ES97A-15 Operation and Control of Power Systems

22/23

Department
School of Engineering
Level
Taught Postgraduate Level
Module leader
Li Ran
Credit value
15
Module duration
14 weeks
Assessment
30% coursework, 70% exam
Study location
University of Warwick main campus, Coventry

Description

Introductory description

ES97A-15 Operation and Control of Power Systems

Module web page

Module aims

This module aims to present the current (advanced) technologies and trends in development that will shape future electrical power systems. The students will gain a comprehensive knowledge and understanding of the construction, operation and control principles of power systems. They will learn advanced analytical skills for examining different modes of operation in complex systems. The students will be introduced (through assignment) to ETAP which is a package widely used in industry for power system analysis and design. The content includes the following main elements:

- Generation, Transmission and Distribution of Electrical Power
- Balanced and Unbalanced 3-Phase Systems
- Load Flow Analyses
- Fault and Stability Analyses of Power Systems
- Power System Protection Concepts and Techniques

- Operational Security Control
- Benefits and Limitations of Wide Area Measurement (WAM)
- Effects and Management of Distributed Generation
- Flexible AC Transmission Systems (FACTS) and High Voltage DC (HVDC) Transmission Technologies
- Power Quality Monitoring and Management
- Renewable Power Penetration and Grid Code Requirements
- The Role of Energy Storage and the Development of Relevant Technologies
- Smart Grids: Communications and standards, demand side response, wide area measurements, privacy and cyber security.

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

- Fundamentals of 3-Phase AC Power Systems
- Planning and Expansion of Power Systems
- Power Flow Calculation and Security Analysis of Network Operation
- Fault Calculation and Power System Protection
- Power System Stability Calculation and Control
- Wind Turbine/Farm Characteristics
- Challenges of Wind Power Integration in Power Systems
- Shunt Reactive Power Compensation Technologies
- Controllable Series Compensators in Transmission Networks
- HVDC Transmission – LCC Technologies
- VSC (voltage source converters) – HVDC
- Control of Grid-Connected VSC
- Flexible AC Transmission Systems (FACTS)
- Integration of Large Scale PV Generation
- Marine Renewable Generation
- Control of Power System Frequency and Voltage
- OLTC – On Load Tap Changer of Transformers
- Handling of Power Quality Issues in Power Systems
- Fault Level Management
- Combined Heat and Power
- Microgrids
- Smart Grids: Communications and standards, demand side response, privacy and cyber security

Learning outcomes

By the end of the module, students should be able to:

- Evaluate the effectiveness of using wide area measurement systems.
- Critically assess the effects of future renewable penetration and distributed generation, and

the ability to apply advanced control techniques.
- Demonstrate a systematic knowledge of the complex operation and control of modern power systems, of the constitution of current and future generation power systems, of load flow, of stability and faults in current generation and of future power systems, including frequency and voltage control.
- Demonstrate an advanced understanding of power quality monitoring and control.
- Understand the latest research developments in smart grids.

Indicative reading list

1. Seifi H. and Sepasian M.S., Electric Power System Planning - Issues, Algorithms and Solutions, Springer 2011
2. Wildi T., Electricl Machines, Drives, and Power Systems, Pearson Prentice Hall, 2014
3. Weedy B.M., Cory B.J., Jenkins N., Ekanayake J.B. and Strbac G. Electric Power Systems (5th Ed), John Wiley & Sons, 2012
4. Kundur P., Power System Stability and Control, McGraw-Hill, 1994
5. Horowitz S.H. and Phadke A.G., Power System Relaying (4th Ed), John Wiley & Sons, 2014
6. Freris L. and Infield D., Renewable Energy in Power Systems, John Wiley & Sons, 2020

Subject specific skills

Ability to be pragmatic, taking a systematic approach and the logical and practical steps necessary for, often complex, concepts to become reality

Transferable skills

Numeracy: apply mathematical and computational methods to communicate parameters, model and optimize solutions
Apply problem solving skills, information retrieval, and the effective use of general IT facilities
Plan self-learning and improve performance, as the foundation for lifelong learning/CPD
Exercise initiative and personal responsibility, including time management, which may be as a team member or leader

---

Study

Study time

Type	Required
Lectures	26 sessions of 1 hour (17%)
Tutorials	2 sessions of 1 hour (1%)
Practical classes	2 sessions of 2 hours (3%)
External visits	1 session of 2 hours (1%)
Total	150 hours

Type	Required
Other activity	2 hours (1%)
Private study	114 hours (76%)
Total	150 hours

Private study description

Guided Independent Learning 114 hours

Other activity description

2x1 hour Revision Class

Costs

No further costs have been identified for this module.

Assessment

You must pass all assessment components to pass the module.

Assessment group D5

	Weighting	Study time
Assignment Assignment report (8 pages).	30%	
Online Examination 2 X 1hr QMP with short break in between ~Platforms - AEP,QMP	70%	

- Online examination: No Answerbook required

Feedback on assessment

The students will obtain feedback through contact with lecturer during office hours. Exercises will be given after every lecture and solutions will be provided in the next week. The students will also obtain written feedback on the laboratory and simulation report. There will also be cohort level feedback on examinations.

Past exam papers for ES97A

Availability

Courses

This module is Core for:

- Year 1 of RESA-H6P9 Postgraduate Research Wide Bandgap Power Electronics
- Year 1 of TESA-H643 Postgraduate Taught Electrical Power Engineering
- Year 1 of TESA-H642 Postgraduate Taught Energy and Power Engineering
- Year 4 of UESA-H606 Undergraduate Electrical and Electronic Engineering MEng
- Year 5 of UESA-H607 Undergraduate Electrical and Electronic Engineering with Intercalated Year

This module is Optional for:

- Year 4 of UESA-H116 MEng Engineering with Exchange Year
- Year 5 of UESA-H115 MEng Engineering with Intercalated Year
- Year 2 of TESA-H1A0 Postgraduate Taught Sustainable Energy Technologies

This module is Option list A for:

- Year 4 of UESA-H114 MEng Engineering