Pearson BTEC Level _ Higher Nationals in Engineering (RQF)

Unit: 43 Further Electrical Machines and Drives

Unit Workbook 3

in a series of 4 for this unit

Learning Outcome 3

DC Drives and their Industrial Applications

Table of Contents

GUIDANCE 3
Introduction to DC Drives and their Application to Emerging Areas. 4
Operating Modes of DC Drives 8
Analysis of Closed Loop Control of a DC Drive. 14
Transfer Functions an Overview: 23
Computer Simulation Modelling. 23

GUIDANCE

This document is prepared to break the unit material down into bite size chunks. You will see the learning outcomes above treated in their own sections. Therein you will encounter the following structure.

Purpose

Explains *why* you need to study the current section of material. Quite often learners are put off by material which does not initially seem to be relevant to a topic or profession. Once you understand the importance of new learning or theory you will embrace the concepts more readily.

Theory

Conveys new material to you in a straightforward fashion. To support the treatments in this section you are strongly advised to follow the given hyperlinks, which may be useful documents or applications on the web.

Example

The examples/worked examples are presented in a knowledge-building order. Make sure you follow them all through. If you are feeling confident then you might like to treat an example as a question, in which case cover it up and have a go yourself. Many of the examples given resemble assignment questions which will come your way, so follow them through diligently.

Question

Questions should not be avoided if you are determined to learn. Please do take the time to tackle each of the given questions, in the order in which they are presented. The order is important, as further knowledge and confidence is built upon previous knowledge and confidence. As an Online Learner it is important that the answers to questions are immediately available to you. Contact your Unit Tutor if you need help.

Challenge

You can really cement your new knowledge by undertaking the challenges. A challenge could be to download software and perform an exercise. An alternative challenge might involve a practical activity or other form of research.

Video

Videos on the web can be very useful supplements to your distance learning efforts. Wherever an online video(s) will help you then it will be hyperlinked at the appropriate point.

Introduction to DC Drives and their Application to Emerging Areas.

In this section we will examine the application of DC drives within areas such as smart grid and renewable energy sources.

The requirement for more sustainable electrical power supplies has led to a move away from conventional centralised AC electrical power generation and largescale transmission infrastructure. The traditional means of electricity generation are giving way to more decentralised systems in countries across the world where electrical transmission and distribution is more costly and often too difficult to achieve.

Even where traditional methods remain an option, there has been greater focus placed upon alternative technologies that are both renewable and decentralised, generating, and supplying electrical power more locally in relation to where it is required.

It is becoming more common for landowners, homeowners, commercial premises, and organisations to employ decentralised forms of renewable power generation on their land and property and so remove their dependence upon mains generated power supplies derived from fossil fuel, as the following diagram aims to illustrate:

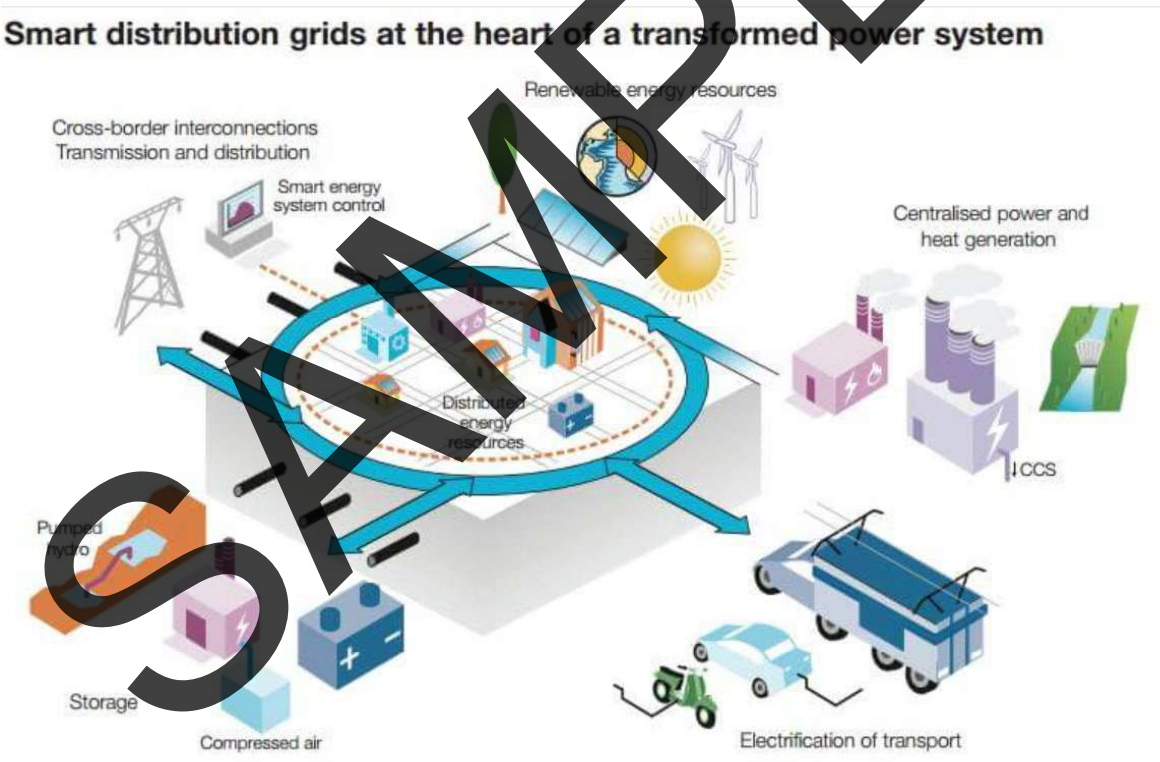

Fig 1 Distributed vs Centralised Power within a Smart Grid arrangement.

Homeowners and industrial premises are capitalising on the many benefits offered by decentralised renewable energy schemes and combining these with more cost-effective electrical systems which also offer increased efficiency and reliability.

We can appreciate the number of industrial systems that rely upon electrical drives for their continued operation e.g., Liquid pumps, Compressors, HVAC fans, Conveyor belts, Machine presses, Machine tools etc.

The inherent fluctuation in power from renewable energy sources such as wind and photovoltaics has led to problems with power balancing. However, the idea of linking all these electrical systems together would help to make the electrical supply more energy efficient and stable, which partly explains why Intelligent DC grid systems are gaining in popularity.

Smart grids:

A smart grid may be defined as an electricity network enabling a two-way flow of electricity and data with digital communications technology, enabling us to detect, react, and pro-act to changes in usage and multiple issues. Smart grids enable electricity customers to become active participants in the manner electricity and data is generated and consumed.

A smart grid serves several purposes and the movement from traditional electric grids to smart grids is driven by multiple factors, including the deregulation of the energy market, evolutions in metering, changes on the level of electricity production, decentralisation (distributed energy), the advent of the involved 'prosumer', changing regulations, the rise of microgeneration and (isolated) microgrids, renewable energy mandates with more energy sources and new points where and purposes for which electricity is needed (e.g. electrical vehicle charging points).1

Some people in the industry do not talk about smart grids anymore. They see that term as referring to a first stage where advanced metering infrastructure (AMI) initiatives were deployed with first-generation smart meters. They prefer to speak about power grid modernization, given that this relates to far more elements than smart metering, e.g., sending data in two directions and adding power to the grid in the opposite direction.

Although many countries, regions, states etc. had already implemented smart metering initiatives a decade ago, there are still several countries where this has only just started. The challenges of grid players are mainly those seen within the decentralisation of energy generation and the transmission thereof.

Although mains electricity is generated and transmitted as AC, the application of DC has many advantages, not least quick starting and stopping and higher starting torque. They are good for applications with constant speed (although variable speeds can be achieved when combined with electronic control devices). Also, they are often regarded as being cheaper and easier to control than AC.

In addition to electrical drives, computers, smartphones, and LEDs all operate with DC and therefore need an adapter to convert AC power from the grid. Yet on the supply front, the situation is also changing. Whereas conventional power plants, such as coal-fired and nuclear, produce alternating current, locally installed and renewable energy resources such as photovoltaic plants — or, for that matter, electrochemical energy storage systems — only ever supply direct current.

DC drives broadly comprise the permanent magnet or field wound construction.

Their fundamental power source being typically derived from batteries, fuel cells, or unregulated-off grid photovoltaic systems.

1 https://www.i-scoop.eu/industry-4-0/smart-grids-electrical-grid/