Unit 217 Electrical energy systems

Unit summary
This unit is about the analysis and design of the generation, transmission, distribution and supply of electrical energy in a contemporary industrial society.

Aims
The unit aims to develop the candidate's knowledge of electrical generation, 3 phase systems of transmission and distribution and the environmental impact of electrical energy systems.

Prerequisites
It is expected that candidates will have a working knowledge of the materials in the four compulsory papers of the Certificate examination and with other material as set out in the intended learning outcomes for subject 9107-107 Electrical and electronic engineering.

Learning outcomes
There are **four** outcomes to this unit. The candidate will be able to:

- Assess energy conversion, economics and environment
- Understand power generation
- Describe transmission and distribution systems
- Analyse systems and understand system operation

Guided learning hours
It is recommended that 300 hours should be allocated for this unit. 120 of those hours are actual taught hours. This may be on a full time or part time basis.

Key Skills
This unit contributes towards the Key Skills in the following areas:

N4.1
Develop a strategy for using application of number skills over an extended period of time.

N4.2
Monitor progress and adapt your strategy, as necessary, to achieve the quality of outcomes required in work involving:

- deductive and inferential reasoning;
- algebraic manipulation.

N4.3
Evaluate your overall strategy and present the outcomes from your work, including use of charts, diagrams and graphs to illustrate complex data.

Occupational Standards
This unit has been mapped to the following National Occupational Standards:

1.1.1 Identify the requirements of clients for engineering products or processes
1.1.2 Produce specifications for engineering products or processes
2.1.1 Determine the production requirements of engineering products and processes
2.1.2 Specify production methods and procedures to achieve production requirements
3.1.1 Determine the installation requirements for engineering products or processes
3.1.2 Specify installation methods and procedures to achieve installation requirements
4.1.1 Determine the operational requirements of engineering products or processes
4.1.2 Specify operational methods and procedures to achieve operational requirements
5.1.1 Determine the maintenance requirements of engineering products or procedures
6.1.1 Analyse the risks arising from engineering products and processes
6.2.1 Assure the quality of engineering products or processes
8.1.1 Maintain and develop own engineering expertise

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Outcome 1 Assess energy conversion, economics and environment

Knowledge requirements
The candidate knows how to:

1 describe methods of producing electrical energy using fossil fuel
   a coal
   b diesel
   c gas
2 assess the cost of fossil fuel usage for generating electricity
3 describe energy conversion in electrical energy generation
   a wind
   b solar
   c wave
   d hydro
4 describe oil, gas and steam turbines
5 describe and assess
   a system loads
   b loss factors
   c tariffs (capacity and energy charges)
   d load management
   e forecasting
6 describe system layout including interconnection for
   a security
   b transfer across territorial boundaries
   c retail distribution
   d dominant costs and restraints

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Outcome 2 Understand power generation

Knowledge requirements
The candidate knows how to:

1 identify types of synchronous generators
   a cylindrical rotor
   b salient pole
2 describe the parameters and operating characteristics of synchronous generators
3 calculate and assess short circuit performance
4 describe parallel operation with single control by
   a governors
   b automatic voltage regulators (AVR's)
5 explain an operating chart and its derivation including
   a stability limits
   b rating limits
6 ensure electrical earthing arrangements are adequate

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Outcome 3 Describe transmission and distribution systems

Knowledge requirements
The candidate knows how to:

1 describe power transformers
- a types of construction
- b parameters
- c testing connections (delta/star)
- d use of tap-changers
- e sequence impedances

2 describe overhead lines
- a construction
- b parameters
  - i short equivalent circuits
  - ii medium equivalent circuits
  - iii long equivalent circuits
- c voltage stress calculations
- d conductors
- e natural load
- f need for compensation

3 describe types of cables for transmission circuits
- a operational parameters
- b insulation
- c need for compensation

4 describe substation components
- a switchgear operating principles of main types
  - i gas
  - ii airblast
  - iii oil
  - iv vacuum
- b breaking and making capacity
  - i asymmetrical
  - ii symmetrical

5 describe substation layouts and types

6 describe instrumentation transformers and transducers

7 recognise the need for surge diverters

8 appreciate high voltage direct current transmission
   a characteristics
   b economics
   c converter operation
9 assess the design of distribution systems for reliability and economic operation in
   a urban areas
   b rural areas
10 understand voltage control under maximum and minimum load conditions
11 describe the metering and protection of the consumer and system

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Outcome 4 Analyse systems and understand system operation

Knowledge requirements
The candidate knows how to:

1 analyse network representation
   a network equations method solution (iterative) (Gauss Seidel method) including
      i per unit concepts
      ii fault and unbalanced calculations
      iii symmetrical components
2 understand the concepts and calculations involved in steady state and transient stability
3 understand step-by-step and equal area criterion
4 understands methods used for increasing system stability limits
5 understands over voltage and surges on systems
   a causes
   b generation
   c protection
6 understand modern system control concepts
   a digital systems
   b data transmission links
   c energy systems and management
   d role of control engineers
7 understand system frequency and voltage control from a control centre
8 understand scheduling and dispatch generation for minimum operating
   a cost
   b reliability
   c spinning reserve
9 understand forms of system protection
10 understand system safety requirements

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Recommended reading list

Core texts	Author(s)	Publisher	ISBN
Electric Power Systems	Weedy, Cory	John Wiley	0471976776
Power System Analysis	Grainger, Stevenson	McGraw Hill	0071133380
Electrical Energy Systems Theory, an Introduction	Elgerd	McGraw Hill	007099286X o/p