Department of Electrical and Electronic Engineering (EEE)
Bangladesh University of Engineering and Technology

COURSE OUTLINE
Jan 2025

EEE 203 – Energy Conversion I

PART A: General Information

1.	Course Number	EEE 203
	Course Title	Energy Conversion I
	Credit (Contact) Hours	3.0 (3.0)
2.	Level and Term (Section)	Level-2, Term-I
	Academic Term	Jan 2025
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 A:** Sun 09 am, Mon 09 am, Tue 09 am
7.	Important Dates	For important dates and examination schedules and latest updates, please follow the Teams Group
8.	Course Teacher(s)	**Section A:** **Dr. Hafiz Imtiaz,** Professor Dept. of EEE, BUET Email: hafizimtiaz@eee.buet.ac.bd Office: ECE 128, ECE Building Website: https://hafizimtiaz.buet.ac.bd

PART B: Course Details

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

- *Single-phase Transformer:* principle of operation, construction, no load and excitation current, behaviour during loading, effect of leakage flux, ideal transformer, leakage reactance and equivalent circuit of a transformer, equivalent impedance, voltage regulation, per unit quantities, regulation, losses and efficiency, determination of parameters by tests, polarity of transformer windings, vector group, transformer parallel operation. Harmonics in excitation current, transformer inrush current.
- *Poly-phase Transformer:* three phase transformers, connections, harmonic suppression in three phase transformer connection.
- *Autotransformer:* construction, working principle, auto-transformer vs. potential divider, copper saving, advantages/disadvantages, phasor diagrams, equivalent circuits, conversion of a two-winding transformer to an auto-transformer, applications.
- *Instrument transformers:* measurement of high voltages and currents in power system using P.T. and C.T. (respectively). Use of P.T. and C.T. with protective devices.
- *Three-phase Induction Motor:* rotating magnetic field, reversal of rotating magnetic field, synchronous speed, torque in induction motor. Construction - squirrel cage, wound rotor; slip and its effect on rotor frequency and voltage, equivalent circuit of an induction motor, air gap power, mechanical power and developed torque, torque speed characteristic, losses, efficiency & power factor, classification, motor performance as a function of machine parameters, shaping torque speed characteristic and classes of induction motor, per unit values of motor parameters, determination of induction motor parameters by tests, methods of braking, speed control.
- *Induction Generator:* operation, characteristics, voltage build up, applications in wind turbine.

10. Course Objectives

- To understand the construction and operations of various transformers, 3-phase induction motor and induction generator
- To analyse the characteristics of polyphase induction motors, to calculate various machine parameters based on design data and test results
- To demonstrate the parallel operation of polyphase transformers
- Application of induction generator for harvesting renewable energy e.g., wind turbine

11. Background Knowledge required

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

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 transformers and 3-ϕ induction motor/generator by **applying** the knowledge of electrical circuits and electromagnetic induction	PO1	C2, C3	Lectures, Discussions	Assignment, Class test, Final exam
2	**Analyse** the techniques of parallel operations of transformers (single to single phase, poly to poly phase)	PO2	C4	Lectures, Discussions	Assignment, Class test, Final exam
3	At the end of the course the students will be able to **design/develop** three-phase transformer using single-phase transformers	PO3	C6	Lectures, Discussions	Assignment, Final exam

***Program Outcomes (PO):** **PO1** Engineering Knowledge, **PO2** Problem Analysis, **PO3** Design/development Solution, **PO4** Investigation, **PO5** Modern tool usage, **PO6** The Engineer and Society, **PO7** Environment and sustainability, **PO8** Ethics, **PO9** Individual work and team work, **PO10**. Communication, **PO11** Project management and finance, **PO12** Life-long Learning

****Cognitive Domain Taxonomy Levels:** **C1** – Remember, **C2** – Explain, **C3** – Apply, **C4** – Analyse, **C5** – Evaluate/Compare, **C6** – Create/Design.

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

13. 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.

14. Distribution of Marks

Class Participation	10%
Homework, Assignment and Quizzes	20%
Final Examination	70%
Total	100%

15. Textbook

- Electric Machinery Fundamentals by Stephen J. Chapman, McGraw-Hill, 2012 (5th edition)

16. Reference books and relevant resources

- 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

N.B. 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.

17. Lecture Plan

Week	Lectures	Topic
1	1-3	*Single-phase Transformer:* principle of operation, construction, no load and excitation current, behaviour during loading, effect of leakage flux.
2	4-6	Ideal transformer, leakage reactance and equivalent circuit of a transformer, equivalent impedance, voltage regulation.
3	7-9	Per unit quantities, regulation, losses and efficiency, determination of parameters by tests.
4	10-12	Polarity of transformer windings, vector group, transformer parallel operation. Harmonics in excitation current, transformer inrush current.
5	13-15	*Poly-phase Transformer:* three phase transformers, connections, harmonic suppression in three phase transformer connection.
6	16-18	*Autotransformer:* construction, working principle, auto-transformer vs. potential divider, copper saving, advantages/disadvantages.
7	19-21	Phasor diagrams, equivalent circuits, conversion of a two-winding transformer to an auto-transformer, applications.
8	20-24	*Instrument transformers:* measurement of high voltages and currents in power system using P.T. and C.T. (respectively). Use of P.T. and C.T. with protective devices.
9	25-27	*Three-phase Induction Motor:* rotating magnetic field, reversal of rotating magnetic field, synchronous speed, torque in induction motor.
10	28-30	Construction - squirrel cage, wound rotor; slip and its effect on rotor frequency and voltage, equivalent circuit of an induction motor, air gap power, mechanical power and developed torque.
11	31-33	Torque speed characteristic, losses, efficiency & power factor, classification, motor performance as a function of machine parameters.
12	34-36	Shaping torque speed characteristic and classes of induction motor, per unit values of motor parameters.
13	37-39	Determination of induction motor parameters by tests, methods of braking, speed control.
14	40-42	*Induction Generator:* operation, characteristics, voltage build up, applications in wind turbine. Summary review.

18. Mapping of Knowledge Profile (K), Complex Engineering Problem Solving (CP) and Complex Engineering Activities (CA)

K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	CP 1	CP 2	CP 3	CP 4	CP 5	CP 6	CP 7	CA 1	CA 2	CA 3	CA 4	CA 5
√	√	√		√	√			√						√					

19. Important University Policies

- Please check the following link for Rules and regulations for the undergraduate programmes: https://www.buet.ac.bd/info/Academicinformation/RulesUndergradprogram