Academic Year	AY2019-2020	**Semester**	1, 2
Course Coordinator	Associate Professor Gooi Hoay Beng		
Course Code	EE3015		
Course Title	Power Systems and Conversion		
Pre-requisites	EE2001 Circuit Analysis		
No of AUs	3		
Contact Hours	Lecture (26 hours); Tutorial (12 hours); and Laboratory (3 hours).		
Proposal Date	11 December 2018		

Course Aims

The aim of this course is to provide fundamental knowledge for B.Eng. (EEE) students who wish to specialize in power engineering in their profession. It introduces you to the overall structure of the electric power supply system, starting from power generation to power transmission, distribution and power conversion. It includes basic concepts of power systems operation and techniques of solid-state power conversions, electric drives and applications of power electronics.

Intended Learning Outcomes (ILO)

By the end of this course, you would be able to:

1. Explain how power systems generate, transmit and distribute power.
2. Represent the electric power supply systems in terms of power system components.
3. Analyse power supply systems and power balance equations using per unit systems.
4. Explain how generator synchronisation, and voltage and frequency control are performed at a power plant for both the grid-connected and isolated power system.
5. Perform fault analysis for balanced power systems and shunt compensation to maintain voltage.
6. Describe the principle of power conversion and various power converters.
7. Describe dc and ac electric drives.
8. Give examples on the applications of power electronics in power systems.

Course Content

Fundamentals of Power Systems. System Operation. Power Conversion. Electromechanical Power Conversion Systems. Applications of Power Electronics in power systems.

Course Outline

S/N	Topic	Lecture Hours	Tutorial Hours
1	Three-phase systems and introduction to base quantities of per-unit systems, Per-unit systems	3	1
2	Active & reactive power flows and synchronous generators	3	2
3	Transmission lines	2	1
4	Z_{Bus} matrix method for fault analysis	3	2
5	Z_{Bus} matrix method and shunt compensation	3	1
6	Power conversion and various converters	6	2
7	Electric drives	3	2
8	Applications of Power Electronics in power Systems	3	1

	Total hours	**26**	**12**

Assessment (includes both continuous and summative assessment)

Component	**Course LO Tested**	**Related Programme LO or Graduate Attributes**	**Weighting**	**Team/Individual**	**Assessment rubrics**
Final Examination	1-8	EAB SLO a, b, c	60%	Individual	
1. Continuous Assessment 1 (CA1): Quiz #1	1-5	EAB SLO a, b, c	10%	Individual	
2. CA2: Quiz #2	6	EAB SLO a, b, c	10%	Individual	
3. CA3 – Lab 10%	3 – 4, 6, 8	EAB SLO a, b, c	10%	Team	
4. Oasis Assignment	1-5	EAB SLO a, b, c	10%	Individual	
Total			100%		

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)
EE3015 Power System and Conversion	PE	●	◐	●								○	○

1. Explain how power systems generate, transmit and distribute power.	EAB SLO* a,b,c
2. Represent the electric power supply systems in terms of power system components.	EAB SLO* a,b,c
3. Analyse power supply systems and power balance equations using per unit systems.	EAB SLO* a,b,c
4. Explain how generator synchronisation, and voltage and frequency control are performed at a power plant for both the grid-connected and isolated power system.	EAB SLO* a,b,c
5. Perform fault analysis for balanced power system and shunt compensation to maintain voltage.	EAB SLO* a,b,c
6. Understand the principle of power conversion and various power converters	EAB SLO* a,b,c
7. Understand dc and ac electric drives	EAB SLO* a,b,c
8. Understand the applications of power electronics in power systems.	EAB SLO* a,b,c

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

* Please refer to Appendix 3 on the EAB accreditation SLO

Formative feedback

Approach	**How does this approach support students in achieving the learning outcomes?**
Lecture	Weekly lectures
Tutorial	12 tutorial sessions to help students achieve the learning outcomes

Reading and References

Textbooks

1. Chapman Stephen J, Electric Machinery and Power System Fundamentals, 1st Edition, McGraw-Hill, 2002. (TK2000.C466E)
2. Paresh C. Sen, Principles of Electric Machines and Power Electronics, 3rd Edition, John Wiley and Sons, 2014. (TK2000.S474p 2014)

References

1. Wildi Theodore, Electrical Machines, Drives and Power Systems, 6th Edition, Pearson/Prentice-Hall, 2006. (TK2182.W673 2006)
2. Weedy Birron Mathew and Cory Brian John, Electric Power Systems, 4th Edition, John Wiley, 2012. (TK1001.W394 2012)
3. Muhammad H. Rashid, Power Electronics: devices, circuits, and applications, 4th Edition, Pearson, 2014. (TK7881.15.P887pe 2014)

Course Policies and Student Responsibilities

Refer to the links for:

Course policies:
http://www.ntu.edu.sg/Students/Undergraduate/AcademicServices/Pages/AcademicUnitSystem(AUS).aspx

CA guidelines:
http://www.eee.ntu.edu.sg/Programmes/CurrentStudents/undergraduate/undergraduatefull-time/Pages/CourseRegistration.aspx

Instructions to Examination Candidates:
http://www.ntu.edu.sg/Students/Undergraduate/AcademicServices/Examination/pages/instructionstoexamcand.aspx

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
Prof Gooi Hoay Beng	S1-B1c-82	6790 4941	EHBGOOI@ntu.edu.sg
Prof Christopher Lee H.T.	S2-B2c-101	6790 5369	chtlee@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course LO	Readings/ Activities
1	Three-phase systems and introduction to base quantities of per-unit systems	1, 2, 3	No tutorial this week – students will receive their tutorial question sheets
2	Per-unit systems	1, 2, 3	Tutorial #1: PU System I
3	Active & reactive power flows and synchronous generators	1, 2, 3	Tutorial #2: PU System II
4	Synchronous generators	1, 2, 3, 4	Tutorial #3: Synchronous Generators I
5	Transmission lines	1, 2, 3	Tutorial #4: Synchronous Generators II
6	Z_{Bus} matrix method for fault analysis	1, 2, 3, 5	Tutorial #5: Transmission Lines
7	Z_{Bus} matrix method and shunt compensation	1, 2, 3, 5	Tutorial #6: Z_{Bus} Matrix and Shunt Compensation
Recess			
8	Introduction to power conversion and harmonics.	6	Quiz #1 in tutorial room and Oasis assignment in Lab
9	AC-DC conversion	6	Tutorial 8: Power conversion and harmonics
10	DC-DC conversion	6	Tutorial 9: AC-DC, DC-DC conversion.
11	DC-AC Conversion	6	Tutorial 10: DC-AC conversion, and Quiz #2 in LT

12	DC and AC drives systems	6, 7	Tutorial 11: DC-AC Conversion
13	Other applications of power electronics	6 - 8	Tutorial 12: DC and AC drive systems

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.