Universiti Malaysia PAHANG

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Publisher
Universiti Malaysia Pahang
Kuantan
2016

First Published, 2016

Perpustakaan Negara Malaysia Cataloguing-in-Publication Data

Ruhaizad Ishak
ELECTRICAL POWER SYSTEM / RUHAIZAD ISHAK,
Norainon Mohamed, Norhafizah.
ISBN 978-967-0691-93-0
1. Electric power systems. 2.Electrical engineering.
I. Norainon Mohamed. II. Norhafizah. III. Title.
621.31

Published By:
Publisher
Universiti Malaysia Pahang
Lebuhraya Tun Razak, 26300 Gambang
Kuantan, Pahang Darul Makmur
Tel: 09-549 3273 Fax: 09-549 3281

Layout & Printing:
Percetakan Muafakat Jaya Sdn. Bhd (105038-M)
6, Jalan Perdagangan 16, Taman Universiti Industrial Park,
81300, Skudai Johor.
Tel: 07-520 6740 Fax: 07-520 6741

PREFACE

This book is written to introduce the fundamental of electrical power system which are the overview of power system, generation, transmission lines, distribution, representation of components, basic power system analysis. Electrical power system may be broadly categorized into four types of activities: Electricity generation, transmission, distribution and loads. One of the essential components of power systems is three phase ac generator known as synchronous generator or alternator. In Malaysia, at power generating, the generating voltage is from 11 kV-20 kV and 50 Hz frequency. The voltages will be transferred to the higher voltages to 132 kV, 275 kV and 500 kV. At distribution level, the voltages will be transformed into lower level to 33 kV or 11 kV. In a common definition, the distribution system is a part of the electrical utility system between the bulk power source and the consumer's service switches. Loads of power systems are divided into residential, industrial and commercial. Very large industrial loads may be served from the transmission system. Large industrial loads are served directly from sub-transmission network, and small industrial loads are served from primary distribution network. The industrial loads composite loads, and induction motors form a high proportion of these load. These composite loads are functions of voltage and frequency and form a major part of the system load. Commercial and residential loads consist of largely of lighting, heating, and cooling. These loads are independent of frequency and consume negligibly small reactive power. In Malaysia, the power generation sector is principally dominated by three integrated power producer companies: Tenaga Nasional Berhad (TNB), Sabah Electricity Sdn Bhd (SESB) and Sarawak Energy Berhad (SEB). TNB and SESB fall under the jurisdiction of the Energy Commission (EC), whilst SEB is under jurisdiction of the Sarawak State Government. TNB is the main electricity suppliers for Peninsular Malaysia while east Malaysia is covered by SESB (Sabah) and SEB (Sarawak).

Chapter 2 is devoted to the per unit representation. It represents the three phase system on a single line diagram. Also, it will cover the topic on the reactance and impedance diagram of a three phase power system by calculating the per unit value of any quantity in a three phase power system. For steady state balance operation, the model of generator, transformer and load will be represented and perform the steady state analysis power systems. In addition of the topic, the fault current, bus voltages and line currents when a balanced fault occurs is a system will be determined and estimating the short circuit capacity at a bus.

The purpose of transmission network is to transfer electric energy form generating units at various locations to the distribution system which ultimately supplies the load. Transmission lines also interconnect neighbouring utilities which permits not only economic dispatch of power within regions during normal conditions, but also transfer of power between regions during emergencies. All transmission lines in a power system exhibit the electrical properties of resistance, inductance and capacitance and also conductance. The inductance and capacitance are due to the effects of magnetic and electric fields around the conductor. These parameters are essential for the development of the transmission line module used in power system analysis. Transmission lines are represented by an equivalent model with appropriate circuit parameters on a "per-phase" basis. The terminal voltages are expressed from one line to neutral, the current from one phase, and thus, the three-phase system is reduced to an

equivalent single-phase system. The model used to calculate voltages, currents and power flows depends on the length of the line. In this chapter, the circuit parameters and voltage and current relation are first developed for "short" and "medium" lines. Next, the long line theory is presented and expression for voltage and current along the distributed line model are obtained. Since the terminal conditions at the two ends of the line are primary importance, an equivalent π model is developed for long line model. Chapter 3 and 4 are explained in depth of the transmission line parameters (resistance, inductance and capacitance) and transmission line models, respectively.

The electricity industry works in a simple model of converting energy resources into electricity. The structure, operation and financial implications form a natural monopoly in the electricity market all over the world. The electricity industry in Peninsular Malaysia (Tenaga Nasional Berhad –TNB) and Sabah (Sabah Electricity Sdn Bhd – SESB) is regulated under the Energy Commission (*Suruhanjaya Tenaga*). On the other hand, electricity industry in Sarawak is being regulated under the state government. Cost of electricity from generation to distribution before reaching the end users will be translated into *tariff*. The fuel cost is mixed between market pricing and subsidised pricing. Malaysia's coal supply is fully market based pricing as it is procured through international market. On the other hand, natural gas, still subsidised by Malaysia government and supplied by PETRONAS. Power factor is a measure of the active power compared with the reactive power. The higher power factor, the lower is the reactive power. It is also a measure of how effectively the current is being converted into useful work output and more particularly is a good indicator of the effect of the load current on the efficiency of the supply. Estimation of electricity bill, comparison Malaysia tariff and other countries, obtaining the power factor are covered in Chapter 5.

The intention of this book is to be used as a reference to undergraduate students in the field of power system course. Therefore, it is hope that this book be the source of the fundamental of power system field for the students to be prepared as a competent engineer.

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