| Title | Demonstrate and apply fundamental knowledge of digital and analogue electronics for IMC technicians | | |
|-------|------------------------|---------|----|
| Level | 3 | Credits | 12 |

| Purpose | This unit standard covers an introduction to digital and analogue electronic devices and circuits for IMC technicians. |
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People credited with this unit standard are able to:
– demonstrate knowledge of number systems used in digital electronics;
– demonstrate knowledge of simple logic circuits;
– demonstrate and apply knowledge of A/D and D/A conversion;
– demonstrate fundamental knowledge of semiconductor switching devices and their applications;
– demonstrate fundamental knowledge of operational amplifiers and their applications; and
– demonstrate fundamental knowledge of d.c. power supplies and electronic regulators.

| Classification | Industrial Measurement and Control > Industrial Measurement and Control - Theory |
|----------------|--------------------------------------------------------------|

| Available grade | Achieved |
|-----------------|----------|

### Guidance Information

1    References
     Health and Safety at Work Act 2015 and associated regulations;
     and all subsequent amendments and replacements.

2    Definitions
     *A/D* – analogue to digital.
     *ASCII* – American Standard Code for Information Interchange.
     *BCD* – binary coded decimal.
     *D/A* – digital to analogue.
     *BJT* – bipolar junction transistor.
     *d.c.* – direct current.
     *dB* – decibels.
     *Fundamental knowledge* – for the purposes of this unit standard means having some relevant theoretical knowledge of the subject matter with the ability to use that knowledge to interpret available information.
     $g_{FS}$ – forward transconductance.
     $h_{FE\ (SAT)}$ – d.c. forward current gain at saturation.

*Industry practice* – those practices that competent practitioners within the industry recognise as current industry best practice.

$I_{Cmax}$ – maximum collector current.

$I_{Dmax}$ – maximum drain current.

*LED* – light emitting diode.

*MOSFET* – metal oxide semiconductor field effect transistor.

$P_{Cmax}$ – maximum collector power dissipation.

$R_{DS(ON)}$ – static drain to source on-state resistance.

*SCR* – silicon controlled rectifier.

$V_{CEO}$ – collector-emitter voltage with base open.

$V_{CEsat}$ – collector emitter voltage at saturation.

$V_{DSS}$ – drain-source saturation voltage.

3    Range

    a    Electrical, radiation, and workshop or laboratory safety practices are to be observed at all times.

    b    All measurements are to be expressed in Système Internationale (SI) units and multipliers.

    c    Use of non-programmable calculators is permitted during assessments.

    d    All activities and evidence presented for all outcomes and performance criteria in this unit standard must be in accordance with legislation, policies, procedures, ethical codes, Standards, applicable site and industry practice; and, where appropriate, manufacturers' instructions, specifications, and data sheets.

# Outcomes and performance criteria

## Outcome 1

Demonstrate knowledge of number systems used in digital electronics.

## Performance criteria

1.1    Convert signed and unsigned numbers to and from the decimal number system to signed binary, two's-complement binary, octal, hexadecimal, and binary coded decimal.

    Range    maximum of 8 bit binary, 4 digit octal, and 4 digit hexadecimal numbers.

1.2    Add and subtract binary numbers.

    Range    evidence of three different additions and three different subtractions is required.

1.3    Add and subtract hexadecimal numbers.

    Range    evidence of three different additions and three different subtractions is required.

1.4 Describe special binary code formats.

Range may include but is not limited to – 8421, ASCII, BCD to seven segment, Gray code;
evidence of two codes is required.

**Outcome 2**

Demonstrate knowledge of simple logic circuits.

**Performance criteria**

2.1 Obtain Boolean expressions from given logic diagrams and truth tables.

Range maximum of ten terms and limited to three variables.

2.2 Develop logic diagrams from Boolean expressions.

Range maximum of three variables.

2.3 Describe common logic parameters.

Range switching voltage thresholds, power supply requirements, sink and source capabilities.

2.4 Explain handling precautions when using logic components.

2.5 Describe uses of simple logic devices.

Range latch, counter, shift register.

**Outcome 3**

Demonstrate and apply knowledge of A/D and D/A conversion.

**Performance criteria**

3.1 Explain terms associated with A/D and D/A converters.

Range may include but are not limited to – D/A conversion, A/D conversion, flash, successive approximation, dual slope, resolution, quantisation error, conversion time, clock pulse, linearity, delay, sampling, zero cross error, oversampling, filter coefficient, multiplier;
evidence of twelve is required.

3.2 Identify A/D and D/A converter types from schematic diagrams.

Range evidence of four A/D and two D/A converters required.

3.3 Describe one A/D application and one D/A converter application.

3.4        Explain A/D conversion with the aid of diagrams.

           Range        may include but is not limited to – characteristics, sample and
                        hold, conversion time, clock, sampling, cut-off frequency,
                        multiplier, accumulator;
                        evidence of six required.

3.5        Explain D/A conversion with the aid of diagrams.

           Range        may include but is not limited to – converter characteristics,
                        conversion time, clock, sampling, cut-off frequency, multiplier;
                        evidence of five required.

3.6        Apply one A/D converter and one D/A converter to a given specification in
           accordance with industry practice.

**Outcome 4**

Demonstrate fundamental knowledge of semiconductor switching devices and their
applications.

**Performance criteria**

4.1        Describe three types of two terminal semiconductor devices in terms of their
           basic operation, characteristics, and application.

           Range        may include but is not limited to – rectifier diodes, Schottky diodes,
                        Zener diodes, LEDs.

4.2        Describe typical configurations, operating parameters, and applications of
           optocouplers and opto-isolators.

           Range        may include but is not limited to – photo diode, phototransistor,
                        photo-Darlington, triac optocouplers;
                        evidence of two devices and two applications for each device is
                        required.

4.3        Compare bipolar and enhancement-mode field effect transistors in terms of
           construction, operating characteristics, and applications in switching circuits.

           Range        devices – pnp and npn transistors, n-channel and p-channel
                        MOSFETs.
                        Operating characteristics:
                        BJT – $h_{FE\,(SAT)}$, $V_{CEO}$, $I_{Cmax}$, $P_{Cmax}$, $V_{CEsat}$;
                        MOSFET – $g_{FS}$, $I_{Dmax}$, $V_{DSS}$, $R_{DS\,(ON)}$.
                        Applications – evidence of two designs each for both BJTs and
                        MOSFETs is required.

4.4        State advantages and disadvantages of solid state switches.

4.5     Describe power semiconductor devices in terms of their basic operation, characteristics, and application.

        Range       devices – SCRs, triacs, MOSFET, IGBT;
                     evidence of three is required;
                     applications – controlled rectifiers, inverters.

**Outcome 5**

Demonstrate fundamental knowledge of operational amplifiers and their applications.

**Performance criteria**

5.1     Describe the function of operational amplifiers in terms of electronic building blocks with examples of typical applications.

        Range       typical applications – audio pre-amplifier, transducer signal amplifier, buffer.

5.2     Compare parameters for an idealised and a typical practical operational amplifier.

        Range       parameters – differential gain, input impedance, output impedance, maximum output amplitude in relation to supply voltage, slew rate, bandwidth (3dB and unity gain), offset, common mode rejection.

5.3     Sketch typical operational amplifier configurations and explain their practical operation and features.

        Range       configurations may include but are not limited to – voltage follower (unity gain buffer), inverting, non-inverting, inverting summing, differential, differentiator, integrator, comparator, voltage to current converter, current to voltage converter;
                     evidence of four configurations is required.

5.4     Explain the operation and application of an instrumentation amplifier as a transducer signal amplifier.

**Outcome 6**

Demonstrate fundamental knowledge of d.c. power supplies and electronic regulators.

**Performance criteria**

6.1     Explain the operation of half-wave and full-wave rectification for d.c. power supplies.

        Range       single and bridge, simple capacitor filter.

6.2     Explain three-terminal series regulators, and analyse and experimentally evaluate typical circuits based on manufacturers' data sheets.

6.3     Explain the concepts, operation, and application of switch-mode power supplies.

**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 | 28 November 2013 | 31 December 2027 |
| Rollover and Revision | 2 | 28 June 2018 | 31 December 2027 |
| Review | 3 | 30 January 2025 | 31 December 2027 |

| Consent and Moderation Requirements (CMR) reference | 0003 |
|---|---|

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