

# ELECTRIC MOTORS: UNDERSTANDING, SELECTION & SPEED CONTROL

## INTRODUCTION

Among the disciplines of electrical engineering, electric motors seem to be one of the most demanding for the engineers. They are used in commercial and industrial applications to furnish the mechanical power required to drive mechanical loads and to control various industrial processes, home appliances, automobiles etc. Typically 60-80 % of the electricity used in the industrial sector and about 35 % of the electricity used in the commercial sector is consumed by electric motors. The power supplied to the motor is usually conditioned by a power semiconductor controller to obtain the desired load torque, speed and direction of rotation at any given time. The proper selection of the motor is dictated by the nature of the load requirements, the type of power available and the type of controllers commercially manufactured to meet the load requirements. Electric motors understanding, selection and control is, therefore, undoubtedly essential.

## COURSE OBJECTIVES

This course is designed to introduce the subject of Electric Motors: Understanding, Selection & Speed Control, with concentration on:

- Classifications, construction and relative merits of electric motors
- Understanding motor terminology and nameplate parameters
- Equivalent circuits and basic relationships of the main types of motors
- Torque-speed characteristics of the main types of motors
- Methods of speed control of the different types of motors
- Variable speed drive: advantages and needs
- Elements of electric drive systems:
  - Mechanical Loads: classification
  - Power semiconductor Switches and Controllers
- Power semiconductor drive of DC Motors: Techniques and Control Topologies
- Power semiconductor drive of 3-Ph Induction Motors: Techniques and Control Topologies
- Proper motor selection, maintenance, repair and replacement

## PRESENTER

### Prof. Sadeq Abdullah Hamed

Professor Hamed received the B.Sc. degree in Electrical Power Engineering from Damascus University, Syria, in 1980. From 1980 to 1982, he was with the Department of Electrical Engineering at Jordan University, Amman, Jordan. He received the M.Sc. and Ph.D. degrees in Power Electronics and Systems from the University of Manchester Institute of Science and Technology (UMIST), Manchester, U. K., in 1983 and 1986 respectively. In 1986, he joined the Department of Electrical Engineering, Jordan University, as an Assistant Professor. Since September 2005, Prof. Hamed is the Chairman of Department of Electrical Engineering, Jordan University. He was the Chairman of the 5th and 6th Jordanian International Electrical & Electronics Engineering Conference JIEEE. Research activities of Prof. Hamed include design and implementation of DC and AC power conditioning systems, modeling and simulation of DC & AC motor drive systems using PWM control, UPS systems and energy saving in industry application. Prof. Hamed is a member of the IEE, IEEE and the Jordanian Engineers Association. List of Publications and more details can be found in the accompanied CV.

## PROGRAM

### Electric Motors: General Introduction

- Classification of Electric Motors
- Motor Terminology
- Motor Nameplate and Nominal Parameters
- Ratings, Sizing and Selection of Motors

### Elements Of Electric Drive Systems

- Basic components of an Electric Drive System
- Mechanical Loads: classification according to torque-speed characteristics
- Electric Motors: torque-speed characteristics
- Motor-Mechanical Load joint characteristics
- Power Sources requirements
- Power Semiconductor Switches and Converters
- Specifications of Drive Systems

### DC Motors: Principles And Speed Control

- Construction and classification of DC Motors
- EMF, Torque and Power relations
- Armature Reaction, Commutation & Sparking
- Torque-Speed characteristics and applications
- Speed Control of DC Motors: methods and characteristics:
  - Armature Voltage Control
  - Field-Weakening Control
- Applications: 4-Quadrant operation
- Starting of DC Motors: the problems and the remedies
- Rectifiers-Controlled DC Motor drives
- Chopper-Controlled DC Motor drives
- Harmonics generation in DC drive systems
- Motor De-rating and Torque Pulsations
- DC Motor selection and applications

### Principles Of Ac Rotating Motors

- Rotating Magnetic Field and principle of operation
- Synchronous Speed, Poles Creation and Direction of Rotation
- Classification & construction of three-phase motors
- EMF equation of AC three-phase motors

### 3-PH Synchronous Motors

- Classification and principle of operation
- Equivalent circuit parameters and basic relationships
- Torque-Speed characteristics and Pull-Out Torque
- Starting methods of 3-Phase Synchronous Motors
- Speed control of 3-Phase Synchronous Motors
- V-Curves: application in Power Factor Correction

### 3-PH Induction Motors: Principles And Speed Control

- Classification, constructional and slip
- Equivalent Circuit of 3-Phase Induction Motors
- Power Flow Diagram and basic relationships
- Torque-Speed characteristics: NEMA Classes
- Testing and parameters determination
- Starting of 3-Phase Induction Motors
- Speed control of 3-Phase Induction Motors: methods
- VS Inverters:
  - Power circuit configuration
  - Control topologies: PWM Control Topologies
- AC voltage regulators:
  - Power circuit configuration
  - Control topologies: Phase-Angle control
- Variable-Voltage Variable-Frequency (VVVF) and the (V/f) control strategy
- Harmonics Generation: Motor De-Rating and Torque Pulsations
- Induction Motors Selection and Applications