Education and Training of Power Engineers in Australia

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ABSTRACT: *The paper deals with the field of electrical power engineering and its relevance and sustainability in the future. With increasing concerns about global warming and green house gases, the electricity energy generation, conversion and utilisation will play an important part in future growth and development. The authors have highlighted the present state of Power Engineering and suggested few areas, which can invigorate and sustain its development in the new emerging areas.*

1 INTRODUCTION

Electrical Engineering is a well-established field of study and power engineering is the oldest sub-discipline of it. Electrical Engineering field has expanded much rapidly over the last few decades with rapid advances in solid-state electronics, communication, computer systems and microprocessors, computer control, artificial intelligence etc. [1-4]. It was rather natural to accommodate new developments in already crowded curricula by removing or rationalising existing course structures. Due to huge new developments, new degree programs have emerged as specialist disciplines e.g. electronic engineering, computer engineering, communication engineering, control engineering and of course electrical power engineering and even highly specialised sub-discipline of photovoltaic and solar energy [5-7]. Power engineering education has gone through various stages including earlier golden era of large-scale electrification, later an era of automation and computer control and more recently an era of restructuring/ deregulation and privatisation and energy conservation [8-19]. It is expected that the future of power engineering will concentrate on alternative electrical energy sources, power quality issues, smart drive systems, distributed generation and electric vehicles and better forms of storage, use of superconductivity and other highly efficient and smart materials.

Large numbers of Australian and overseas universities have eliminated power engineering teaching and research from their curriculum due to lack of student interest [12,13]. It has produced a crisis in power and energy engineering education. With restructuring and rationalisation in electric utilities, many qualified power engineers have left the industry and very few have taken their positions. There is ensuing crisis in industry and academia in the next few years when such an important area of economic activity will not be well maintained. It is essential that power engineering should be taught as an essential component of any electrical engineering program with more emphasis on power conservation, new forms of electricity generation, including renewable sources, embedded/distributed generation, power quality and EMC issues [20].

2 PRESENT STATE AND FUTURE CHALLENGES IN TEACHING

The traditional components of electrical power energy are as follows:

- Electrical machines
- Electrical drive system
- Power electronics
- Power system analysis
- Power generation transmission and distribution
- High voltage engineering
- Power system protection and control

Some newly emerging areas of technologies also require the essential elements of electrical power engineers e.g. Mechatronics and robotics require essential of power electronic and control, electrical machines and drives.

2.1 ELECTRICAL MACHINES

There is very little teaching done at undergraduate (UG) level in the designs of electrical machines. It is more devoted from a users point of view. There is need to include some modern developments in such areas, such as

- Permanent magnet machines
- Brushless motors
- Stepper motors
- Variable reluctance drives and control

2.2 POWER ELECTRONICS

This subject needs to be taught more from a practical application point of view. There needs to be more of an emphasis on new developments.

- Power supply design
- Applications in power system
- Application in traction and future electric vehicle and hybrid vehicles development
- Soft switching techniques
- Issues resulting from power electronics e.g. power quality and EMC

2.3 POWER SYSTEMS ENGINEERING

It covers electric motors, power converters and associated control as an integrated system. This area needs to be taught as an integrated area with possible use of multimedia and computer simulations. New developments in microprocessors, control techniques and DSP applications and dynamics can be easily incorporated.

In addition to traditional area, some new additions need to be included by moving some of traditional topics such as load flow, planning etc. to postgraduate (PG) level.

- Distributed/ embedded generation
- Effects of penetration of new and renewable energy power
- Power quality issues
- Developmental electricity markets, short term load forecasting
- Business aspects of electricity markets

2.4 ELECTROMAGNETIC COMPATIBILITY (EMC)

This seems to an old area of traditionally of interest to communication engineering. It has taken on significance due to application of power electronics in industry, computer application and transportation. There are stringent standards/requirements covering such issues as EMC certifications. The author believes that this is to be introduced at UG level, which can be of interest to all electrical/ electronic/ computer/ telecommunication engineers or even mechatronic engineers. It can easily cover important areas of EMI/ EMC, testing, ramifications and mitigation techniques. It may also address the issues of many simplifying assumptions in traditional analysis and design.

2.5 ENERGY SYSTEMS

This subject can cover fundamentals of generation and distribution systems, power electronics. In addition to this new areas are to be included.

- Wind and solar energy and conversion to electricity.
- Fuel cell and other alternative sources of electricity generation, OTE, wave energy.
- Economics of green power.
- Operational aspects of large penetrations of renewable energy in power systems.

3 PRESENT STATE AND FUTURE CHALLENGES IN RESEARCH

A general look at research activities in universities and research centres and organizations provide an indication of activities as follows:

Renewable Energy
Electrical Machines Design
Power Electronics and control
Electrical drives
Power System Protection and Control
Power Quality and EMC
High Voltage Engineering
De-regulation Issues

There is an urgent need to rationalize the research efforts not by consolidation but cooperative efforts one or two schools concentrate their efforts is one or two areas of research based on expertise or form formal (or informal consortia).

Electrical Machines

Electrical Machines (Design & Analysis)
This is generally concentrated on PM or VR machines (generators/motors)
Permanent magnet couplers, Gears and magnetic bearings.

Control

Vector Control of Drive Systems (IM, PM and VR).
Direct Torque Control
Sensorless Control (IM, PM and VR).
Neuro-Fuzzy Control (IM, PM and VR).

Electrical Drive Systems

Converter Topologies for drive systems
Soft-switching techniques
EMC and noise issues
Electric vehicle Applications

Energy Systems

Power Quality/ EMC
Power Systems Control and Protection
Renewable Energy Engineering (wind, solar)
Distribution/Embedded Generation
High Voltage Engineering
Load Forecasting
Power Electronics in Power Systems
Active filters
FACTS
Applications of superconductivity

Power Electronics

Soft-switching techniques
Electronic ballasts
Power electronic control for renewable energy systems

Fuel cell and battery storage/systems development has traditionally been undertaken by chemical engineers and other physical scientist and rarely by electrical power engineers. There is certainly need to develop some research initiatives on the effects of such technologies on Power Systems.

Another area, which is still in its infancy, is the electricity as trading commodity on the financial markets. As electricity cannot be stored so easily as traditional commodities as products, such as metals, beverages, foods etc. There is urgent need for universities to develop short courses for business executives, future brokers and traders, investment bankers some essential elements of electrical generation, transportation, distribution and utilization for business communities, through existing business studies programs or stand-alone short courses [21]. The power academic community need to take this important opportunity to develop expertise in short tem load forecasting, future trading in electricity, demand/supply analysis.

It is an area where co-ordination/ co-operative efforts can bring larger gains for their other research activities and development.

4 CONCLUSIONS

The paper outlined the state of teaching and research in electrical power engineering. It has also highlighted the need to improve the teaching of various components of power engineering. A more aggressive approach is required to form research consortia's and develop new and important areas. There is an urgent need to develop some initiatives in the business aspects of electricity markets.

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