EEE 205 – Energy Conversion II

PART A: General Information

1.	Course Number	EEE 205
	Course Title	Energy Conversion II
	Credit (Contact) Hours	3.0 (3.0)
2.	Level and Term (Section)	Level-2, Term-II
	Academic Term	January 2023
3.	Type of Course	Core Course
	Offered to	EEE
4.	Pre-requisite Course(s)	None
5.	Course Website	Designated Microsoft Teams Group for each section
6.	Lecture Schedule	**Section C:** Sun 09 am, Mon 09 am, Tue 09 am
7.	Important Dates	For important dates and examination schedules and latest updates, please follow the course website/Teams Group
8.	Course Teacher(s)	**Section A: Dr. Md. Nasim Ahmed Dewan,** Professor Dept. of EEE, BUET Email: dewan@eee.buet.ac.bd **Section B: Dr. Abdul Hasib Chowdhury**, Professor Dept. of EEE, BUET Email: hasib@eee.buet.ac.bd **Section C: Dr. Hafiz Imtiaz** Associate Professor Dept. of EEE, BUET Email: hafizimtiaz@eee.buet.ac.bd Office: ECE 128 Website: http://hafizimtiaz.buet.ac.bd

PART B: Course Details

9. Course Content (As approved by the Academic Council)

- Synchronous Generator: construction, armature (stator) and rotating field (exciter), excitation system with brushes and brushless excitation system, cooling, generated voltage equation of distributed short pitched armature winding, armature winding connections and harmonic cancellation in distributed short pitched winding, equivalent circuit, synchronous impedance, generated voltage and terminal voltage, phasor diagram, voltage regulation with different power factor type loads, determination of synchronous impedance by tests, phasor diagram, salient pole generator d-q axes parameters, equivalent circuit, generator equations, determination of d-q axes parameters by tests, equation of developed power and torque of synchronous machines (salient and non-salient pole motor and generator).
- Parallel Operation of Generators: requirement of parallel operation, conditions, synchronizing, effect of synchronizing current, hunting and oscillation, synchroscope, phase sequence indicator, load distribution of alternators in parallel, droop setting, frequency control, voltage control, house diagrams.
- Synchronous Motors: construction, operation, starting, effect of variation of load at normal excitation, effect of variation of excitations, V curves, inverted V curves and compounding curves, power factor adjustment, synchronous capacitor and power factor correction.
- DC Motors: principle of operation, constructional features, back emf and torque equations, armature reaction and its effect on motor performance, compensating winding, problems of commutation and their

mitigations, types of dc motors and their torque speed characteristics, starting and speed control of dc motors, applications of different types of dc motor.

- Single Phase Induction Motor: operation, quadrature field theory, double revolving field theory, split phasing, starting methods, equivalent circuit, torque-speed characteristic and performance calculation.
- Renewable Energy: Introduction to photovoltaic systems.

10. Course Objectives

- To understand the construction and operations of synchronous generator (alternator), synchronous motor, DC motor, single phase induction motor and photovoltaic system
- To analyse the characteristics of salient and non-salient pole generators and motors, to calculate various machine parameters based on design data and test results
- To demonstrate the parallel operation of generators/infinite bus system
- To be familiar with the application of renewable energy technology such as photovoltaic systems

11. Knowledge required

Fundamental concepts of Electrical Circuits I & II course, application of Faraday's law, and Energy Conversion I course

12. Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	**Explain** the operations of synchronous and other (1-ϕ, DC) electrical machines by **applying** the knowledge of electrical circuits and electromagnetic induction	PO(a)	C2, C3	Lectures, Discussions	Assignment, Class test, Final exam
2	**Analyse** the techniques of parallel operation of alternator (to another alternator and to infinite bus system)	PO(b)	C4	Lectures, Discussions	Assignment, Class test, Final exam
3	**Design** solar home system satisfying necessary requirements	PO(c)	C6	Lectures, Discussions	Assignment, Final exam
4	**Compare** renewable energy technology with conventional energy generation technology	PO(g)	C5	Lectures, Discussions	Assignment, Class test, Final exam

Cognitive Domain Taxonomy Levels: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation, **Affective Domain Taxonomy Levels**: **A1**: Receive; **A2:** Respond; **A3:** Value (demonstrate); **A4:** Organize; **A5:** Characterize; **Psychomotor Domain Taxonomy Levels: P1:** Perception; **P2**: Set; **P3:** Guided Response; **P4:** Mechanism; **P5:** Complex Overt Response; **P6:** Adaptation; **P7:** Organization

Program Outcomes (PO): **PO(a)** Engineering Knowledge, **PO(b)** Problem Analysis, **PO(c)** Design/development Solution, **PO(d)** Investigation, **PO(e)** Modern tool usage, **PO(f)** The Engineer and Society, **PO(g)** Environment and sustainability, **PO(h)** Ethics, **PO(i)** Individual work and team work, **PO(j)**. Communication, **PO(k)** Project management and finance, PO**(l)** Life-long Learning

* For details of program outcome (PO) statements, please see the departmental website or course curriculum

13. Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
✓	✓	✓	✓	✓		✓		✓	✓	✓									

14. Lecture Plan

Week	Lectures	Topic
1	1-3	Synchronous Generator: construction, armature (stator) and rotating field (exciter), excitation system with brushes and brushless excitation system.
2	4-6	Cooling of generator. Generated voltage equation of distributed short pitched armature winding, armature winding connections and harmonic cancellation in distributed short pitched winding.
3	7-9	Equivalent circuit, synchronous impedance, generated voltage and terminal voltage, phasor diagram, voltage regulation with different power factor type loads.
4	10-12	Determination of synchronous impedance by tests, phasor diagram, salient pole generator d-q axes parameters, equivalent circuit, generator equations.
5	13-15	Determination of d-q axes parameters by tests, equation of developed power and torque of synchronous machines (salient and non-salient pole motor and generator).
6	16-18	*Parallel Operation of Generators:* requirement of parallel operation, conditions, synchronizing, effect of synchronizing current, hunting and oscillation.
7	19-21	Synchroscope, phase sequence indicator, load distribution of alternators in parallel, droop setting, frequency control, voltage control, house diagrams.
8	20-24	*Synchronous Motors:* construction, operation, starting, effect of variation of load at normal excitation, effect of variation of excitations.
9	25-27	V-curves, inverted-V curves and compounding curves, power factor adjustment, synchronous capacitor and power factor correction.
10	28-30	*DC Motors:* principle of operation, constructional features, back emf and torque equations, armature reaction and its effect on motor performance, compensating winding, problems of commutation and their mitigations.
11	31-33	Types of dc motors and their torque speed characteristics, starting and speed control of dc motors, applications of different types of dc motor.
12	34-36	*Single Phase Induction Motor:* operation, quadrature field theory, double revolving field theory, split phasing.
13	37-39	Starting methods, equivalent circuit, torque-speed characteristic and performance calculation.
14	40-42	*Renewable Energy:* Introduction to photovoltaic systems. Summary review.

15. Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

16. Distribution of Marks

Class Participation 10%

Continuous Assessment	20%
Final Examination	70%
Total	100%

17. Textbook/References

- Electric Machinery Fundamentals, Stephen Chapman, ISBN-13: 978-0073529547
- Electric Machines Theory, Operation, Applications, Adjustment, and Control by Charles I. Hubert, 2002 (2nd edition)
- Principles of Electric Machines and Power Electronics by P.C. Sen, 2014 (3rd edition)
- Handbook of Renewable Energy Technology edited by A. F. Zobaa, World Scientific Co., 2011
- Alternating Current Machines by A.F. Puchstein and T.C. Lloyd, 1942 (2nd edition)
- Online resources or supplementary materials will be shared with the class on a need basis

Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

Course Outline Prepared by	Yeasir Arafat	12/05/2022
Course Outline Reviewed by	Dr. Nahid Al Masood Dr. Hafiz Imtiaz	12/05/2022