



Course Syllabus
ET222: Electrical Machines II

Semester / Session: 4th (Fall-2019) / 2018-2022

Program: BS Electrical Engineering Technology

Instructor: Dr. Ateeq-Ur-Rehman Shaheen
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Office Hours: 11: 00 AM to 01: 00 PM (Tue, Thu)

Schedule (Theory Class): Thu 08:00 AM to 11:00 AM

Course TA: N.A.

Course Description: This course is intended to provide a basic introduction to the theory of electromechanical energy in the context of AC machines. In depth analysis of synchronous generator & induction motors will be carried out for different characteristics. Single phase AC fractional-horsepower motors will also be covered in the course with introduction of split phase, shaded pole, universal and repulsion motors.

Catalog Data:

Course Code:	ET-222
Course Title:	Electrical Machines II
Credit Hours:	4
Course Designation:	Engineering Foundation
No of Sessions per week:	01 (Total 16 sessions)
Session Duration:	180 min

Course Objectives: The objective of this course is to teach the principle and working of single and three phase AC machines.

Catalog Description: **ET-222 Electrical Machines II, Credits (4)**
Three Phase Induction Motors: Construction, working principle, types, equivalent circuits, starting methods, speed control and applications. **Synchronous Motors:** Construction, principle of operation, characteristics, applications. **Single Phase Motors:** Universal, shaded pole, split phase, repulsion motors, speed control, starting methods. **Alternators:** Construction, principle of operation, armature reaction, voltage regulation, synchronization and parallel operation.

Prerequisite: NIL



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Prerequisites by

Topics: NIL

Co-requisite: NIL

Textbook: **Stephen J. Chapman** “Electric Machinery Fundamental”, 5th Edition, McGraw- Hill International Edition.

References:

1. A.E. Fitzgerald, “Electric Machinery”, 6th Edition, McGraw-Hill International Edition.
2. Charles I. HUBERT, “Electric Machines: Theory, Operating Applications, and Controls”, 2nd Edition, Prentice Hall, 2001.
3. Hindmarsh, “Electrical Machines”, McGraw-Hill. (Latest Edition)
4. Matthew Scarpino, “Motors for Makers: A Guide to Steppers, Servos, and Other Electrical Machines”, 1st Edition, Que Publishing.

Program Learning

Outcome:

This course is designed in conjunction with the following PLOs.

PLO4: Investigation: An ability to investigate complex engineering problems in a methodical way including literature survey, design and conduct of experiments, analysis and interpretation of experimental data and synthesis of information to derive valid conclusions.

Course Learning Outcome (CLO):

CLO #	CLO Outline	Relevant PLO	Learning Domain & Level	Assessment
1	Assess the operation of AC machines (Synchronous and Asynchronous) and Special Purpose Electrical Machines in a power system	4	C - 5	A1, Q1, MD, FL

Note: C- Cognitive, A- Assignment, Q- Quiz, MD- Mid, FL- Final

Course Professional Outcome/ Industrial Usage:

This course is an introductory course on Electrical Machines. It is designed for students in electrical engineering. It introduces students to the types, working, characteristics, analyses and problems that may arise within the context. It also equips the students with fundamental concepts and analyses skills to evaluate.

Course Outline and

Sessions Breakdown: I. Introduction to Induction Motor (CLO-1)
(07 Sessions)



Construction, working principle, types, equivalent circuits, starting methods, speed control and applications.

II. Synchronous Motor (CLO-1)
(01 Sessions)

Construction, principle of operation, characteristics, applications.

III. Single Phase AC Motors (CLO-1)
(03 Sessions)

Universal, shaded pole, split phase, repulsion motors, speed control, starting methods.

IV. Alternators (CLO-1)
(4 Sessions)

Construction, principle of operation, armature reaction, voltage regulation, synchronization and parallel operation.

Computer Usage: Not applicable unless otherwise stated.

**Projects /
Design Activities:** NIL

Evaluation Criteria:	1. Assignments	10%	CLO1
	2. Quizzes	10%	CLO1
	3. Mid-Term Exam	30%	CLO1
	4. Final Exam	50%	CLO1

Policies

- (a) No makeup tests or quizzes, except in case of emergency, e.g. illness and accident. For makeup tests, medical certificate is required and the instructor must be notified in advance of the test.
- (b) No late assignment will be accepted.
- (c) Topics and schedule mentioned here are tentative. They may be slightly changed depending on the interest / pace of class.
- (d) **Class notes and Handouts:**

Students must take notes in the class. Equations, expressions and problems would be copied from the board as the instructor writes while, the student should note down important points as the instructor delivers the lecture both as orally and through slides. This body of material would form the most important asset of the student for exam preparation and in obtaining good grades.

Additional study material supplementing the class notes is the text book. The student must always inculcate the habit of book reading for deepening and strengthening the concepts gained in the class.

(e) **Attendance Policy:**

Class attendance is mandatory. You are expected to be present in all classes. The students having their attendance less than 75% will not be allowed to appear in the exam and will be awarded "F" grade hence forth.

(f) **Homework Policy:**



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- **You SHOULD NOT** copy homework from classmates. You may consult with the instructors or one of your classmates if there is a homework problem that you find difficult.
- Copying assignment will not carry any benefit because quizzes will be based on assignments and most of the assignments will be marked based on quizzes.
- Late homework is not accepted for any reason.
- Homework papers should have a cover page showing name, ID number, date, problem number and assignment number.
- Class serial number should appear on the top right hand corner of the cover page.
- All problems in an assignment set should be arranged sequentially.
- A4 Paper should be used for Assignments.

(g) Quizzes:

These will be held promptly on the designated day. They will cover the material taught the previous weeks. Late arrival or non-attendance without a legitimate excuse will mean that you are ineligible to take that quiz.

(h) Academic Dishonesty:

The UOS is an academic community whose purpose is the pursuit of knowledge and the development of its graduates as leading experts in their academic disciplines. All members of this community must be committed to the principles of truth and academic honesty. Academic dishonesty includes the following acts committed knowingly or intentionally by the student:

- **Cheating:** Using or attempting to use unauthorized materials and assistance, such as notes, study aids, electronic communication devices of any sort, or any other forms of unauthorized information or consulting any unauthorized sources, in any academic assignment, exercise, or examination.
- **Fabrication:** Falsifying or inventing research, citations, or any information on any academic assignment, exercise, or examination.
- **Plagiarism:** Representing another's words or ideas as one's own or failing to give proper credit to outside sources of information in any academic assignment, exercise, or examination.
- **Facilitating academic dishonesty:** Aiding or assisting another in cheating, fabrication or plagiarism.

Students who have committed an act of academic dishonesty are subject to one or more of the following penalties:

- A written warning
- A reduction in grade for the assignment
- A zero grade for the assignment
- A reduction of grade for the course, including an **F** grade for the course.
- Suspension from the Wah Engineering College for one or more semesters.
- Expulsion from the Wah Engineering College.

Records of incidents of academic dishonesty will be kept on file at the Wah Engineering College and may be reported to the student's guardian and sponsor.



Students who are in doubt about whether certain academic activities are honest or not should discuss the matter with the course instructor or consult the WEC policy on academic integrity.

Disclaimer:

- (i) The instructor reserves the right to change, and adjust the policies and class schedules at any time during the semester.

COURSE DISTRIBUTION ON WEEKLY BASIS

Weeks	Lecture	Topics to be covered	Reference
WEEK 01	1	Introduction Induction motor Construction, working and principle of IM Development of induced torque in induction motor	Text Book Chapter 6
WEEK 02	2	Introduction Induction motor Types of induction motor Squirrel cage and slip ring induction motor and their merits, demerits and comparison Concept of rotor slip and its Expression	Text Book Chapter 6
WEEK 03	3	Introduction Induction motor Concept of rotor frequency and its relation with slip, example 7.1, Equivalent circuit of induction motor Rotor circuit and slip effects Final equivalent circuit.	Text Book Chapter 6
WEEK 04	4	Power and Torque Calculations Power flow diagram of induction motor Calculation of different losses in an induction motor.	Text Book Chapter 6
WEEK 05	5	Speed Control of Induction motor Pole changing method Line frequency method Voltage control method	Text Book Chapter 6
WEEK 06	6	Speed Control of Induction motor V/f control for controlling the speed Rotor resistance control method Torque speed characteristics for each method	Text Book Chapter 6
WEEK 07	7	Starting of IM Wye-delta starter Auto transformer starter Resistance starting Soft starting	Text Book Chapter 6



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		Rotor resistance starting control	
WEEK 08	8	Synchronous motor Construction, working Principle of operation, Torque speed characteristics V-curves of synchronous motor Application in power factor improvement	Text Book Chapter 5
WEEK 09		Mid-Term	CLO1
WEEK 10	9	Single phase Machines Universal Motor: Construction, principle of operation and application Shaded-Pole Motor: Construction, principle of operation and application	Text Book Chapter 9
WEEK 11	10	Single phase Machines Split-Phase Motor: Construction, principle of operation and application Repulsion Motor: Construction, principle of operation and application	Text Book Chapter 9
WEEK 12	11	Single phase Machines Speed Control Starting Methods	Text Book Chapter 9
WEEK 13	12	Induction Generator Basic principle, working and construction Voltage build up phenomenon in stand-alone system Applications	Text Book Chapter 6
WEEK 14	13	Synchronous Generator Basic principal and working, Salient pole and cylindrical rotors and their comparison Brushless exciters and pilot exciters Application of synchronous generators Synchronous speed expression	Text Book Chapter 4
WEEK 15	14	Synchronous Generator Equivalent circuit of synchronous generator Armature resistance and leakage inductance Phasor diagrams at different power factor loads, Derivation of power expressions	Text Book Chapter 4
WEEK 16	15	Synchronous Generator Modes of operation of synchronous generator, Working alone, working in parallel with same SG, and connected to infinite bus bar House diagram and sharing of power	Text Book Chapter 4



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		Synchronization of alternator with infinite bus bar	
WEEK 17		Revision	
WEEK 18		Final Examination	CLO-1