NANYANG TECHNOLOGICAL UNIVERSITY

Teaching, Learning and Pedagogy Division

Reg. No. 200604393R

COURSE OUTLINE

Academic Year	AY2020/21	**Semester**	1
Course Coordinator	So Ping Lam		
Course Code	EE4503		
Course Title	Power Engineering Design		
Pre-requisites	Before AY2021-22 Sem2:	EE3010 Electrical Devices & Machines and EE3015 Power Systems & Conversion	
	AY2021-22 Sem2 and onwards:	EE3010 Electrical Devices & Machines and EE3015 Power Systems & Conversion or EE2005 Electrical Devices & Machines and EE3015 Power Systems & Conversion	
No of AUs	2 AUs		
Contact Hours	39 hours (Lecture)		
Proposal Date	5 March 2020 (REF#ACC-CN-2020/06_ITN-02)		

Course Aims
There are two modules in this course. The course aim of the first module is to introduce the basic principles and procedures for the design and assessment of low-voltage and high-tension distribution networks. The course aim of the second module is to provide a platform to apply the knowledge acquired on power system protection to solve some realistic protection problems in power distribution systems, taking into consideration of the relevant industrial standards.

Intended Learning Outcomes (ILO)
By the end of the course, students will be able to: 1. give a basic account of the relevant technical concepts and the international standards in the design and operation of distribution systems. 2. design large electrical installations for power distribution systems such as residential and commercial buildings, airports and mass transport systems, manufacturing and industrial processing plants. 3. apply the theories and concepts learnt to design a target distribution system and the associated protection schemes. 4. design protection schemes for industrial distribution systems. 5. apply the knowledge and skills acquired to solve power engineering problems.

Course Content

In this design course, the students will apply the concepts of various power system analysis techniques and system performance criteria in designing a medium/low-voltage distribution system and protection schemes for some typical industrial distribution networks. Students are required to carry out the detailed design with hands-on exercise and extensive use of computer simulation software. Students are also required to verify the results of the final design to meet specifications.

Course Outline

S/N	Topic	Lecture Hours
1	<u>Design of Distribution Networks</u> Distribution network configurations. Power distribution equipment. Electrical loads. Load data and estimation. Planning and design criteria. Current carrying capacity of conductors and cables. Voltage drop calculations. Short-circuit calculations for thermal considerations. Protection against electric shock. Equipment sizing and selection criteria. Compensation for reactive power. Lightning protection. Standby generator and uninterruptible power supply.	21
2	<u>Design of Protection Schemes for Industrial Plants</u> Fault current calculation of industrial distribution networks. Coordination of overcurrent protection. Differential relaying schemes for power transformers. Protection for capacitor banks. Busbar protection for a typical substation. Stator earth fault protection for a generator.	18
	Total hours	39

Assessment (includes both continuous and summative assessment)

Component	Course LO Tested	Related Programme LO or Graduate Attributes	Weighting	Team/ Individual	Assessment rubrics
1. Final Examination	1, 2, 5	EAB SLO* (a), (b), (c), (d), (e)	50%	Individual	
2. Continuous Assessment (CA): Design Assignment	3, 4, 5	EAB SLO* (a), (b), (c), (d), (e), (i), (j)	50%	Individual**	
Total			**100%**		

* Please refer to Appendix 3 on the EAB accreditation SLOs.

** Students are encouraged to open discussion and brainstorm to propose solutions.

Mapping of Course SLOs to EAB Graduate Attributes (new requirement to update School database)

Course Student Learning Outcomes	Cat	EAB's 12 Graduate Attributes* (indicate full/partial/weak moon/blank for the whole course for SLO a-l)											
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)
EE4503 Power Engineering Design	PE	●	●	●	●	◐				◐	◐		

1. Give a basic account of the relevant technical concepts and the international standards in the design and operation of distribution systems.	EAB SLO* (a), (b), (c), (d), (e)
2. Design large electrical installations for power distribution systems such as residential and commercial buildings, airports and mass transport systems, manufacturing and industrial processing plants.	EAB SLO* (a), (b), (c), (d), (e)
3. Apply the theories and concepts learnt to design a target distribution system and the associated protection schemes.	EAB SLO* (a), (b), (c), (d), (e), (i), (j)
4. Design protection schemes for industrial distribution systems.	EAB SLO* (a), (b), (c), (d), (e), (i), (j)
5. Apply the knowledge and skills acquired to solve power engineering problems.	EAB SLO* (a), (b), (c), (d), (e)

Legend: ● Fully consistent (contributes to more than 75% of Student Learning Outcomes)
◐ Partially consistent (contributes to about 50% of Student Learning Outcomes)
○ Weakly consistent (contributes to about 25% of Student Learning Outcomes)
Blank Not related to Student Learning Outcomes

Formative feedback

You will be able to receive the feedback through:

1. assignment scores and answers;
2. brief comments on assignment reports for individual students;
3. report on overall assignment performance;
4. examination results; and
5. markers' report on overall examination performance and performance analysis on each examination question.

Learning and Teaching approach

Approach	How does this approach support students in achieving the learning outcomes?
LECTURE	The lectures provide important design concepts for the knowledge and skills that you will develop in Learning Outcomes 1 to 5. The lectures comprise explanations of theories and have many design examples for students to practice. The lectures can help students to understand how to apply the knowledge and theories learnt to solve practical power engineering problems, thus helping them to achieve Learning Outcomes 1 to 5.

TUTORIAL	(no tutorial)
LABORATORY (if any)	The hands-on exercises are in every week to allow you to apply what you have learnt for each topic given in the lecture. Assignments are also given to allow you to work on mini projects with all topics combined when you acquire sufficient knowledge and skills, thus achieving Learning Outcomes 1 to 5.

Reading and References

TEXTBOOKS

1. Ismail Kasikci, Analysis and Design of Low-voltage Power Systems: An Engineer's Field Guide, 1st Edition, Wiley-VCH, 2004. (TK1001.K19)
2. Blackburn J Lewis and Domin Thomas J, Protective Relaying: Principles and Applications, 4th Edition, CRC Press, 2014. (TK2861.B628 2014)

REFERENCES

1. Code of Practice for Electrical Installations, (Singapore Standard, CP5 2018), Enterprise Singapore, 2018. (QC100.S617 CP5 2018)
2. Anderson Paul M, Power System Protection, 1st Edition, McGraw-Hill, 1999. (TK1010.A548 & e-book)

Course Policies and Student Responsibilities

General: You are expected to complete all hands-on exercises and take all scheduled assignments by due dates. You are expected to take responsibility to follow up with course notes, assignments and course related announcements.

Continuous assessments and hands-on exercises: You are required to attend all continuous assessments and work on the hands-on exercises.

Absenteeism: Continuous assessments and hands-on exercises make up a significant portion of your course grade. Absence from continuous assessments and hands-on exercises without officially approved leave will result in no marks and affect your overall course grade.

Academic Integrity

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values.

As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the academic integrity website for more information. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Course Instructors

Instructor	Office Location	Phone	Email
A/P So Ping Lam	S1-B1c-77	6790 5026	eplso@ntu.edu.sg
Er Mok Kam Tim, Timmy	---	9673 1484	ktmok@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course LO	Readings/ Activities
1	Distribution Network Configurations	1, 2, 5	Standard CP5 and Hands-on Design
2	Compensation of Reactive Power	1, 2, 5	Standard CP5 and Hands-on Design
3	Selection of Cable Size and Emergency Power Supply	1, 2, 5	Standard CP5 and Hands-on Design
4	Protection Against Electric Shock	1, 2, 5	Standard CP5 and Hands-on Design
5	Electrical Load Estimate and Fault Calculation	1, 2, 5	Standard CP5 and Hands-on Design
6	Lightning Protection	1, 2, 5	Standard CP5 and Hands-on Design
7	Power Distribution Equipment	1, 2, 5	Standard CP5 and Hands-on Design
Recess Week	---		---
8	Power System Protection	3, 4, 5	Design Notes and Hands-on Design
9	Overcurrent Protection	3, 4, 5	Design Notes and Hands-on Design
10	Problems in Overcurrent Protection	3, 4, 5	Design Notes and Hands-on Design
11	Overvoltage Protection	3, 4, 5	Design Notes and Hands-on Design
12	Busbar and Transformer Protection	3, 4, 5	Design Notes and Hands-on Design
13	Motor and Generator Protection	3, 4, 5	Design Notes and Hands-on Design

Appendix 3: The EAB (Engineering Accreditation Board) Accreditation SLOs (Student Learning Outcomes)

a) **Engineering knowledge:** Apply the knowledge of mathematics, natural science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems
b) **Problem Analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c) **Design/development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
d) **Investigation:** Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e) **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations
f) **The engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g) **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for the sustainable development.
h) **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i) **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.
j) **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k) **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and economic decision-making, and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l) **Life-long Learning:** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.