

# ES97A-15 Operation and Control of Power Systems

**20/21**

**Department**

School of Engineering

**Level**

Taught Postgraduate Level

**Module leader**

Li Ran

**Credit value**

15

**Module duration**

14 weeks

**Assessment**

60% coursework, 40% exam

**Study location**

University of Warwick main campus, Coventry

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## 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 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., Electric 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

TBC

## Transferable skills

TBC

## Study

### Study time

Type	Required
Lectures	26 sessions of 1 hour (14%)
Tutorials	2 sessions of 1 hour (1%)
Practical classes	2 sessions of 2 hours (2%)
External visits	1 session of 2 hours (1%)
Other activity	2 hours (1%)
Private study	114 hours (60%)
Assessment	40 hours (21%)
Total	190 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.

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## Assessment

You must pass all assessment components to pass the module.

### Assessment group D3

	Weighting	Study time
Assignment 1: Voltage Control Philosophy of an Industrial Power System	30%	20 hours
Understand the evolution of an industrial power system and the need to conducting design studies. Through the exercise, the students will get some hand on experience about load flow, stability and fault level analysis of power systems, and develop knowledge of techniques to control them.		
Assignment 2: Renewable Generation and Grid Impacts	30%	20 hours
The students will enhance their knowledge about renewable generation systems and their impacts on the grid. Simulation will be conducted to show the characteristics of the renewable systems, leading to analyses on the modern technologies to manage such impacts.		
Online Examination	40%	
2 X 1 HR QMP TO BE SCHEDULED IN SAME TIME SLOT WITH SHORT GAP INBETWEEN		

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- Students may use a calculator
- Engineering Data Book 8th Edition
- Graph paper

## 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 quizzes. There will also be cohort level feedback on examinations.

## Availability

### Courses

This module is Core for:

- 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

This module is Core optional for:

- Year 1 of RESA-H6P9 Postgraduate Research Wide Bandgap Power Electronics

This module is Optional for:

- TESA-H1A0 Postgraduate Taught Sustainable Energy Technologies
  - Year 1 of H1A0 Sustainable Energy Technologies
  - Year 2 of H1A0 Sustainable Energy Technologies

This module is Option list A for:

- Year 4 of UESA-H114 MEng Engineering