University of Macau
Faculty of Science and Technology
Department of Electrical and Computer Engineering

Part A: Course Outline

Course Title:	Electric Machines		
Course Code:	ECEB220	Year of Study:	2
Course Mode:	Theoretical with substantial laboratory/ practice content		
Compulsory/Elective:	Compulsory		
Course Prerequisites:	ECEB122 Circuit Analysis		
Prerequisite Knowledge	Circuit Analysis, Differential Equations, Electromagnetism		
Class/Laboratory Schedule:	3-hour lecturer, 2-hour experiment/tutorial per week		
Duration	One semester	Credit Units	4
Text Books and References:	[1] Electric Machinery Fundamentals, Stephen J. Chapman, McGraw-Hill [2] Electric Machinery , A. E. Fitzgerald, Charles Kingsley Jr., and Stephen Umans, McGraw Hil		
Course Description:	This course introduces fundamental concepts and principles of operation of transformers, DC machines, synchronous machines and induction machines to the students and equips the students with basic experimental and modelling skills for handling problems associated with these devices..		
Topics Covered	1. Theory of electromechanical energy conversion 2. Concepts of fundamental torque equation, EMF equation and rotating fields 3. Principles of operation of transformers and machines 4. Fundamental characteristics of transformers and machines 5. The equivalent circuits and mathematical models of transformers and machines 6. Construction of transformers and machines		
Course Objectives:	To introduce basic concept, construction and working principle of transformers and machines [a,c, e] To introduce voltages relationship between primary side and secondary side for different Yy and Dy three phase transformer structures [a] • To equip the students with basic experimental and modelling skills for transformers and machines. [a, e, k] • To prepare the students to apply the equivalent circuits and mathematical models of transformers and machine in different cases. [a, b, k] • To introduce the students the basic design consideration for transformers. [a, c] • To explore the students the requirement for paralleling synchronous generators and the behavior of synchronous generators operated in parallel.[a, e, k]		
Course Assessment:	Quiz: 10%		

<table>
<tr><td></td><td>Notes+assignment : 10%
Experiment + (oral or presentation) : 25%
Test: 25%
Final Exam. : 30%</td></tr>
<tr><td>Relationship to Program Objectives and Outcomes</td><td>This course primarily contributes to ECE program outcomes that develop students' abilities to:
a. Ability to apply knowledge of mathematics, science and engineering.
e. Ability to identify, formulate and solve engineering problems.
k. Ability to use the techniques, skills and modern engineering tools necessary for engineering practice.

This course secondarily contributes to ECE program outcomes that develop students' abilities to:
b. Ability to design and conduct experiments.
c. Ability to design a system, component or process to meet desired needs.</td></tr>
<tr><td>Course Contents and Relationship to Program Criteria:</td><td>
<table>
<tr><th>Week no.</th><th>Topics</th><th>Program Criteria</th></tr>
<tr><td>3</td><td>Transformer
Construction, Basic operating principle, Functions of transformers, Single Phase Transformer Under No Load operation, Single Phase Transformer With Load operation, open circuit and short circuit tests and Determination of the Parameters in the Equivalent Circuit, Three Phase Transformer</td><td>BS, ES, CV,DIC</td></tr>
<tr><td>3</td><td>DC motor
Introduction to DC Machines, DC Motors: Principles of operation, production of torque, torque-current and torque-speed characteristics of motors, Methods of excitation – Self and separately excited generators, Speed control of DC motor.</td><td>BS, ES, CV</td></tr>
<tr><td>3</td><td>Synchronous generators
Construction, The Speed of Rotation, The Internal Generated Voltage, The Equivalent Circuit, The Phasor Diagram, Power and Torque in Synchronous Generator, Measuring Synchronous Generator Model Parameters, The Synchronous Generator Operating Alone, Parallel operation of AC Generators, Synchronous Generator Ratings</td><td>BS, ES, CV</td></tr>
<tr><td>3</td><td>Induction motors
Motor Construction, Basic Induction Motor Concepts, The Equivalent Circuit, Powers and Torque in Induction Motor, Induction Motor Torque-Speed Characteristics, Variations in Induction Motor Toque-Speed Characteristics, Starting Induction Motors Speed Control of Induction Motor, Determining Circuit Model Parameters</td><td>BS, ES, CV,</td></tr>
<tr><td>2</td><td>Synchronous Generator Models for Fault Analysis
Transient due to Short circuit, Flux Linkage Conservation, Development of Mathematical Models for Fault Analysis.</td><td>BS, ES, CV, DA</td></tr>
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Contribution of Course to meet the professional component:	This course equips students to understand the principles, construction, basic design consideration, characteristics, equivalent circuit and mathematical models of two important devices in ECE field, i.e. synchronous machines and induction machines. Students should be able to apply knowledge of mathematics and engineering, and identify formulas to solve power engineering problems.
Course Instructor(s):	Dr. Chi Kong Wong
Prepared by:	Dr. Chi Kong Wong

Part B: General Course Information and Policies

Instructor: Dr. Chi Kong Wong Office E11-3052
Office Hour: Monday 3:30~5:30 p.m. or by appointment Phone: 4364
e-mail: ckwong@umac.mo

Programme Educational Objectives

1. **Problem Solving:** Graduates have the ability to think in a critical and evaluative manner and to consider a broad perspective, in order to solve technical and nontechnical problems.
2. **Leadership and Communication:** Graduates will provide effective leadership, act in an ethical manner and skills will include the ability to communicate well and to work successfully within diverse groups.
3. **Market Acceptance:** Graduates will have successful careers in the academic environment, industrial and government organizations.
4. **Technical Competence:** Graduates will be technically competent and have a thorough grounding in the fundamentals of math and science in electrical and computer engineering and experience in engineering design. They will be able to use modern engineering techniques, skills, and tools to fulfill societal needs.

Scale: 1 (Highest) to 4 (Lowest)

	Problem Solving	Leadership and Communication	Market Acceptance	Technical Competence
Electrical Machines	1	4	2	1

Remark:

- Objective for “Problem Solving” can be achieved by assignments, laboratories, mid-term exam and final exam.
- Objective for “Leadership and Communication” can be achieved by report writing and (oral or presentation). However, leadership training is not given by this course.
- Objective for “Market Acceptance” can be achieved by the course contents that are required in industries.
- Objective for “Technical Competence” can be achieved by using fundamentals of math and science in electrical and computer engineering and experience in experiment.

Program Criteria Policy:

Course VS Program Criteria
Scale: 1(Highest) to 4 (Lower)

Course	PS	DIC	BS	CS	ES	DE	LA	CV	DM
Electric Machines		4	3		1	4		3	

Terms:
Probability and Statistics (PS), Differential and Integral Calculus (DIC), Basic Science (BS), Computer Science (CS), Engineering Science (ES), Differential Equation (DE), Linear Algebra (LA), Complex Variables (CV), Discrete Mathematics (DM)

Relationship of course to Programme Outcomes:

	Program Outcomes											
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**
ECEB220 Electric Machines	TP	P		P	T		P					

Course VS Course Outcomes

***T – TEACH; P – PRACTICE; M – MEASURED**

Program Outcome Policy:

Course VS Course Outcomes
(H= Highly Related, S = Supportive, N = None)

Course	a	b	c	d	e	f	g	h	i	j	k	l
Electric Machines	H	S	N	N	H	N	N	N	N	N	H	N

The electrical and computer engineering program outcomes are:

a. Ability to apply knowledge of mathematics, science and engineering.
b. Ability to design and conduct experiments.
c. Ability to design a system, component or process to meet desired needs.
d. Ability to function on multidisciplinary teams.
e. Ability to identify, formulate and solve engineering problems.
f. Understanding of professional and ethical responsibility.
g. Ability to communicate effectively.
h. Broad education necessary to understand the impact of engineering solutions in global and societal context.
i. Recognition of the need for and an ability to engage in life-long learning.
j. Knowledge of contemporary issues.
k. Ability to use the techniques, skills and modern engineering tools necessary for engineering practice.
L. an ability to use the computer/IT tools relevant to the discipline along with an understanding

Curriculum Detail

ECEB220 Electric Machines

Timetabled work in hours per week			No of teaching weeks	Total hours	No /Duration of exam papers	Max marks available from:	
Lecturer	Tutor	Practice				Exams	Course
3	1	1	14	70	1/5 hours	30	70

Term: 5th

Hours			Percentage content of					
Lecturer	Lab/tut	Other	Maths	Basic Science	Engineering Science	Engineering Design and Synthesis	Complementary Studies	Computer Studies

42	14/14	0	20	20	50	10	0	5

Design Elements

% of Design Content	Design Content in Course Work	Design Project	Design Content in Laboratories
10%	X	--	--

Course Assessment Policy:

- Homework assignments will be given to students according to the course progress, no late submission is accepted. Zero mark will be given when homework is copied.
- Notes will be collected, no late submission is accepted.
- 2-3 Quizzes will be held during the semester.
- 1-2 experiments will be performed during the semester, no late submission is accepted. Zero mark will be given when homework is copied.
- 1 test and 1 final exam will be performed.