Title	**Demonstrate knowledge of electronics in power engineering**		
Level	**5**	**Credits**	**15**

Purpose	People credited with this unit standard are able to: • demonstrate knowledge of and apply theorems to the analysis of d.c. circuits, • demonstrate basic knowledge of terminal semiconductor devices, • demonstrate and apply knowledge of BJTs and enhancement mode MOSFETs in switching circuits, • demonstrate knowledge of using transistor devices as single stage small signal amplifiers, • demonstrate knowledge of general-purpose operational amplifiers, • demonstrate an understanding of, and apply fundamental principles of digital electronics, and • describe the operation of linear and switching d.c. power supplies. This standard provides electricity supply industry power technicians with the fundamental knowledge of power protection and control network theory, and hardware.

Classification	Electricity Supply > Electricity Supply - Power System Maintenance

Available grade	Achieved

Guidance Information

Definitions
a.c. – alternating current.
BJT – bipolar junction transistor.
CMOS – complementary metal oxide semiconductor.
d.c. – direct current.
FPGA – field programmable gate array.
GAL – generic array logic.
IGBT – insulated gate bipolar transistor.
LED – light emitting diodes.
MOSFET – metal oxide semiconductor field effect transistor.
SISO – serial in serial out.
SIPO – serial in parallel out.
TTL – transistor-transistor logic.

Outcomes and performance criteria

Outcome 1

Demonstrate knowledge of and apply theorems to the analysis of d.c. circuits.

Performance criteria

1.1 Problems are solved and demonstrated for d.c. networks using Thevenin and Superposition theorems.

Range two d.c. voltage sources and three resistors.

Outcome 2

Demonstrate basic knowledge of terminal semiconductor devices.

Range at least two devices.

Performance criteria

2.1 The basic operation, characteristics, and application of terminal semiconductor devices are described.

Range includes but is not limited to – small signal diodes, rectifier power diodes, Schottky diodes, Zener diodes, light-emitting diodes (LEDs).
Evidence of three diodes is required.

2.2 Manufacturer device specifications are interpreted for power diodes to evaluate suitability in rectification circuits.

Range maximum, average and peak ratings for power, voltage and current in forward and reverse quadrant.

2.3 Typical applications of devices are explained with the aid of a simple circuit, and any necessary additional functional components required are calculated.

Range includes but is not limited to – signal clipping using diodes, simple zener shunt regulator, LED biasing.

2.4 The operation of half-wave and full-wave rectification for d.c. power supplies is explained in terms of characteristics, output waveforms, diode current, and application.

Range half wave and full wave bridge, simple capacitor filter.

2.5 The approximate output voltage and percentage ripple for a full wave capacitor input filter power supply is calculated.

Outcome 3

Demonstrate and apply knowledge of BJTs and enhancement mode MOSFETs in switching circuits.

Performance criteria

3.1 Operation and parameters of semiconductor device used as a non-linear electronic switch is explained.

Range devices – BJT, MOSFET (enhancement), IGBT;
parameters may include – operating voltage, drive requirements, Safe Operating Region.

3.2 Circuit configuration are explained, and component values determined to enable devices like electric motors, LEDs and relays to be driven from the outputs of logic gates or input/output ports on microcontrollers.

3.3 Power dissipation of an electronic switch is calculated and compared for the ON state.

Range devices – BJT, MOSFET, IGBT.

3.4 Use of a flywheel diode in a switched inductive circuit is described.

Outcome 4

Demonstrate knowledge of using transistor devices as single stage small signal amplifiers.

Range BJT, MOSFET.

Performance criteria

4.1 Application of a small signal linear amplifier in class A is explained.

4.2 Biasing requirements for transistor circuits to operate in a linear mode in class A is explained.

Range includes but is not limited to – complete waveform, Q point, no clipping or distortion.

4.3 Methods of transistor biasing are explained with appropriate diagrams and components are calculated for given device and circuit parameters.

Range single resistor, 4 resistor bias, self-bias.

4.4 The production of a.c. signal amplification and voltage stage gain in a transistor amplifier is explained and calculated using device and circuit parameters.

4.5 The effect an emitter or source by-pass capacitor has on stage gain is explained and calculated.

Outcome 5

Demonstrate knowledge of general purpose operational amplifiers.

Performance criteria

5.1 The functional operation and parameters of a general purpose operational amplifier is described.

5.2 Operational amplifier parameters are interpreted from data sheets.

5.3 Circuit configurations and external components are drawn, calculated and verified experimentally for various operational amplifier configurations.

Range inverting, non-inverting, unity gain buffer, voltage to current (5 V to 20mA) and current to voltage (20mA to 5 V).

Outcome 6

Demonstrate an understanding of, and apply fundamental principles of digital electronics.

Performance criteria

6.1 Basic gates are drawn, and operation and parameters are described for TTL and CMOS technologies.

Range AND, OR, NOT, XOR and alternative gates.

6.2 Combination logic is drawn, generated from Boolean expressions and truth tables, analysed, simplified and implemented by demonstration.

Range maximum of four variables, De Morgan’s laws, Karnaugh map.

6.3 Digital flip-flops are described, drawn, analysed using truth tables, and implemented by demonstration.

Range S-R flip flop, J-K, D, level and edge triggering.

6.4 A circuit for an asynchronous four bit binary up-counter is drawn and its operation explained and verified by demonstration.

Range J-K and/or D types in toggle mode.

6.5 A circuit for an asynchronous four-bit decade up counter is drawn, operation described with the aid of timing diagrams, and verified by demonstration.

6.6 A circuit for a four-bit shift register is drawn, operation described with the aid of timing diagrams, analysed with truth tables, and verified by demonstration.

Range SISO, SIPO.

6.7 Binary decoders are drawn and explained.

Range may include – 2 to 4.

6.8 The concept of programmable gate arrays is explained, and applications implemented using gate arrays by programming for simple combination logic or counter circuits.

Range includes but is not limited to – GAL or FPGA.

Outcome 7

Describe the operation of linear and switching d.c. power supplies.

Performance criteria

7.1 The concept and operation of shunt and series electronic regulators is explained.

7.2 A positive three terminal adjustable series electronic integrated circuit regulator is investigated, experimentally evaluated, and programmed to give a predetermined output voltage.

7.3 The concept of electronic switching supplies stepping up and down the input voltage is explained, experimentally evaluated and programmed to give a predetermined output voltage.

Range buck, boost.

7.4 Switch mode and linear power supplies are compared.

Range efficiency, operating input and output voltage range, stability, types of applications.

This unit standard is expiring. Assessment against the standard must take place by the last date for assessment set out below.

Status information and last date for assessment for superseded versions

Process	Version	Date	Last Date for Assessment
Registration	1	20 July 2017	31 December 2024
Review	2	2 March 2023	31 December 2024

Consent and Moderation Requirements (CMR) reference	0120

This CMR can be accessed at http://www.nzqa.govt.nz/framework/search/index.do.