

Academic Year: ( 2022 / 2023 )

Review date: 30-05-2022

Department assigned to the subject: Electrical Engineering Department

Coordinating teacher: MONTILLA D'JESUS, MIGUEL EDUARDO

Type: Compulsory ECTS Credits : 6.0

Year : 4 Semester : 1

**REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)**

- Magnetic circuits and transformers
- Control Engineering
- AC Electric machines

**OBJECTIVES**

- Ability to selection, analysis, and size of electric drives.
- To know the schemes of the electric motors speed control
- Ability to control an electric drive and simulate dynamic response

**DESCRIPTION OF CONTENTS: PROGRAMME****LESSON 1. Introduction to electric drives and mechanical system**

- 1.1) Introduction, Law of Motion for electric drives.
- 1.2) Basic principles of mechanics (moment-of-inertia, angular acceleration, gearbox, pulleys and flexible mechanical system)

**LESSON 2. Introduction to DC machines and DC-DC converters**

- 2.1) Principle of operation of the separately excited and series DC motors
- 2.2) Speed control of the separately excited and series DC motors (steady-state study)
  - 2.2.1) Principles of speed control by varying applied voltage.
  - 2.2.2) Principles of speed control by varying excitation flux.
- 2.3) Rectifier AC-DC power, controlled and uncontrolled.
- 2.4) Step-Down (Buck) and Step-up (Boost) converters

**LESSON 3. DC Motor Drives**

- 3.1) Operating principles in DC-motor drives (torque control, speed control, and flux control).
- 3.2) Speed control in the separately excited DC motor.
- 3.3) Dynamic Model of the DC motor

**LESSON 4. AC Motor Drives (inverter)**

- 4.1) Introduction to frond-end Inverter, Definition of Space vectors, Clarke transformation, and Park transformation. Inverter model in Stator Reference Frame.
- 4.2) Operating Principles of frond-end Inverter
- 4.3) Controller design for Inverter (space vector PWM)
- 4.4) Limits of the Inverter.

**LESSON 5. Dynamic model of the induction motor and Scalar Speed Control**

- 5.1) Dynamic model of the induction motor (cage rotor)
- 5.2) Scalar control of induction motors

**LESSON 6. Vector control systems for induction motors**

- 6.1) Introduction
- 6.2) Transformation of the dynamic model of the machine for vector control
  - 6.2.1) Field Orientation Principle. Torque Control. Rotor flux Control.
  - 6.2.2) Torque-speed characteristics for vector control. Rotor flux orientation.
  - 6.2.3) Direct and indirect vector control
- 6.3) Direct vector control induction motor fed by converter which operates as a current source (torque, speed and flux control)
- 6.4) Direct vector control induction motor fed by converter which operates as a voltage source (torque, speed and flux control)

## LEARNING ACTIVITIES AND METHODOLOGY

-The development of the course will be based on master classes with previous comprehensive reading of texts on some of the topics to be developed, individual tutorials. (3 ECTS credits).

-Lab practices. On the other hand, classes will be taught in the computer lab for students to develop through computer models (MATLAB / Simulink) all knowledge acquired on the DC and AC electric drives. Group and individual tutoring (3 ECTS credits)

## ASSESSMENT SYSTEM

### A. ORDINARY SESSION

#### 1.- Continuous assessment (EvC)

- Computer Test (50 % over 10)
- Homework's notes in small group (37,5% over 10)
- Note of laboratory practice (12,5 % over)

#### 2.- Ordinary assessment (EvO)

#### 3.- Final Note

-If the student PRESENTS ALL assigned homework (small group) with AVERAGE TOTAL NOTE ABOVE 3 and he/she is SUITABLE in the lab practices:

$$\text{FINAL NOTE} = 0,4 \cdot \text{EvC} + 0,6 \cdot \text{EvO}$$

### B. EXTRAORDINARY ASSESSMENT

#### 1.- Continuous assessment (EvC)

- Computer Test (50 % over 10)
- Homework's notes in small group (37,5% over 10)
- Note of laboratory practice (12,5 % over 10)

#### 2.- Extraordinary assessment (EvE)

#### 3.- Final Note (Maximum score obtained according to the following points a and b)

- a) FINAL NOTE = EVE + Test lab additional if you did not attend any or all of the practices (EPLA)
- b) Criteria to consider continuous assessment (EvC)

-If the student PRESENTS ALL assigned homework (small group) with AVERAGE TOTAL NOTE ABOVE 3 and

he/she is SUITABLE in the lab practices:

$$\text{FINAL NOTE} = 0,4 \cdot \text{EvC} + 0,6 \cdot \text{EvE} + \text{EPLA}$$

In either calls the conditions to pass the subject:

FINAL NOTE = > 5 (greater than or equal to 5)

(\* ) Marks obtained in the laboratory for the course for subsequent courses will not be saved. In the ordinary call, the note of practices will be greater than 5.

**% end-of-term-examination:** 60

**% of continuous assessment (assignments, laboratory, practicals...):** 40

## BASIC BIBLIOGRAPHY

- Chapman Stephen J , Máquinas Eléctricas, McGraw Hill.
- Fitzgerald Arthur Eugene, Máquinas Eléctricas. , McGraw Hill.
- Fraile Mora Jesús , Máquinas Eléctricas. , McGraw Hill.
- Krause Paul C, Analysis of Electric Machinery., IEEE.
- Leonhard Werner, Control of Electrical Drives., Springer.
- Mohan Ned, Power Electronic: converter, application and design. , John Wiley & Sons.

## ADDITIONAL BIBLIOGRAPHY

- Theodore Wildi Máquinas Eléctricas y Sistemas de Potencia, Prentice Hall, 2007
- Trzynadlowski, Andrzej M. The Field Orientation Principle in Control of Induction Motors, Kluwer Academic Publishers, 1994

