College**: **TGGS**
Degree Level: **Master**

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. Neville Watson and Jos Arrillaga, "Power System Electromagnetic Transients Simulation", The Institution of Engineering and Technology, London, United Kingdom, 2003

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.