Electrical Workers Registration Board

Teaching Guidelines for Electrician

Examination Prescriptions for Theory and Regulations Tuition

and

Practical Skill Assessments

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1 Introduction

Under the Electricity Amendment Act 2006 the Electrical Workers Registration Board (the Board) has a responsibility to set the registration criterion and ensure that all persons applying for electrical registration are competent.

As part of the competency requirements sixty-six (66) essential capabilities for electricians incorporating 31 critical items have been agreed between the Board and Australian Licensing Authorities.

Electrician examination prescriptions in these Teaching Guidelines are structured around the agreed essential capabilities. This document has been prepared to assist tutors in the development and delivery of courses for trainees and candidates who need to complete any or all of the following to be eligible to apply for registration as an **electrician**:

(a) capstone testing – pass the Electrician Theory Examination and/or the Electrician Regulations Examination.

(b) The electrician three-stage practical skill assessment programme or an electrician practical examination.

Tuition provided for theory or regulations or the practical skill assessment must cover **all** of the subject matter in the relevant part of this document.

While the examination prescriptions in these guidelines are detailed, they do not, however, cover every aspect. For example, it should not be inferred that a particular subject should be limited to specific examples listed to adequately cover:

(a) examination subject matter

(b) requirements to be incorporated in the National Certificate in Electrical Engineering (Electrician for Registration) (Level 4).

2. Scope

Theory and Regulations Prescriptions are for capstone examination purposes and as a minimum incorporate 31 critical items and elements from the agreed 66 essential capabilities.

Candidates undergoing tuition in accordance with these prescriptions should receive the full range of theory and regulations tuition incorporating the 66 essential capabilities either by:

(a) satisfactorily completing a Board-approved competency-based training system for the issue of a Level 4 National Certificate; or

(b) alternatively, satisfactorily complete training under an experience pathway in New Zealand approved by the Board or, in an overseas jurisdiction that is recognised by the Board as a satisfactory equivalent.

3. Electrician Registration Requirements

To be eligible for registration as an electrician, under the "Rules of the Board" an applicant must therefore provide evidence to the Board that they have:

(a) satisfactorily completed a formal training course or courses of study for electrician accredited by the Board or that the Board accepts is equivalent; and

(b) completed a Board approved electrician competency base training system or completed four years' practical training/experience in the work of an electrician covering all the skills as prescribed by the Board; and

(c) passed the Board electrician theory and regulations capstone examinations as required by the Board; and

(d) passed three stages practical skill assessments, or a practical examination prescribed by the Board, or satisfactory completion of competency-based assessments that the Board accepts is equivalent, and

(e) satisfactorily completed instruction in safe working practices, testing, basic first aid and cardiac-pulmonary resuscitation as approved by the Board.

4. Limits of Work under the "Rules of the Board"

The types of work a registered electrician is permitted to carry out are:

(a) the installation or maintenance of conductors used in works or installations; and

(b) the installation or maintenance of fittings connected, or intended to be connected, to conductors used in works or installations; and

(c) the connection or disconnection of fittings to or from a power supply, other than by means of a plug or pin inserted into a socket, or an appliance coupler inserted into an appliance inlet; and

(d) the maintenance of appliances; and

(e) the testing of work described in paragraphs (a) to (d) above; and

(f) the certification of work described in paragraphs (a) to (d) above; and

(g) the supervision of any work described in paragraphs (a) to (f) above.

5. Examination Prescriptions

Considerable effort has been made to provide a distinction between theory and regulations prescriptions in this document. However, duplications are unavoidable because many of the 66 agreed essential capabilities contain elements of theory subject matter and information that is derived from Electricity Regulations or Electrical Standards.

(a) **Electrician theory examinations** will cover any aspect of the Theory Prescription allocated with A or B knowledge designations and may also contain elements with C or D designations. In addition, theory examination questions will contain aspects of the Regulations Prescription that a candidate is expected to know without the need to directly access references from Regulations or Standards.

For example, the minimum acceptable insulation resistance values for an electrical installation (as required in Section 8 of AS/NZS 3000) may be incorporated into a theory question relating to insulation resistance testing of low voltage electrical installation. Likewise, the maximum leakage current values and tripping times for RCDs affording protection against electric shock (as prescribed in regulation 24).

However, where candidates are required to solve questions that involve calculations specifically relating to selection of cables, extracts from the relevant Standard/s will be included in that examination paper.

(b) **Electrician regulation examination** – questions will cover any of the aspects in the Regulations Prescription. It may also include some aspects of underpinning electrical theory knowledge necessary to understand and apply a Regulation, a Standard or a Code of Practice.

For example, a sound understanding of electrical instrument testing procedures is required to carry out insulation resistance testing **or** in service testing of RCDs on an electrical installation, and therefore may be incorporated in questions on testing to comply with the Electricity (Safety) Regulations 2010 and Section 8 of AS/NZS 3000:2007 and any additional requirements cited in the relevant Companion Standards.

6. Practical Skill Assessments

To ensure that applicants for registration are competent, a three-stage practical skill assessment programme has been established by the Board that incorporates the agreed essential capabilities elements and critical practical skills.

Note: The three-stage practical assessment programme is applicable to electrician, electrical installer and electrical engineer registration class applicants.

7. Safety

Safety must be emphasised at all times, whether it be classroom tuition, carrying out practical exercises or practical skill assessments. Safety, not only of tutors, assessors and candidates, but also others who may in future depend on the candidate's standard of workmanship and competency is paramount.

8. Definitions

Unless the context otherwise requires, within these guidelines:

Act means the Electricity Act 1992 and the Electricity Amendment Act 2006

Code or ECP means New Zealand Electrical Code of Practice issued under Part IV of the Act

Regulation means the Electricity (Safety) Regulations 2010

Standard means, as the case may be:

- AS/NZS3000:2007 and companion Standards as cited in Schedule 2 of the Electricity (Safety) Regulations 2010, being:
  - a New Zealand Standard (NZS)
  - a Australian Standard (AS)
- a joint Australian/New Zealand Standard (AS/NZS)
- a British Standard (BS)
- an International Electrotechnical Commission Standard (IEC)
- an International Standards Organisation (ISO).

Section means a section of the Electricity Act 1992 and the Electricity Amendment Act 2006.

Interpretations and terms are also defined in the Electricity Act 1992, the Electricity Amendment Act 2006, the Electricity (Safety) Regulations 2010 and AS/NZS 3000:2007 incorporating Amendment 1.

9. Reference Texts

The Electricity Act 1992 reprint dated April 2010 which includes the Electricity Amendment Act 2006.

The Electricity (Safety) Regulations 2010.

EWRB supervision procedures for trainees (published 31 March 2010).

AS/NZS 3000:2007 – electrical installations incorporating Amendment 1 (known as Australian and New Zealand Wiring Rules).

Standards cited in Schedule 2 of the Electricity (Safety) Regulations 2010 (list follows):

Electricity (Safety) Regulations 2010
Schedule 2 Standards

Abbreviations used in regulations	Full title
AS 4777.1	AS 4777.1:2005 Grid connection of energy systems via inverters – Installation requirements.
AS/NZS 1677.2	AS/NZS 1677.2:1998 Refrigeration systems – Safety requirements for fixed applications: including Amendment 2.
AS/NZS 2500	AS/NZS 2500:2004 Guide to safe use of electricity in patient care.
AS/NZS 3000	AS/NZS 3000:2007 Electrical Installations (known as the Australian/New Zealand Wiring Rules) including Amendment 1.
AS/NZS 3001	AS/NZS 3001:2008 Electrical Installations – Transportable structures and vehicles including their site supplies: including Amendment A.
AS/NZS 3002	AS/NZS 3002:2008 Electrical Installations – Shows and carnivals, subject to variation that references to AS/NZS 3439.4 must be read as AS/NZS 3439.4:2009.
AS/NZS 3003	AS/NZS 3003:2003 Electrical Installations – Patient areas of hospitals, medical and dental practices and dialyzing locations.
AS/NZS 3004.1	AS/NZS 3004.1:2008 Electrical Installations – Marinas and recreational boats – marinas.
AS/NZS 3004.2	AS/NZS 3004.2:2008 Electrical Installations – Marinas and recreational boats – recreational boats installations.
AS/NZS 3009	AS/NZS 3009:1998 Electrical Installations – Emergency power supplies in hospitals.
AS/NZS 3010	AS/NZS 3010:2005 Electrical Installations – Generating sets.
AS/NZS 3012	AS/NZS 3012:2003 Electrical Installations – Construction and demolition sites, subject to variation that references to AS/NZS 3439.4 must be read as references to AS/NZS 3439.
AS/NZS 3014	AS/NZS 3014:2003 Electrical Installations – Electric fences including Amendment 1.
AS/NZS 3016	AS/NZS 3016:2002 Electrical Installations – Electric security fences including Amendment 1.
AS/NZS 3112	AS/NZS 3112:2004 Approval and test specification – Plugs and sockets including Amendment 1.
AS/NZS 3190	AS/NZS 3190:2009 Approval and test specification – Residual current devices (current-operated earth leakage devices).
AS/NZS 3439	AS/NZS 3439.4:2009 Low-voltage switchgear and control gear assemblies – particular requirements for assemblies for construction sites (ACS).
AS/NZS 3551	AS/NZS 3551:2004 Technical management programs for medical devices including Amendment 1.

Abbreviations used in regulations	Full title
AS/NZS 3760	AS/NZS 3760:2003 In-service safety inspection and testing of electrical equipment including Amendment 1.
AS/NZS 3820	AS/NZS 3820:2009 Essential safety requirements for electrical equipment.
AS/NZS 3823	AS/NZS 3823:1998 Electrical Installations – cold-cathode illumination systems.
AS/NZS 4509.1	AS/NZS 4509.1:2009 Stand alone power systems – safety and installation.
AS/NZS 4701	AS/NZS 4701:2000 Requirements for domestic electrical appliances and equipment for reconditioning or parts recycling.
AS/NZS 5033	AS/NZS 5033:2005 Installation of photovoltaic (PV) arrays including Amendment 1.
AS/NZS 5761	AS/NZS 5761:2005 In-service safety inspection and testing – second-hand electrical equipment prior to sale.
AS/NZS 5762	AS/NZS 5762:2005 In-service safety inspection and testing – repaired electrical equipment.
AS/NZS 60079.14	AS/NZS 60079.14:2009 Explosive atmospheres – electrical installations design, selection and erection.
AS/NZS 60079.17	AS/NZS 60079.17:2009 Explosive atmospheres – electrical installations inspection and maintenance.
AS/NZS 60950	AS/NZS 60950.1:2003 Information technology equipment – safety – general requirements including Amendments 1, 2 and 3.
AS/NZS 61000.3.2	AS/NZS 61000.3.2:2007 Electromagnetic compatibility (EMC) – Limits – Limits for harmonic current emissions (equipment input current less than or equal to 16 amperes per phase) including Amendment 1.
IEC 60050	IEC 60050: International electro-technical vocabulary.
IEC/TS 60479-1	IEC/TS 60479-1 Ed 4.0 Effects of current on human beings and livestock – Part1: General aspects.
IEC 61000-3-2	IEC 61000-3-2 Ed 3.2 Electromagnetic compatibility (EMC) – Limits – Limits for harmonic current emissions (equipment input current less than or equal to 16 amperes per phase) as amended by deviation in IEC 61000-3-2;2007 including Amendment 1.
IEC 61000-3-3	IEC 61000-3-3 Ed 2.0 Electromagnetic compatibility (EMC) – Part 3-3 Limits – Limits of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems with current less than or equal to 16 amperes per phase and not subject to conditional connection.
IEC 61000-3-4	IEC 61000-3-4 Ed 1.0 Electromagnetic compatibility (EMC) – Part 3-4 Limits – Limitation of emission of harmonic currents in low-voltage supply systems with rated current less greater than 16 amperes.
IEC 61000-3-5	IEC 61000-3-5 Ed 2.0 Electromagnetic compatibility (EMC) – Part 3-5 Limits – Limits of voltage fluctuations and flicker in low-voltage supply systems with rated current greater than 75 amperes.

Abbreviations used in regulations	Full title
IEC 61000-3-11	IEC 61000-3-11 Ed 1.0 Electromagnetic compatibility (EMC) – Part 3-11 Limits – Limits for harmonic currents produced by equipment connected to public low-voltage supply systems with input current greater than 16 amperes and less than or equal to 75 amperes per phase.
IEC 62128-1	IEC 62128-1 Ed 1.0 Railway applications – Fixed installation – Part 1 Protective provisions relating to electrical safety and earthing.
ISO/IEC 17050-1	ISO/IEC 17050-1 Conformity assessment – Supplier's declaration of conformity – Part 1 General requirements.
NZS 3003.1	NZS 3003.1:(2003) Electrical installations – Patient areas of hospitals and medical and dental practices – Testing requirements.
NZS 6115	NZS 6115:2006 Electrical installations – Mobile electro-medical connectable installations: subject to variation that references in this standard to NZS3019 must read as references to AS/NZS3001.
NZS 6116	NZS 6116:2006 Safe application of electricity in meat processing industry.
NZS 7901	NZS 7901:2008 Electricity and gas industries – Safety management system for public safety.

Codes of practice	Full title
ECP 34	New Zealand Electrical Code of Practice for Electrical Safety Distances (NZECP 34:2001).
ECP 35	New Zealand Electrical Code of Practice for Power Systems Earthing (NZECP 35:1993).
ECP 36	New Zealand Electrical Code of Practice for Harmonic levels (NZECP36:1993) issued on 4 February 1993.
ECP 41	New Zealand Electrical Code of Practice for Single Wire Earth Return Systems (NZECP41:1993) issued on 4 February 1993.
ECP 46	New Zealand Electrical Code of Practice for High Voltage Live Line Work (NZECP46:2003) issued on 12 October 2001.
ECP 50	New Zealand Electrical Code of Practice for Repair of Domestic Electrical Equipment (NZECP50:1993) issued on 4 February 1993.
ECP 51	New Zealand Electrical Code of Practice for Electrical Wiring Work in Domestic Premises (NZECP51:1993) issued on 4 February 1993.
ECP 60	New Zealand Electrical Code of Practice for Inspection, Testing and Certification of Low Voltage AC Railway Signalling Control Circuits (NZECP60:1997) issued on 6 July 1997

10. Theory

Subject matter for electrician training under the "Rules of the Board" is based on 66 essential capabilities incorporating 31 critical items. Critical items are allocated A and B knowledge designations.

Letters "A", "B", "C" and "D" appearing in the right-hand margin represent levels of knowledge candidates are expected to attain by completing Board accredited or Board approved courses of study – designations are as follows:

A Thorough knowledge
B Good working knowledge
C General knowledge
D Basic understanding.

11. Basic Electrical Theory

(a)	Demonstrate how energy is converted through heat, chemical, magnetic and mechanical processes.	**C**
(b)	Demonstrate knowledge of ohms law, material resistivity, resistor parameters, and introduction to measuring methods.	**C**
(c)	Demonstrate knowledge of how electrical energy is produced from various forms of energy.	**C**
(d)	Explain the operation of a simple practical circuit including current path, circuit control, load, EMF source and conductors.	**C**
(e)	Determine the resistance, voltage and power in any part of a d.c. series and/or parallel circuit using practical knowledge and safe use of measuring instruments.	**C**

12. Systems of Supply

12.1 New Zealand electrical supply system

(a)	Illustrate with labelled diagrams the New Zealand electrical supply system showing the generation, transmission and distribution systems.	**A**
(b)	State the typical voltages involved in each of the above areas.	**B**
(c)	Draw and label the three phase four wire New Zealand distribution system to show how it can be used to supply: • a three phase consumer • a two phase consumer • a single phase consumer.	**A**
(d)	State the relationship between line and phase voltages and line and phase currents for both star and delta connections.	**A**
(e)	State the advantages of balancing the load over the three phases.	**A**

(f)	Calculate the power in a three phase load.	**B**
(g)	Determine the neutral current in a three phase star connected load.	**B**

12.2 Multiple earth neutral system

(a)	Explain how the MEN system of supply in New Zealand is configured.	**A**
(b)	Explain reasons for earthing the neutral at multiple points.	**B**
(c)	List the features of the multiple earth neutral (MEN) system used in New Zealand.	**B**
(d)	Explain the implications of a missing MEN link in an installation during fault conditions in respect to; line voltage to earth, fault current path, earth loop impedance and operation of protective devices.	
(e)	Distribution type system: explain that an alternative system (eg, distribution system) can be connected downstream of the MEN system.	**A**

13. Electrical Protection

13.1 Protection

(a)	State what is meant by the terms rated current and excess current protection.	**A**
(b)	Describe the danger of excess current to cables and equipment.	**A**
(c)	State forms of excess current protection: • close excess current protection • coarse excess current protection.	**A**
(d)	Explain the following terms applicable to sub-circuit protection: • voltage rating • current rating • utilisation categories – that replace fusing factors • breaking capacity and kVA rating.	**A**
(e)	Describe, with the aid of labelled diagrams the construction, operation principles and applications of the following protective devices: • semi-enclosed rewirable fuses (installed in existing installations) • HRC fuses labelled in accordance with BS88:1998, IEC and AS/NZS 60269 • miniature circuit breakers • cartridge fuses • fusible links • magnetic overload relays • thermal overload relays.	**A**

(f) Understand and explain the following terms as related to protective devices: **A**
- Current rating
- Voltage rating
- Fusing current
- Utilisation category
- Tripping factor
- Cut-off characteristic
- Time verses current characteristic
- Category of duty
- Discrimination
- Back-up protection
- Rupturing capacity
- Prospective short-circuit current
- Sensitivity
- Earth-fault loop impedance.

13.2 Residual current devices (RCDs)

(a) Understand that RCDs provide supplementary protection the users of electrical appliances and equipment. **A**

(b) Demonstrate knowledge of the maximum tripping current and operating times for RCDs to be deemed electrically unsafe (see regulation 24). **A**

(c) Explain the checking and testing requirements to ensure that RCDs installed for protection against shock are type A for New Zealand. **A**

(d) Understand the operating principles of an RCD. **A**

(e) Be aware of how RCDs are classified including: **A**
- method of operation
- type of operation
- number of poles and current paths
- possibility of adjusting the residual operating current
- resistance to unwanted tripping due to voltage surges
- behaviour of the presence of d.c. components
- protection against external influence
- method of mounting
- method of connection.

(f) Understand the operational characteristics of RCDs and how different types of the available RCDs operate including: **A**
- residual current-operated circuit breakers (RCCB)
- residual current-operated circuit breakers with overcurrent protection (RCBO)
- socket-residual current protection devices (SRCD)
- portable residual current protection devices (PRCD)
- RCDs functionally independent of line voltage (used in residential type switchboards and SRCDs)
- RCDs functionally dependent on line or auxiliary voltage (used in PRCDs)
- typical residual current ratings
- classification of RCDs according to the presence of d.c. components.
- load leakage currents.

(g) Methodologies for installing RCDs in residential situations, industrial and commercial situations, single phase and three phase. **A**

(h) Understand and apply the principles relating to protection for safety in AS/NZS 3000 and the role RCDs can play in protection for additional safety in damp situations. **A**

(i) Understand and apply the requirements of: **A**
- AS/NZS 3000 regarding the installation of RCDs in domestic and residential premises
- regarding the use of RCDs with hand-held electrical appliances.

(j) Understand the considerations of installing 10 mA RCD for protecting areas of increased risk and children against electric shock as detailed in Section 2.6.1 of AS/NZS3000. **A**

(k) Testing RCDs to ensure compliance with regulation 24. **A**

13.3 Isolating transformers

(a) Describe the basic operating principle of an isolating transformer. **B**

(b) Explain why an isolating transformer provides maximum safety when used with only one electrical appliance connected. **A**

(c) Explain why it is necessary, when two or more electrical appliances are connected simultaneously to one isolating transformer, their earth continuity conductors are bonded together at the transformer but must not be earthed. **B**

(d) Understand that the isolating transformer may be used in conjunction with other approved safeguards for extra protection where considered desirable. **C**

(e) Explain why transformers are rated in kVA and not Watts or kW. **C**

14. Electrical Safety – Personal

14.1 Effects of current

(a) Demonstrate knowledge of the physiological effects of electricity on humans. **A**

(b) Explain:

- Why peak voltages are an important consideration in respect to insulation resistance values providing protection from exposure to electric shock. **A**
- The danger of simultaneously contacting active (phase) and neutral or active (phase) and earth conductors. **A**
- The effects that varying values of voltages, current, duration of contact and other conditions (wet or punctured skin, etc) have on the severity of electric shock received by the victim. **A**

14.2 Isolation procedures

(a) State the benefits of working equipment that has been isolated. **A**

(b) Explain the SAFETY TAG system. **A**

(c) State the benefits of using the safety tag system to promote safety in the workplace. **A**

(d) Explain methods employed to isolate and “lock off” equipment. The importance of using danger tags when working on equipment which may become live. **A**

(e) Explain the importance of the PROVE TEST PROVE safety rule and, the benefits of TESTING before touch to prevent electric shock. **A**

(f) Explain the conditions covering the use of SAFETY TAGS, their correct placement and removal procedures. **A**

(g) Detail written isolation procedures. **A**

14.3 Legislative requirements for workplace safety

(a) Understand that employers are required by legislation to provide and maintain equipment and PPE supplied for employees use in a safe condition. **B**

(b) Understand that employees must use the PPE supplied by the employer and comply with all employer established safety procedures. **B**

14.4 Safe working practices

(a) Explain that it is essential to identify hazards and potential hazards and take appropriate steps to eliminate, isolate or minimise the hazard risk by observing safety measures at all times to ensure the safety of: **A**

- electricians, electrical workers or electrical trainees
- other workers in the area
- members of the public
- equipment and property.

(b)	Explain that electricians are required to be conversant with the Electricity Safety Regulations to be competent.	**A**
(c)	Explain the importance of using the correct tools, clothing and equipment that is appropriate for the job and trained to competently use any specialised equipment required.	**A**
(d)	Explain the importance of preliminary safety checks and observing proven safety rules when working at height and when ladders and scaffolding are involved.	**A**
(e)	Understand that when good housekeeping and tidy work habits are practised, it promotes a safety culture in the workplace.	**A**
(f)	Explain that personal protective equipment (PPE) such as covers, mats, gloves, safety harnesses, insulated tools and glasses or goggles, etc, are required to be manufactured to an approved safety standard.	**A**
(g)	Explain that regular checks are required to retain the integrity of the safety equipment.	**A**
(h)	Explain why it is necessary to use insulated tools of an approved type when working on electrical fittings.	**A**
(i)	Explain that when working in outdoor or damp situations it is important to supply electrical appliances from either an isolating transformer or from an RCD.	**A**
(j)	Detail the dangers when working with metal ladders, tape, tools and the like on or near electrical supplies or equipment.	**A**
(k)	Explain the dangers of working in explosive atmospheres and stress the importance of ensuring that all electrical equipment is correctly isolated before removing any covers, etc.	**A**
(l)	Explain the procedures when a fire is discovered.	**A**
(m)	Explain the procedures for rescue of a person or persons in contact with live conductors or equipment.	
(n)	Detail the types of fire extinguishers that are suitable for use on electrical fires and explain how each type is used.	**A**
(o)	Detail the dangers/hazards involved when working on high voltage fittings.	**A**
(p)	Explain the precautions necessary when working on circuits which have capacitors connected or other sources of stored energy.	**A**
(q)	Detail the requirements and the need for the presence of a second competent person, in situations where a danger or a potential risk exists.	**A**
(r)	Explain the DANGERS and HAZARDS associated with SHORT CIRCUITS and where potentially high PROSPECTIVE SHORT CIRCUIT CURRENTS could be present.	**A**
(s)	Understand concepts associated with working in the vicinity of high voltage equipment, distribution systems and exposure to risk from step and touch potentials, induced voltages, creepage and inadequate clearances.	**B**
(t)	Explain that electrical arcing exposes the victims of electric shock to additional hazards: arc eye and serious burns.	**A**

(u)	Explain that electricians are not permitted to work on live high voltage lines or equipment without written approval of the asset owner.	**A**
(v)	Explain that under Schedule 1(2) electricians are however, permitted to operate works, electrical installations, switching of works, etc., if they are deemed competent to undertake such work having received training, instruction and approval from the asset owner.	**B**

15. Transformers and their Applications

15.1 General

(a)	Explain the principles of operation for the double wound transformer and the autotransformer.	**B**
(b)	State the formulae and perform transformer calculations involving voltage ratios, current ratios, turns ratios and kVA ratings.	**B**
(c)	Describe the basic construction of a power transformer.	**C**
(d)	Explain why the low voltage windings are generally placed closest to the core and why special additional insulation separates them from the high voltage winding.	**D**
(e)	Explain the terms ‘iron losses’ and ‘copper losses’ and the practical methods of reducing these losses.	**D**
(f)	Explain that the kVA rating of a transformer is limited by the temperature of the core and windings.	**B**
(g)	Describe the methods employed to dissipate the heat energy from the cores and windings of various transformer types.	**C**
(h)	Describe the effect of the load current on the secondary terminal voltage of a transformer.	**C**
(i)	Explain the term ‘regulation’ as applied to transformers.	**D**
(j)	Explain that the regulation of a transformer can be maintained by incorporating tap changing.	**D**
(k)	Explain how the primary and secondary windings of a three phase transformer are configured to achieve these four basic combinations: • star – star • star – delta • delta – star • delta – delta	**B**

15.2 Voltage transformers

(a)	Describe a voltage transformer, its operation and applications.	**C**
(b)	State the common secondary voltages of a voltage transformer when supplied at its full primary voltage.	**C**

(c)	Using typical symbols, show how voltage transformers would be represented on diagrams.	**C**

15.3 Current transformers

(a)	Describe the current transformer, its operation and applications.	**C**
(b)	Explain the term ‘Burden’, as it relates to current transformers.	**C**
(c)	State the common secondary current ratings of current transformers.	**C**
(d)	Using typical symbols, show how CTs would be represented on diagrams.	**C**
(e)	State the precaution that must be taken before disconnecting the load from a current transformer.	**A**

16. Selection of Cables

(a)	Explain that the cable selection process involves factors such as the current and voltage rating, environmental conditions, length of run, earthing requirements, mechanical factors and additional considerations including derating factors and perspective short circuit currents.	**A**
(b)	Provide examples and explain how a cable is chosen for a stated application considering all of the above factors.	**A**
(c)	Determine cable type and size required for a sub-circuit under specified load conditions, using the appropriate parts of AS/NZS 3000 and AS/NZS 3008.1.2 for a stated application.	**A**
(d)	Determine the maximum demand for domestic and non domestic mains and sub-mains in accordance with AS/NZS3000:2007.	**B**

(e) Determine the cable type and size of mains and sub-mains for given applications, including: **A**

- **cables types:**
  flexible (PVC, TPS, rubber-sheathed)
  fixed wiring (TPS, conduit wire, neutral screened cable, XLPE, SWA)
  underground
  aerial
- **consideration of:**
  conductor material
  maximum conductor temperature
  air and soil ambient temperatures (de-rating and re-rating factors)
  mechanical protection
  installation method
  maximum demand
  length of run
  grouping
  current carrying capacity
  short circuit capability
  voltage drop
  earth loop impedance.

(f) Demonstrate sound understanding of installation techniques for a wide range of “low voltage” cable types in accordance with AS/NZS3000 and AS/NZS3008.1.2 including: **B**

- enclosed in conduit
- installed on a cable tray
- clipped to the surface
- underground wiring
- aerial wiring

considering such factors as:

- conductor material
- maximum conductor temperature
- air and soil ambient temperatures (de-rating and re-rating factors)
- mechanical protection
- grouping
- current carrying capacity
- length of run
- voltage drop limitations
- earth loop impedance.

(g) Candidates are expected to demonstrate a good appreciation for selecting the correct and appropriate protective device associated with the cable chosen for the stated application. **B**

17. Switchboards and Isolation Devices

(a)	Define the terms ‘mains switchboard’, ‘switchboard’, and ‘switchgear’ refer to the regulations interpretations and AS/NZS 3000.	**B**
(b)	Discuss the special requirements for main switchboards, MEN switchboards and distribution switchboards as per AS/NZS 3000.	**A**
(c)	Explain with reference to AS/NZS 3000 requirements for switchboards considering: 1. the location 2. access to the wiring and switchgear 3. protection against the spread of fire 4. environment and mechanical conditions 5. revenue metering (energy distributor) requirements 6. prospective short circuit current levels.	**B**
(d)	Explain the application of AS/NZS 3000 and the earthing requirements for MEN switchboards.	**A**
(e)	Describe the different types of fittings and accessories used as isolation devices for electrical circuits, located on switchboards.	**C**

18. Basic Electronics and Semi-conductor Devices

(a)	Explain the function, characteristics and typical applications of the following devices: Diodes — Diacs SCRs — Thermistors Transistors — Zener diodes Triacs	**C**
(b)	State that semiconductor devices are temperature sensitive and explain the methods of heat dissipation.	**A**
(c)	Explain that there is a possibility of damage occurring to semiconductor device during insulation resistance testing.	**A**
(d)	Give examples of the causes of transient voltages on power supply circuits and explain how these can be minimised to prevent damage to semi-conductor devices.	**A**
(e)	Explain the term ‘peak inverse voltage’ with respect to semiconductor devices.	**A**
(f)	Explain the differences between the semiconductor device and circuit conditions with respect to peak inverse voltage.	**A**
(g)	State that the PIV is referred to as V rrm.	**B**
(h)	Explain with the aid of diagrams the operation of a single diode as a half wave rectifier.	**A**
(i)	Explain with the aid of diagrams the operation of a single SCR as a controlled rectifier.	**C**

(j)	Explain with the aid of diagrams fullwave rectification using different transformer and diode arrangements on a single phase supply.	**A**
(k)	Explain how a transistor is used: • as a switch • as a common emitter amplifier	**C**
(l)	Explain with the aid of a diagram how a triac controls the load current in an a.c. circuit.	**B**
(m)	Explain with aid of diagrams controlled full wave rectification on a single phase supply.	**C**
(n)	Explain with the aid of diagrams how three phase half and full wave rectification can be achieved using diodes and a suitable transformer.	**A**
(o)	Compare the output waveforms of all the above uncontrolled rectifiers in terms of smoothness of the output.	**C**
(p)	State that capacitors, chokes and resistors are used for filtering the output of rectifier circuits.	**A**

19. The Purpose and Use of Test Instruments

(a)	Explain the purpose and give typical applications of the following types of test instruments. Insulation resistance tester — Phase rotation meter Voltmeter — Ammeter Earth loop impedance tester — Ohmmeter RCD tester	**A**
(b)	Explain how the above types of test instrument should be connected to test a circuit.	**A**
(c)	Detail any specific precautions required when using the above instruments.	**A**
(d)	Explain the importance of ensuring that the correct connections, functions and range are selected on the test instrument before it is used to test a circuit.	**A**

20. Testing of Installations, Appliances and Fittings

(a)	Explain that an electrician should approach an installation for testing in both an orderly and logical manner.	**A**
(b)	Explain that visual and mechanical checks of the installation are required by AS/NZS3000 prior to instrument testing. Explain that this is done to ensure that all the specific requirements for issuing compliance certification are satisfied	**A**
(c)	Explain the specific tests that are required by AS/NZS3000 and state the test instrument type required to perform each of those tests.	**A**

(d)	Describe the methods of carrying out the tests specified in AS/NZS3000:2007 stating the minimum and maximum values (where appropriate) that are acceptable.	**A**
(e)	Explain that specific installations have additional checks and test requirements as prescribed in the companion Standards listed in Schedule 2.	**A**
(f)	State that regulation 70 specifies the installation work requiring inspection by a registered electrical inspector prior to connection to the power supply.	**A**
(g)	State that all the tests of installation wiring work as detailed under regulation 65 and certification for compliance regulation 66 to 69 must be completed before connection to a power supply.	**A**
(h)	Detail and identify those fittings that form part of the installation which may be damaged by test voltages.	**B**
(i)	Explain the methods by which fittings can be either disconnected from the circuit under test or shorted out to prevent damage from the test voltages.	**B**
(j)	State the requirement that approvals are required before equipment can be connected to a power supply.	**B**
(k)	State that following repairs electrical appliances must be tested to ensure they are safe in accordance with the requirements of AS/NZS 5762 (regulation 90(2)).	**A**

21. Testing, Inspection and Certification

(a)	Define the terms: Testing; Certification and Inspection as prescribed in Schedule 1 of the Electricity Safety Regulations 2010.	**A**
(b)	List the types of installation work requiring testing and certification by a registered electrician before connection to the supply.	**A**
(c)	List the types of installation work which can only be inspected by a registered electrical inspector.	**A**
(d)	List the installations that are subject to periodic inspections by electrical inspectors.	**B**
(e)	Explain who is responsible for performing the prescribed tests associated with the completion of the compliance documentation involving: • self certification – work which does not require inspection • work requiring inspection – by a registered electrical inspector.	**A**
(f)	Understand that certifying prescribed electrical work means that the work: • is electrically safe and has been tested in accordance with the Standards cited in the Regulations • has been carried out in accordance with the Standards cited by the Regulations.	**A**
(g)	Describe how the tests for compliance are performed and state the values which are acceptable.	**A**

(h) Understand that the Certificate of Compliance must be: **A**

- completed as soon as practicable and in no case later than three days after the work is completed, but no later than the end of the day on which the contract for the work terminates; and
- one copy of the certificate must be given to the person for whom the work was carried out within 20 days of the certificate being completed; and
- one copy of the certificate must be retained for three years by the person certifying the work.

A copy must be supplied to the Board within 20 working days of a written request from the Board.

(i) State that wiring installation work is subject to audit by the Electrical Workers Registration Board to ensure worker competency. **B**

22. Three Phase Motors and Starters

22.1 Three phase motor construction

(a) Describe the components of a three phase induction motor, ie. **B**

(i) rotor – include differences between cage and wound types.

(ii) stator windings

(iii) iron circuit.

(b) Describe the frame types and ventilation methods available, giving typical applications for each type. **B**

22.2 Three phase induction motor principles

(a) Explain the principles of operation of a three phase induction motor in terms of the stator rotating field, rotor currents and flux, relative motion between the rotating field and rotor and the direction of rotor rotation. **B**

(b) Define the terms: **B**

(i) synchronous speed

(ii) slip speed (expressed as % of synchronous speed)

(iii) full load speed (N rotor).

(c) Draw a torque/speed characteristic graph to explain relationship between slip, NS and NR. **B**

(d) Explain the effect that a reduction in supply voltage has on the line currents of a loaded induction motor. **A**

(e) Explain the effects on a three phase induction motor if one supply line is open circuited on: **A**

(i) star connected motor

(ii) delta connected motor.

(f) Explain the effects on a three phase induction motor if one of the stator windings is reversed. **B**

(g) Explain how the winding reversal problem may be diagnosed and rectified. **C**

(h) Explain the effect of load on an induction motor's P.f. and efficiency. **B**

(i) Explain how capacitors are connected to three phase induction motors to correct the power factor and to reduce line current. **A**

(j) Explain how: **B**
- (i) the direction of rotation is changed in a three phase induction motor
- (ii) The windings of a three phase motor may be connected in either star or delta and the effects on voltage rating and power produced.

(k) Explain the difference between starting current and run current for a three phase induction motor and how they may be calculated. **B**

(l) Solve problems involving three phase induction motors including: **B**
- (i) true power, apparent power, reactive power
- (ii) synchronous speed, full load speed, frequency and slip
- (iii) output power, voltage, run currents, start current and P.f. for both star and delta connections
- (iv) input power, output power, torque, efficiency and speed.

22.3 Three phase induction motor starters

(a) Describe the protection a motor starter may provide and explain how this may be achieved. **A**

(b) Describe how phase reversal protection can be provided. **A**

(c) Describe the operation of a D.O.L. starter. **B**

Give advantages, disadvantages and applications for D.O.L. starters.

(d) Explain why reduced voltage starting is required in some installations, including advantages and disadvantages. **A**

(e) Describe the operation of the following types of reduced voltage starters including advantages, disadvantages for specific applications. **A**
- (i) Star – Delta.
- (ii) Auto transformer.
- (iii) Primary resistance.
- (iv) Electronic (eg. soft starting and wave chopping types).

23. Single Phase Motors

23.1 Single phase induction motor operation

(a) Explain how a single phase supply can be used to provide an alternating magnetic field. **B**

(b) Explain how phase splitting can be used to provide starting torque in a single phase motor. **B**

23.2 Types of single phase induction motors

(a) Describe the operation and construction of the following types of single phase induction motors. Include advantages, disadvantages, applications and reversal connections for each type: **B**
- (i) split phase (resistance start)
- (ii) capacitor start
- (iii) permanently split capacitor (capacitor start and capacitor run)
- (iv) capacitor start capacitor run (dual value capacitor).

(b) Explain how external start relays may be used to start single phase induction motors. Include advantages, disadvantages and applications for each type. **C**

23.3 Additional single phase motors

(a) Explain the operation and construction of the following types of single phase motors – include the advantages and disadvantages, application, and reversal procedures for each type – universal, shaded pole, synchronous. **B**

(b) Explain methods of speed control for universal motors and state typical applications where universal motor speed control is employed. **B**

24. Selection and Suitability of Motor Protection

(a) Explain why electric motors may require protection against: **A**
- (i) excess current
- (ii) mechanical overload
- (iii) under voltage
- (iv) phase failure
- (v) phase reversal

(b) Describe the construction and operating principle of both thermal and magnetic overload units. **B**
- (i) for the protection of three phase motors
- (ii) for the protection of single phase motors

(c) Explain the use of the following protective systems: **C**
- (i) phase failure
- (ii) phase reversal
- (iii) thermistor

(d) Explain back up protection and discrimination with respect to protecting motor circuits. **B**

25. Alternators

(a)	Explain the basic construction of an alternator.	**B**
(b)	Describe and explain the various types of commonly used rotors.	**B**
(c)	Describe the types of prime movers.	**B**
(d)	Explain the basic principles of A.C. generation three-phase.	**B**
(e)	Explain the relationship between and perform calculations involving frequency, number of pairs of poles, and speed.	**B**

26. Prescribed Electrical Work Requiring Inspection

(a)	Explain that certain installation work requires inspection by a registered electrical inspector prior to connection to the power supply.	**A**
(b)	Detail the requirements of regulation 70 and list the installation work that requires inspection.	**A**
(c)	Explain that regulation 72 cites companion Standards that cover the inspection requirements for installation work in addition to AS/NZS3000.	**A**

27. Lighting

(a)	Define the following terms and state the unit: • luminous intensity • luminous flux • illuminance.	**C**
(b)	List the essential components required to produce good illumination.	**C**
(c)	Explain that recommended and recognised minimum levels of illuminance are required for various work areas.	**B**
(d)	Explain the basic principles of operation of the following: • sodium vapour low pressure and high pressure • mercury vapour high pressure • metal halide • neon lighting • incandescent • fluorescent lighting low pressure mercury vapour • halogen.	**C**
(e)	Compare the output efficacy, colour output, handling requirements, effects of vibration, ventilation of the above lamp types and practical applications, for each type.	**D**

(f)	Explain colour rendering and give practical examples of applications.	**A**
(g)	Explain the stroboscopic effect of discharge lamps and how this effect can be minimised.	**A**
(h)	Describe with the aid of a circuit diagram the operation of a single tube switch start type fluorescent fitting.	**B**
(i)	Describe the common faults that occur with single tube fluorescent fittings and explain how these are overcome.	**B**
(j)	Describe the hazards that are present with gas discharge lamps and their control circuits.	**A**

28. Regulations Examination Prescription

Regulations examinations are open book and cover all or any aspects of the Regulations Prescription. A prerequisite level of underpinning knowledge of electrical theory is also expected from candidates to demonstrate how regulations or a specific Standard is applied.

As stated earlier in the scope of this document the regulations examination is for capstone purposes and a means to establish candidate competency.

Therefore, elements from 66 essential capabilities incorporating 31 critical items are included in this prescription.

However, the majority of examination questions will be sourced from primary reference documents designated with A and B knowledge levels and supported by supplementary questions from documents designated with C and D knowledge levels as follows:

The Electricity (Safety) Regulations 2010.	**A**
The Electricity Act 1992, reprint 1 April 2010 incorporating the Electricity Amendment Act 2006.	**B**
AS/NZS3000:2007 incorporating Amendment No. 1.	**A**
AS/NZS3008.1.2 (Electrical installations – Selection of cables, typical New Zealand conditions).	**B**
AS/NZS3012	**C**
AS/NZS3019	**C**
AS/NZS3760	**B**
AS/NZS5761	**B**
AS/NZS5762	**B**
NZECP 34	**A**
NZECP 54	**B**

Supplementary questions will also be developed from Companion Standards and applicable New Zealand Electrical Codes of Practice (NZECPs) cited in Schedule 2 of the Electricity (Safety) Regulations 2010.

Companion Standards	**C**
Additional NZECPs	**D**

Electricity (Safety) Regulations 2010
Schedule 2 Standards

Abbreviations used in regulations	Full title
AS 4777.1	AS 4777.1:2005 Grid connection of energy systems via inverters – Installation requirements.
AS/NZS 1677.2	AS/NZS 1677.2:1998 Refrigeration systems – Safety requirements for fixed applications: including Amendment 2.
AS/NZS 2500	AS/NZS 2500:2004 Guide to safe use of electricity in patient care.
AS/NZS 3000	AS/NZS 3000:2007 Electrical Installations (known as the Australian/ New Zealand Wiring Rules) including Amendment 1.
AS/NZS 3001	AS/NZS 3001:2008 Electrical Installations – Transportable structures and vehicles including their site supplies: including Amendment A.
AS/NZS 3002	AS/NZS 3002:2008 Electrical Installations – Shows and carnivals, subject to variation that references to AS/NZS 3439.4 must be read as AS/NZS 3439.4:2009.
AS/NZS 3003	AS/NZS 3003:2003 Electrical Installations – Patient areas of hospitals, medical and dental practices and dialyzing locations.
AS/NZS 3004.1	AS/NZS 3004.1:2008 Electrical Installations – Marinas and recreational boats – Marinas.
AS/NZS 3004.2	AS/NZS 3004.2:2008 Electrical Installations – Marinas and recreational boats – Recreational boats installations.
AS/NZS 3009	AS/NZS 3009:1998 Electrical Installations – Emergency power supplies in hospitals.
AS/NZS 3010	AS/NZS 3010:2005 Electrical Installations – Generating sets.
AS/NZS 3012	AS/NZS 3012:2003 Electrical Installations – Construction and demolition sites, subject to variation that references to AS/NZS 3439.4 must be read as references to AS/NZS 3439.
AS/NZS 3014	AS/NZS 3014:2003 Electrical Installations – Electric fences including Amendment 1.
AS/NZS 3016	AS/NZS 3016:2002 Electrical Installations – Electric security fences including Amendment 1.
AS/NZS 3112	AS/NZS 3112:2004 Approval and test specification – Plugs and sockets including Amendment 1.
AS/NZS 3190	AS/NZS 3190:2009 Approval and test specification – Residual current devices (current-operated earth leakage devices).

Abbreviations used in regulations	Full title
AS/NZS 3439	AS/NZS 3439.4:2009 Low-voltage switchgear and control gear assemblies – Particular requirements for assemblies for construction sites (ACS).
AS/NZS 3551	AS/NZS 3551:2004 Technical management programmes for medical devices including Amendment 1.
AS/NZS 3760	AS/NZS 3760:2003 In-service safety inspection and testing of electrical equipment including Amendment 1.
AS/NZS 3820	AS/NZS 3820:2009 Essential safety requirements for electrical equipment.
AS/NZS 3823	AS/NZS 3823:1998 Electrical Installations – Cold-cathode illumination systems.
AS/NZS 4509.1	AS/NZS 4509.1:2009 Stand-alone power systems – Safety and installation.
AS/NZS 4701	AS/NZS 4701:2000 Requirements for domestic electrical appliances and equipment for reconditioning or parts recycling.
AS/NZS 5033	AS/NZS 5033:2005 Installation of photovoltaic (PV) arrays including Amendment 1.
AS/NZS 5761	AS/NZS 5761:2005 In-service safety inspection and testing – Second-hand electrical equipment prior to sale.
AS/NZS 5762	AS/NZS 5762:2005 In-service safety inspection and testing – Repaired electrical equipment.
AS/NZS 60079.14	AS/NZS 60079.14:2009 Explosive atmospheres – Electrical installations design, selection and erection.
AS/NZS 60079.17	AS/NZS 60079.17:2009 Explosive atmospheres – Electrical installations inspection and maintenance.
AS/NZS 60950	AS/NZS 60950.1:2003 Information technology equipment – Safety-General requirements including Amendments 1, 2 and 3.
AS/NZS 61000.3.2	AS/NZS 61000.3.2:2007 Electromagnetic compatibility (EMC) – Limits – Limits for harmonic current emissions (equipment input current less than or equal to 16 amperes per phase) including Amendment 1.
IEC 60050	IEC 60050: International Electro-technical Vocabulary.
IEC/TS 60479-1	IEC/TS 60479-1 Ed 4.0 Effects of current on human beings and livestock – Part1:General aspects.
IEC 61000-3-2	IEC 61000-3-2 Ed 3.2 Electromagnetic compatibility (EMC) – Limits – Limits for harmonic current emissions (equipment input current less than or equal to 16 amperes per phase) as amended by deviation in IEC 61000-3-2;2007 including Amendment 1.
IEC 61000-3-3	IEC 61000-3-3 Ed 2.0 Electromagnetic compatibility (EMC) – Part 3-3 Limits – Limits of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems with current less than or equal to 16 amperes per phase and not subject to conditional connection.

Abbreviations used in regulations	Full title
IEC 61000-3-4	IEC 61000-3-4 Ed 1.0 Electromagnetic compatibility (EMC) – Part 3-4 Limits – Limitation of emission of harmonic currents in low-voltage supply systems with rated current less greater than 16 amperes.
IEC 61000-3-5	IEC 61000-3-5 Ed 2.0 Electromagnetic compatibility (EMC) – Part 3-5 Limits – Limits of voltage fluctuations and flicker in low-voltage supply systems with rated current greater than 75 amperes.
IEC 61000-3-11	IEC 61000-3-11 Ed 1.0 Electromagnetic compatibility (EMC) – Part 3-11 Limits-limits for harmonic currents produced by equipment connected to public low-voltage supply systems with input current greater than 16 amperes and less than or equal to 75 amperes per phase.
IEC 62128-1	IEC 62128-1 Ed 1.0 Railway applications – Fixed installation – Part 1 – Protective provisions relating to electrical safety and earthing.
ISO/IEC 17050-1	ISO/IEC 17050-1 Conformity assessment – Supplier's declaration of conformity – Part 1 General requirements.
NZS 3003.1	NZS 3003.1:(2003) Electrical installations – Patient areas of hospitals and medical and dental practices – Testing requirements.
NZS 6115	NZS 6115:2006 Electrical installations – Mobile Electro-medical Connectable Installations: subject to variation that references in this standard to NZS3019 must read as references to AS/NZS3001.
NZS 6116	NZS 6116:2006 Safe application of electricity in meat processing industry.
NZS 7901	NZS 7901:2008 Electricity and gas industries – Safety management system for public safety.

Codes of practice	Full title
ECP 34	New Zealand Electrical Code of Practice for Electrical Safety Distances (NZECP 34:2001).
ECP 35	New Zealand Electrical Code of Practice for Power Systems Earthing (NZECP 35:1993).
ECP 36	New Zealand Electrical Code of Practice for Harmonic Levels (NZECP36:1993) issued on 4 February 1993.
ECP 41	New Zealand Electrical Code of Practice for Single Wire Earth Return Systems (NZECP41:1993) issued on 4 February 1993.
ECP 46	New Zealand Electrical Code of Practice for High Voltage Live Line Work (NZECP46:2003) issued on 12 October 2001.
ECP 50	New Zealand Electrical Code of Practice for Repair of Domestic Electrical Equipment (NZECP50:1993) issued on 4 February 1993.
ECP 51	New Zealand Electrical Code of Practice for Electrical Wiring Work in Domestic Premises (NZECP51:1993) issued on 4 February 1993.

Codes of practice	Full title
ECP 60	New Zealand Electrical Code of Practice for Inspection, Testing and Certification of Low Voltage AC Railway Signalling Control Circuits (NZECP60:1997) issued on 6 July 1997.

29. Practical Tasks and Skills Assessment

During the course of practical instruction and assessment; stress the importance of understanding how practical skill tasks relate to “on the job” situations.

The candidate shall demonstrate an acceptable level of skill and competency in the practical skill tasks listed for Stages 1, 2, and 3.

Skill assessment grading

A consistent grading system has been introduced for all registration classes:

C = competent
NC = not competent.

Any skill that has not been assessed is to be awarded a NC result and the reason entered into the comments section on the practical assessment record form.

To pass the practical assessment stage all skills must be successfully completed with “C” entered into corresponding result column and initialled by skill assessor.

30. Stage 1 – Practical Assessment Skills

Skill no.	Definition and task requirements	Essential capability references
1	Cardiac pulmonary resuscitation (CPR) training in New Zealand Resuscitation Council approved methods.	57, 58
2	Electrical safety and safe working practices by observing candidate’s ability to competently use the appropriate tools for the job, apply safety principles whilst carrying out practical skills.	40, 54
3	Make up two single-phase cord extension sets using different types of plug-tops and cord connector fittings.	42
4	(a) Identify, withdraw and replace re-wireable fuse elements at a functional switchboard (selection of correct fuse element size for cable rating). (b) Identify, withdraw and replace HRC fuse links at a functional switchboard – emphasis on replacing fusing factor with correct utilisation category.	31

Skill no.	Definition and task requirements	Essential capability references
5	Terminate flexible cords, cables and conductors using crimp lugs.	42
6	Soldering and de-soldering of: components on printed circuit boards, solder tags.	42
7	Design, install and terminate single-phase TPS sub-circuits for 10 amp and 15 amp flat pin socket outlets protected by RCDs to comply with AS/NZS3000.	31, 44
8	Design, install and terminate TPS sub-circuits incorporating one-way, two-way and intermediate switching of ES and BC lamp holders, ceiling roses and fluorescent lighting protected by RCDs to comply with AS/NZS3000.	31,43, 44, 52, 65
9	Design, install and terminate a three heat switching control circuit to a suitable load.	42,52
10	Design, install and terminate an energy regulator control circuit to a suitable load.	51, 52
11	Using appropriate test instruments obtain voltage and current ratings of single-phase appliances.	6
12	Test three portable electrical appliances in accordance with AS/NZS3760, AS/NZS5761, AS/NZS5762, affix an appropriate tag and complete a EWRB test sheet for each appliance (minimum of two class I appliances).	34, 46
13	Identify at least ten (10) electrical fittings and accessories and state an application for each.	43
14	Identify at least ten (10) flexible cords and cable types and specify a typical application for each type.	41
15	Install a single-phase induction motor and direct on line motor starter, test for safety, connect to the supply and run. Isolate and change the motor connections to reverse direction of rotation and test run.	20, 47
16	Install a three-phase induction motor and direct on line motor starter, test for safety, connect to the supply, test run. Isolate and change the motor connections to change direction of rotation and run.	16, 47
17	Make up, test and tag a three-phase cord extension set.	43
18	Install class I and class II fixed wired appliances connected by flexible cord to permanent connection units.	43, 44, 47
19	Disconnection and re-connection of single-phase fixed wired electrical appliances including safety tagging.	40, 62
20	Basic first aid training – complete a course with St John or Red Cross.	57, 58

31. Stage 2 – Practical Assessment Skills

Skill no.	Definition and task requirements	Essential capability references
1	Electrical safe working practices – observation of candidate's competency to apply safety principles whilst carrying out practical skill tasks.	40, 54
2	Visual checks of sub-circuit wiring for compliance with section 8.2 of AS/NZS3000:2007.	46
3	Testing of an existing installation main earthing conductor and equipotential bonding conductors for compliance with section 8.3.5 of AS/NZS3000:2007.	22, 38, 46
4	Testing installation protective earthing conductors for continuity and acceptable resistance values in accordance with section 8.3.5.2 of AS/NZS3000:2007.	22, 38, 46
5	Testing sub-circuit wiring for polarity and correct connections for compliance with sections 8.3.7 and 8.3.8 of AS/NZS3000:2007.	13, 38
6	Test switchboard mounted residual current devices (RCDs) affording personal protection for compliance with regulation 24, and section 8.3.10.2 (b) of AS/NZS3000:2007.	28, 38, 46
7	Test portable RCDs for compliance with section 2.2.3.4 and Appendix "D" of AS/NZS3760.	46
8	Insulation resistance testing of a Class I portable electrical appliance using the leakage current test method in accordance with section 2.3.3.2 of AS/NZS3760.	13, 38, 46
9	Testing earth fault loop impedance of socket-outlet sub-circuits that are not RCD protected for compliance in accordance with section 8.3.9.1 of AS/NZS3000:2007.	21, 22
10	Live test single-phase and three-phase sub-circuits using appropriate test instruments to obtain voltage, current and earth fault loop impedance values.	6, 13, 38
11	Design, install and terminate sub-circuit wiring for single-phase lighting and socket-outlets enclosed in PVC conduit to comply with AS/NZS3000:2007.	29, 45
12	Design, install and terminate sub-circuit wiring for three-phase socket-outlets enclosed in PVC conduit to comply with AS/NZS3000:2007.	29, 45
13	Make up, test and tag single-phase and three-phase cord extension sets suitable for industrial applications.	13, 42
14	Construct/assemble and wire a MEN switchboard for a domestic installation that incorporates correct components, fittings, layout, wiring and terminations to comply with Part 2 of AS/NZS3000:2007 (energy revenue meters are not required).	31, 32, 43

Skill no.	Definition and task requirements	Essential capability references
15	Design. Install and connect electrical appliance control circuits including protective devices for domestic water heating or space heating or similar applications.	46, 47
16	Design, install, terminate and protected lighting control circuits suitable for switching lighting banks in commercial and industrial applications. Control circuits are to include light sensing devices, contactors or relays etc.	37, 52

32. Stage 3 – Practical Assessment Skills

Skill no.	Definition and task requirements	Essential capability references
1	A comprehensive installation wiring exercise that incorporates Stage 1 and Stage 2 skills including: • wiring a MEN switchboard • mains cabling • sub-circuits wired in TPS • sub-circuits enclosed in PVC conduit • lighting control sub-circuits protected by switchboard mounted RCDs • single-phase socket-outlets sub-circuits protected by switchboard mounted RCDs • a range socket-outlet • a controlled electric water heater sub-circuit • three-phase switched socket-outlets • equipotential bonding conductors connected to metallic piping • a single-phase induction motor supplied from a DOL starter • testing in accordance with AS/NZS3000:2007 for compliance • completion of compliance certification to satisfy regulatory requirements • livening the supply and testing circuits for correct operation.	28, 29, 31, 32, 34, 38, 39, 42, 43, 44, 45, 46, 47, 52, 60, 65
2.	Safe working practices – observation of candidate's competency to apply safety principles whilst carrying out practical skill tasks.	40, 45
3	Install necessary wiring, carry out winding, component connections and safety tests on following **single-phase** cage induction motors. Capacitor start, capacitor start/capacitor run and split-phase. Liven, test run, and then reverse direction of rotation.	20, 47
4	Install component wiring connections and safety tests on **three-phase** cage induction motors. Liven, test run and reverse direction of rotation.	16, 47

Skill no.	Definition and task requirements	Essential capability references
5	Diagnose and locate common single-phase and three-phase cage induction motors electrical faults.	18
6	Direct on line starting for three-phase cage induction motors. Carry out connections and wiring of various starter components for two wire control and three wire control. Circuits to include overload protection and no volt release, local and remote stop/start stations.	16, 17, 18, 43
7	Single-phase universal motor and three-phase slip ring induction motor. Connections, testing, reverse direction of rotation of each motor. Speed control – for either a universal motor or a slip ring motor.	43, 44
8	Three-phase reduced voltage motor automatic starters – star/delta, primary resistance, auto transformer. Install control wiring and power circuits, test and liven a suitable three-phase motor (at least two starter types).	16, 18
9	Testing – an existing single-phase MEN installation – mains, sub-circuit wiring and fittings *in accordance with Section 5 of AS/NZS3019:2007.* *Ensuring the neutral conductor of mains has been positively identified and confirmed as correct by the candidate.*	13, 16, 28, 31, 39, 48
10	Testing – an existing three-phase MEN installation – mains, sub-circuit wiring and fittings *in accordance with Section 5 of AS/NZS3019:2007. Task is to ensure that the candidate positively identifies and confirms that neutral conductor of mains is correctly connected the supply network.*	13, 22, 28, 31
11	Testing – electrical appliances and electrical fittings. In service testing of **three** electrical appliances and completion of an EWRB appliance test sheet for each appliance. Include at least one poly-phase appliance.	13, 39
12	Using Prove–Test–Prove method – Identification and isolation of single-phase and three-phase sub-circuits.	40
13	Disconnection and reconnection of single-phase and three-phase fixed wired electrical appliances using safety tagging system – out of service tags and danger tags.	40, 44, 62
14	Residual current device installed for personal protection. Correct connections and operational testing for compliance with regulation 24 and AS/NZS 3190.	28, 31
15	Isolating transformer installed for personal protection. Correct connections, operational testing for verification of compliance with AS/NZS 3760.	13, 26, 46

Skill no.	Definition and task requirements	Essential capability references
16	Selection and replacement of high rupturing capacity fuse links at a functional switchboard. Tasks to include consideration of cable sizing, connected load and conditions of use. Special emphasis on replacing links labelled fusing factor (class) with correct utilisation category gG or gM.	31
17	Install, wire and terminate necessary components for at least two high intensity discharge light fittings: sodium vapour, mercury vapour and metal halide lamps. Test for safety and then live test each fitting with appropriate HID lamp fitted.	42, 43, 44, 65
18	Satisfactory completion of a basic St John or Red Cross first aid course or equivalent as approved by the Board.	57, 58