Electrical Installation Course C

2360

1998

City & Guilds

Publications and enquiries

City & Guilds publications are available from

Publications Sales
City & Guilds
1 Giltspur Street
London EC1A 9DD

Telephone 020 7294 2850
Facsimile 020 7294 2400

General information about City & Guilds may be obtained from the Customer Services Enquiries Unit at the above address, or on 020 7294 2800, or by e-mailing enquiry@city-and-guilds.co.uk.

Equal opportunities

City & Guilds fully supports the principle of equal opportunities and we are committed to satisfying this principle in all our activities and published material.

For a copy of our Equal Opportunities Policy statement please contact the Customer Services Enquiries Unit.

1 Giltspur Street
London EC1A 9DD
Telephone 020 7294 2468
Facsimile 020 7294 2400
Web site www.city-and-guilds.co.uk

Electrical Installation Course C

2360
1998

For examinations in

2360 Course C certificate

2360 Supplementary studies in Electronics

ST53851 2/98 P-00008313/COVER ST72536 09/01 BILLD

[This page is intentionally blank]

2360 Electrical Installation Competences

1.1 The certificates described in this pamphlet are
   a) the Course C certificate in Electrical Installation Work
   b) the Supplementary Studies certificate in Electrical Installation Work

1.2 The certificates are offered on the recommendation of the National Advisory Committee for Electrical, Electronic and Telecommunications Engineering. The bodies nominating members are listed inside the back cover.

1.3 Other schemes relevant to electrical installation are
   a) **General vocational preparation**
      Communication Skills (3611)
      Numeracy (3750)
      Basic Competence in Information Technology (4242)
      Key Skills (3615)
   b) **Vocational Education**
      Electrical Installation Theory and Practice (2360)
      NVQ in Electrical Engineering (2350)
      Electrical and Electronic Craft Studies (2320)
      NVQ in Functional and Electronic Servicing (2248)
      16th Edition IEE Wiring Regulations (2380)
      Inspection, Testing and Certification of Electrical Installations (2391)
      Design Erection and Verification of Electrical Installations (2400)
      Inspection and Testing of Electrical Equipment (2377)

2360 Electrical Installation Work - Course C

Assessments

2.1 The assessments related to the Course C certificate are listed below.

2360-021	Installation work and regulations	3 hours
2360-022	Electrical science	3 hours
2360-023	Project	40 hours

Project work

2.2 In Course C, colleges are required to confirm on their project marking schedule that candidates have satisfactorily completed a programme of laboratory/workshop activities. The Course C project itself is designed to occupy approximately 40 hours in the later stages of the course. Details of the project will normally be available for colleges by June in the year preceding the examination. The December project will be the same as that set for the preceding June examination. Projects will be marked by the colleges in accordance with a marking schedule provided. The Institute may call for marked projects and schedules from selected colleges to be submitted for review; the colleges concerned will be notified in advance.

2.3 Local secretaries are required to submit on the appropriate marksheets supplied by the Institute, results of candidate assessments for this project. These forms should be returned to the Institute by 30 June or 31 December according to the examination series.

Licentiateship of the City & Guilds (LCG)

2.4 **Electrical Installation**

The LCG is awarded to candidates who have awards at levels 2 and 3, in Career Extension and in industry as shown below

a) **For Level 2:** Course B certificate of the Institute or an REB
or
Part I (Institute or REB) and Part II certificates in Electrical Installation Competences (Electrical Installation Work) or Electrical Installation Theory and Practice

and

b) **for level 3 and career extension together:** Course C certificate

and

c) **for industrial achievement:** The Electrician's certificate, which includes registration as an Approved Electrician.

The provision and conduct of assessments

2.5 Assessments are conducted in accordance with the Institute's *Directory of Vocational Awards*. If there is any inconsistency between the subject regulations set out in this pamphlet and the current *Directory*, the latter prevails.

2.6 The conduct of centre assessments for the certificates in Electrical Installation Competences are moderated by an external assessor.

2.7 The dates of the written papers, assessed by the Institute are given in the *Directory of Vocational Awards*.

2.8 The assignments and centre assessments are prescribed by the Institute but are marked locally. Verifying assessors will be appointed to agree marking standards. Local secretaries are required to submit results of candidates' assessments by the date specified.

Entry for assessments

2.9 Candidates must enter through a City & Guilds registered centre. They may enter for all the assessments required for a certificate at one time or may choose instead to enter for a lesser number and build up credits towards certification. If a candidate already has previous credits, the reference number from the record of achievements or previous results slip must be quoted on the entry documents.

2.10 Entries for assessments under this scheme are confined to centres in the United Kingdom.

Issue of records of achievements and of certificates

2.12 All candidates successful in any assessment will receive a record of achievements towards the certificate for which they aim. There will be three grades of success (DISTINCTION, CREDIT and PASS); The records of achievements will make no mention of assessments for which candidates did not enter, which they failed, or from which they were absent.

2.13 Candidates will receive a certificate when they successfully complete all the required assessments.

2.14 Notification of candidate results, records of achievements and certificates will be issued through the centre at which the candidates entered. Any correspondence must be conducted through that centre.

2.15 Centres will receive consolidated results lists detailing the performance of all the candidates they enter, whether they are completely successful or not.

Syllabus

2360 Electrical Installation Work - Course C Installation Work and Regulations (2360-021)

The objectives indicate in general terms the abilities which the student should be able to demonstrate subject to the limits of the syllabus content.

Syllabus		Objectives
1	Regulations. Regulations for electrical installations.	Demonstrate knowledge of the practical applications to electrical installation work of the current edition of the Regulations for Electrical Installations and the ability to use this knowledge in electrical installation work.
	Electricity at Work Regulations, 1989. Memorandum on the Electricity Regulations (SHW 928).	Demonstrate knowledge of the Electricity at Work Regulations, 1989, concerning generation, transformation, distribution and use of electrical energy in activities subject to the Health and Safety at Work Act,1974.
	Electricity Supply Regulations, 1937 (Regulations 2229 and 32). Explanatory Notes on the Electricity Supply Regulations, 1937, prepared by the Electricity Commissioners.	Demonstrate knowledge of the Electricity (Supply) Regulations in so far as they deal with consumer installations under Regulations 2229 and 32, and of any regulations concerning consumer installation which may be issued by the Electricity Commissioners in addition to, or in substitution for those mentioned above.
	British Standards and Codes of Practice.	State the need for reference to the appropriate British Standards and Codes of Practice when planning and carrying out installation work.

Syllabus

2 Special installations
   a) Explosive area installation. Recognition of areas exposed to the risk of fire and explosion and the selection of suitable installation techniques.
      i) categories of areas of risk
      ii) types of wiring and apparatus for specific areas of risk
      iii) need for special protection against overcurrent
      iv) need for special protection against earth leakage currents
      v) supplies to portable and transportable apparatus including handlamps, consideration of monitored earth leakage protection.
      vi) techniques to be adopted when installing lighting and power, using steel conduit, mineral insulated cables and armoured cables
      vii) need for special techniques when inspecting and testing installations
      viii) intrinsically safe circuits and apparatus

Objectives

Identify risks attendant in the installation of petrol and diesel retailing pumps. Recognise the need to conform to local licensing authorities and statutory regulations. Select means of satisfying safety requirements regarding supply wiring to pump, control of supplies to pump lighting and motors. Draw and explain circuit diagrams for pressurised and pipe ventilated systems. Identify the dangers due to the presence of dust in areas not normally considered to be explosive areas. Describe the special precautions to be observed in installation and maintenance procedures. Identify dangers due to static electricity discharges and simple means of minimising danger. Outline the risks attendant in hospital operating theatres due to static electricity. State simple ways of minimising danger.

Syllabus	Objectives
ix) segregation, ventilation and pressurisation methods of avoiding ignition x) flameproof installations	
b) Hazardous area installation. Areas liable to require consideration due to the presence of deleterious conditions, eg i) mines and quarries ii) heavy plant maintenance depots iii) water and sewage plant iv) lighting of public areas (vandalism) v) outdoor lighting and power vi) steelworks, foundries vii) building and construction sites.	Assess the installation techniques to be employed in areas exposed to hazardous conditions.
c) Agricultural and horticultural installations. Potential hazards to persons, property and animals from the use of electricity due to the abnormal conditions prevalent in agricultural and horticultural establishments, eg i) damp and humid atmosphere	State and explain ways of minimising hazards and risks including i) assessment of wiring systems which will withstand such conditions ii) correct selection, siting and use of suitable equipment and cables for specific areas iii) provision of reduced voltage supplies and/or monitored earth leakage protection

Syllabus	Objectives
ii) mechanical and animal damage iii) chemical corrosion and erosion iv) rough usage by electrically unskilled persons v) rodent and vermin attack vi) earth leakage currents vii) electric fences.	iv) special earthing arrangements. Describe the installation of overhead and underground distribution cables on agricultural and horticultural establishments.
d) High temperature installations	Identify areas requiring special consideration due to high operating temperature conditions and describe cables and terminations for use in high temperature areas. Describe the effects of high temperature on rotating plant and control gear performance, the use of special enclosures, and explain the siting of equipment to avoid defects and premature failure. Describe the effects of high temperatures on luminaires and the use of special enclosures.
e) Low temperature installations.	Identify areas requiring special consideration due to abnormally low operating temperature conditions. State and describe cables and terminations for use in low temperature areas. Describe the effects of low temperature on rotating plant and control gear performance and use of special enclosures. Describe the effects of low temperature conditions on discharge luminaires and choose suitable tubes/lamps and luminaires.

Syllabus	Objectives
f) Corrosive environments.	Identify areas requiring special consideration due to the presence of corrosive atmosphere, liquids and fumes including outdoor installations. Compare relative resistance of normal wiring systems and equipment to deleterious environmental conditions. Identify areas requiring special consideration in the choice of installation systems. Select special installation cables, equipment and techniques to counteract adverse conditions.
g) Fire alarm systems (BS 5839). Types of circuit call points, warning and supervisory devices.	Describe and explain systems of electrically operated fire alarm systems including i) simple open circuit ii) monitored open circuit iii) closed circuit iv) monitored closed circuit. Describe and identify types of call point in use, eg (internal circuitry omitted) i) manual break glass ii) smoke detectors iii) temperature rise detectors iv) rate of temperature rise detectors v) flame detectors. State the factors affecting the siting of call points to afford maximum protection to persons and property.

Syllabus	Objectives
	Describe and identify types of warning devices used for fire alarm systems including i) bells ii) horns iii) sirens iv) warblers v) visual. State the factors affecting the siting of warning devices to afford maximum coverage of premises. Describe and identify types of supervisory devices incorporating, eg i) zone indicators ii) supervisory sounders and diversion relays Demonstrate a brief outline knowledge only of telephone links to fire brigade and police and the restricted warning arrangements for hospitals, and public entertainment premises.
Cables, wiring and power supplies.	Identify and describe types of cable and wiring for use with fire alarm systems and method of installation. Explain the need for reliability of supply i) exclusive main circuit ii) standby supplies. Describe charging and maintenance requirement for cells. Specify the requirements of servicing for simple fire alarm systems. Draw, read and explain circuit diagrams for simple fire alarm systems.

Syllabus		Objectives
h)	Standby supplies.	Recognise buildings and areas requiring the provision of standby sources of supply to ensure
	Maintained supplies.	i) safety of persons ii) security of goods and premises iii) maintenance of manufacturing processes iv) correct working of equipment.
	Emergency supplies.	Describe i) dual supplies ii) battery systems iii) standby generators. Select and describe means of providing supply to essential services section of installation in the event of supply breakdown, eg sectionalised busbars, separate subdistribution arrangement. Draw circuit diagrams to show transfer arrangement to minimize period of supply interruption, (excluding manufacturers' engine control circuit diagrams).
3	Distribution.	
a)	Supply authority network.	Describe the effects of the characteristics of the supply system on the consumer's installation.
b)	Consumers' distribution.	Describe methods of distribution to load centres. Describe multi substation systems on sites and in buildings (single and multistory). Explain the importance of security of supply, use of ring mains, radial feeders, duplicate busbars, means of isolation, balancing of loads and need for discrimination between protective devices. Describe provision for future extension.

Syllabus	Objectives
	Describe and show methods of distribution in industrial, commercial and domestic premises, ie cables, busbar trunking. Demonstrate knowledge of load centres and application of diversity to submains. State factors governing the choice of system.
c) Distribution systems.	Describe the construction and state the use of cables for distribution systems up to 11 kV including PILCSTA, PIAS, Consac, Waveconal, split concentric cables. State labour-saving benefits derived from the use of up-to-date techniques in cable installation. Describe the construction and installation of distribution busbar systems, connection of take-off points.
d) Distribution equipment.	Describe and show a substation layout. Describe methods of cooling transformers. Demonstrate concept knowledge of the forces released on interrupting heavy fault current. Explain how arc control is achieved in the operation of: semi-enclosed fuses, HBC fuses, moulded case circuit breakers, air circuit breakers, oil circuit breakers – plain and assisted types, vacuum circuit breakers. Demonstrate knowledge of air blast circuit breakers.

Syllabus	Objectives
e) Protection of distribution.	State applications for current and voltage transformers related to overcurrent and earth leakage protection. State applications of induction overcurrent relays and earth leakage relays, in the tripping circuit of circuit breakers. Explain fault energy levels and the effect of power factor on these.
4 Metering. a) Supply authority metering.	Describe metering arrangements for domestic tariffs (normal and off-peak). Describe the use of commercial whole current metering: maximum demand indicators. Describe and state industrial CT metering requirements for consumers' installations to enable the connection of the various types of metering including summation metering.
b) Consumers' metering.	Draw and describe installation and connection of voltmeters, ammeters, wattmeters including the use of CTs and VTs as instrument transformers.
5 Earthing. a) Reasons for earthing. b) Methods of earthing.	State the hazards arising from earth leakage currents; shock and fire risks. Describe and explain earth fault loop impedance.

Syllabus	Objectives
	Describe the earth fault loop circuit in relation to methods of earthing. i) terminal provided by supply authority connected via a metallic path to system earth ii) use of earth electrodes iii) PME terminal provided by supply authority.
c) Earth leakage protection.	Describe the installation and testing of earth electrodes. Demonstrate knowledge of voltage gradients and step potential of electrodes. Describe earth leakage protection and requirements for the consumers' installation. State the effects of fortuitous earth paths. Describe and explain i) the earth circuit ii) bonding iii) use of overcurrent protective devices iv) residual current devices v) monitored earthing systems.
6 Protection. Protection of buildings against lightning. CP 326 1965. Methods of protection against lightning strikes. Earthing of protective systems and testing.	Determine the number of air terminations, electrodes and down conductors required. Explain use of building structures in lieu of down conductors. Describe bonding of extraneous metalwork to protection system and bonding to main earthing system. Explain the need for periodic inspection and recording of results. Describe testing the resistance to earth of protection electrodes and measurement of soil resistivity.

Syllabus	Objectives
7 Corrosion and erosion. a) Corrosion and erosion within an electrical installation.	Explain briefly the main causes of corrosion and erosion such as chemical attack, natural atmospheric conditions, moisture, electrolytic action. Describe methods of protection i) selection of suitable materials ii) careful handling of installation materials and storing iii) application of protective techniques such as surface finishes, paints, tapes, gaskets and sheaths; need for preventive maintenance.
b) Cathodic protection of structures and equipment. (This is a specialist function but a knowledge of the principles involved is necessary for those who may be engaged in installing equipment.)	Demonstrate basic knowledge of the theory of cathodic protection, galvanic and impressed current systems. Identify zinc, magnesium and aluminium as sacrificial anode materials. Describe the effects of corrosive waters on immersion heaters and appropriate preventive measures.
8 Equipment. a) Application, installation, methods of starting and control of induction, synchronous and a.c. d.c. motors.	Draw circuit diagrams and describe starting methods including use and operation of control and protective devices. Determine cable sizes. Describe applications of these motors including the effects of environment and use of motor enclosures.

Syllabus	Objectives
b) Application, installation and methods of control of d.c. power supplies obtained through motor generators and silicon rectifiers.	Describe applications and explain operation of motorgenerator and rectifiers. Draw and explain control circuits for standby generators, including the use of time delay. State installation requirements for rectifiers and generators including mobile units.
9 Plant. Foundations and frameworks for electrical plant. Installation of plant.	Describe fixing requirements for transformers, switchgear and motors. Demonstrate basic knowledge of problems in siting of plant, eg vibration, noise levels and leakage of oil.
Methods of handling plant.	Identify and describe correct methods for lifting and moving equipment: safety considerations.
Mechanical transmission of power.	Describe direct drives and belt drives including alignment of pulleys, maximum and minimum spacing of pulleys. Determine belt speed, and pulley speed. Select type and number of belts. Explain use of gear and chain drives. Describe methods of achieving change of speed. State advantages and limitations of each type in respect of the environment.
Maintenance of plant. (with reference to BS 3811 1974 as appropriate.)	Describe maintenance requirements for switchgear, transformers, rotating machines. Describe planned maintenance routines, the use of inspection lists and manufacturers' recommendations.

Syllabus	Objectives
10 Lighting systems. Installation of lighting systems with special consideration of discharge lamps and signs and the associated control gear. Harmonics, cause and effect.	Select and describe suitable luminaires for various situations including office blocks, drawing offices, hospitals, road lighting, stock yards and car parks. Select light source related to the advantages and disadvantages, eg incandescent, fluorescent, halogen, mercury vapour, sodium vapour. Explain stroboscopic effect. State the requirements and identify and solve problems associated with high voltage discharge signs. State the effects of harmonics on installations and equipment.
11 Heating systems. a) Installation of electric space heating systems i) direct; radiant and convection ii) thermal storage: storage radiators and underfloor.	Describe methods of wiring, control and protection of direct and thermal storage installation. Compare the different schemes, stating advantages and disadvantages and explain off-peak tariff arrangements. Demonstrate basic knowledge of heat recovery from lighting systems.
b) Water heating and steam raising by electrical methods.	Describe and compare domestic and commercial water heaters, with reference to types, ratings, installation problems, temperature control. Describe the electrode water heater with reference to installation and temperature control methods.
c) Electric control circuits for heating systems using other fuels.	Draw and explain interconnection of control components (external circuitry only).

Syllabus	Objectives
	Distinguish between total torque developed and shaft torque. Compare the types of single-phase motors in general use, including starting characteristics of capacitor start, capacitor start and run, split phase and shaded pole.
7 Synchronous machines. The synchronous motor and alternator. Power factor improvement by synchronous motors.	Describe the basic constructional feature of the synchronous motor and alternator. Explain the effect of varying excitation and mechanical input to an alternator. Describe methods of synchronising 3-phase alternators and the modification necessary to make synchronous motors self starting. Explain the effect of varying excitation and load of a synchronous motor to achieve power factor improvement.
8 Motor starting and control systems. Revision of starting methods and speed control for d.c. machines.	Demonstrate knowledge of starting currents and torques due to different methods of starting and the effect of these on the supply system. Describe starting methods including the use of the face plate starter, contactor, field and armature regulators. State the functions of the various components of the basic Ward-Leonard system and describe the operations of the circuit. Explain the intermittent rating of starters and continuous rating of field rheostats.

Syllabus	Objectives
Revision of starting methods and speed control for single-phase and 3-phase induction motors.	Describe starting methods including direction-line, star-delta, wound rotor and autotransformer. Describe speed control using pole changing, frequency changing, rotor resistance and thyristor voltage regulation methods.
Motor protective systems and overall control systems.	Use block diagrams as an introduction to overall control systems. Describe and explain supervisory and sequence control of multi-drive units.
9 Measurement. a) Instruments.	Describe principles of operation (not construction) of the types of instruments used to measure voltage, current, power, resistance, (including bridge-type instruments), speed, temperature, frequency and power factor.
b) Uses and applications of analogue and digital instruments i) Permanently installed instruments, including associated external circuits and equipment. ii) Portable instruments. Multi-range meters, 'clip-on' ammeters, continuity testers, insulation testers and earth loop impedance testers. Instruments for testing the resistance of earth electrodes and instruments for testing the operation of residual current and voltage operated protective devices. Pyrometers and tachometers.	Describe uses and applications. With the aid of sketches, describe the use of voltage transformers, current transformers, including selector switches. Demonstrate knowledge of ratio and burden (load) in correct selection of voltage and current transformers. Describe uses and applications of the listed instruments. Describe and use the two wattmeter method of determining power and power factor (without proof of formula).

Syllabus	Objectives
10 A.C. distribution. Single and 3-phase systems up to 11 kV.	Describe 2-, 3- and 4-wire circuits. Explain the need for balance of loads on a 3-phase system and correct distribution of single phase loads on a 3-phase circuit. Demonstrate knowledge of the applications of overcurrent and earth leakage protective devices. Describe and explain discrimination and grading of protective devices.
11 Electronics. The aim of this section is to give a basic understanding of electronic applications in electrical installation work. It is intended that much of the content will be taught within a workshop/laboratory environment.	
Use of the cathode-ray oscilloscope.	Demonstrate knowledge of the oscilloscope as a tool for investigation of circuit behaviour. Determine time, amplitude and frequency from trace measurements.
Operation and applications of transducers: light dependent resistors, photodiodes, phototransistors, strain gauge and piezoelectric pressure transducers, thermocouples, thermistors, variable capacitors and resistors.	Describe briefly the operational function of the listed devices (characteristics are not required). State typical applications.
Elementary treatment of diodes, transistors, zener diodes, diacs, triacs and thyristors.	Describe briefly the operational function of the listed devices (characteristics are not required). State voltage, current and temperature limits. Describe the effects of transients and thermal runaway.

Syllabus	Objectives
Packaging of discrete components and integrated circuits. Printed circuit boards.	Describe briefly the packages used for active components including ICs. State the factors to be observed when replacing components on printed circuit boards.
D.C. power supplies.	Draw circuit diagrams and describe the operation of half-wave, full-wave and bridge circuits including smoothing circuits. Describe simple Zener diode voltage stabilising.
Amplifiers.	Explain operational function of amplifiers treated as a black box. Describe relationship between input, output and gain.
Signal sources: signal and pulse generators.	Describe and use signal sources as a tool for investigation of circuit behaviour. Explain in simple terms markspace ratio.
Logic gates and circuits.	Describe AND, OR, NAND, NOR and NOT gates and use truth tables to illustrate function. (Logic circuits restricted to two inputs per gate and up to four gates.)
Control circuits.	Demonstrate knowledge of methods of gating thyristors and triacs; explain amplitude, phase angle, pulse and burst firing. Describe methods of isolating gates, eg 3-phase control. State precautions necessary when controlling reactive loads, eg discharge lighting and motors. Explain the need for observance of manufacturer's specifications in respect of current, voltage, temperature and polarity. Describe remote control devices, eg infrared and sonic beams.

Syllabus	Objectives
Testing of electronic and semiconductor devices.	State types of test instruments and their uses. Describe the effects of test instruments when applied to circuits. Explain simple go/no go tests on electronic components. Relate sensitivity, polarity and voltage limitations to the use of multimeters for testing electronic components.
12 Utilisation of electric power. Motors. Calculation of electrical/mechanical power requirements.	Determine electrical power required to carry out various mechanical tasks, eg hoists, lifts, pumps.
Heating. Power requirements for heating loads. Selection and siting of the most suitable forms of electrical heating and their associated controls.	Determine electrical power requirements i) by calculation of steady state heat loss from a heated building using recommended design criteria ii) for water heating.
Lighting. Light sources; filament and discharge lamps and associated luminaires. Principles of lighting design.	State and apply terms used in illumination. Calculate illumination by i) inverse square law and cosine law ii) luminous flux method. Describe the cause and effect of glare (glare index NOT to be used in calculation).
Tariffs. Basis and elements of various tariffs in common use.	Briefly explain tariffs and load demand curves. State advantages and limitations of flat rate, block two-part, maximum demand and off-peak tariffs. Calculate costs using typical Electricity Board tariffs.

Syllabus

Power factor. Effect of loads with low power factor; advantages of power factor improvement; power factor improvement calculations.

Objectives

Describe the importance and effect of power factor in the rating of electrical machines and equipment. Explain the economics of power factor improvement. Compare and equate the merits of individual and group improvement methods.

236 Electrical Installation Work - Course C Laboratory/Workshop Activities

The exercises listed are intended to illustrate the principles included in the Course C Installation Work and Regulations and Electrical Science syllabuses and to promote an understanding of the reasons for correct practice.

The exercises should cover a complete course but will need to be adjusted in accordance with the scheme of work used.

Confirmation that a student's programme of laboratory/workshop activities has been completed satisfactorily will be required on individual project marksheets.

1 Investigation into effects of parallel earth paths (eg using simulation panel).
2 Layout wiring requirements and connection of an electrical control system for heating.
3 Diagnostic fault finding on installations.
4 Murray loop test and Varley loop test for cable fault location.
5 Diagnostic fault finding on a.c. and d.c. machines and associated control gear.
6 Magnetisation characteristics of a d.c. generator.
7 Charge and discharge curves (capacitor).
8 Current in a neutral (3-phase unbalanced load) and the effect of a broken neutral.
9 Verification of Kirchhoff's laws.
10 RLC series and parallel a.c. circuits.
11 Resonance (ie variable frequency AND variable reactance).
12 Efficiency and regulation of a transformer.
13 Load tests on d.c. generators, d.c. motors and on induction motors.
14 Load tests on an alternator and on a synchronous motor.
15 Synchronising an alternator on to 'live' busbars.
16 Power factor improvement using synchronous motor.
17 3-phase power factor improvement.
18 Layout, wiring requirements and connection of sequence control for motors.
19 Use of CTs and VTs.
20 Two-wattmeter method (3-phase power).
21 Use of Wheatstone bridge.

22 Installation and commissioning of residual current protective devices.
23 Inverse square and cosine laws of illumination.
24 Investigation of control, operation and output of MV, SV and fluorescent lamps and circuits.
25 Plotting the 'polar' curve for a luminaire.
26 Use of the cathode-ray oscilloscope to determine the amplitude and frequency of alternating voltages.
27 Use of LDRs for automatic lighting systems and of thermocouples for measurement of temperature.
28 Introduction to use of manufacturer's data to identify connections to semiconductor devices.
29 Construction of a simple Zener diode stabilising circuit.
30 Investigation of the operation of a simple amplifier to determine amplifier gain.
31 Production of a simple astable multivibrator to demonstrate the relationship between capacitance, and resistance and the markspace ratio.
32 Construction and testing of basic logic circuits.
33 Construction and investigation of a phase controlled lamp dimming circuit.
34 Use of test instruments to perform simple tests on semiconductor devices.

2360 Electrical Installation Work Supplementary Studies in Electronics (2360-031)

Introduction

5.1 These supplementary studies have been prepared to provide a free standing option in basic electronic systems and related technology which can be taken as an additional award by electrical installation work students.

These studies will be appropriate to those who have already achieved the Part II certificate in Electrical Installation and wish to up-date their knowledge, or as complementary studies to the electronic content of 236 Course C.

The scheme will be separately certificated and will not be a requirement for the 2360 Part I, Part II or Course C awards. Examinations will be available at the December and June series to allow flexibility in course provision.

Assessments and records

5.2 The examination will consist of an objective paper of 60 multiple-choice questions as shown below.

2360-031 Supplementary studies in electronics (MC)	2 hours

Issue of records of achievements and certificates

5.3 Each candidate will receive a record of achievements towards the certificate for which they aim – there are three grades of success DISTINCTION, CREDIT, and PASS.

5.4 Candidates will receive a certificate when they successfully complete all the requirements.

Syllabus

Electrical Installation Work Supplementary Studies in Electronics (236-4-31)

The intention of the scheme is to provide a functional knowledge of the electronic equipment most likely to be met by installation electricians.

The depth of treatment should extend to that sufficient to enable the electrician to perform tests to locate a system malfunction to a readily replaceable unit and to reactivate the system. It is recognised that in some circumstances the electrician will be involved in discrete component replacement and therefore the scheme reflects the need for a basic working knowledge of common electronic components and circuits.

The aims of the scheme can most effectively be achieved if students can see, use and in other ways come into contact with the components, processes and equipment involved and they should therefore be given a practically based experience of the subject.

The syllabus is set out in a format of topics described by objectives, related technology and suggested practical activities. The objectives indicate in general terms the abilities which the student will be expected to demonstrate subject to the limits of the content shown under 'technology'.

1 Component recognition

Objectives

1 Name a listed component from a diagram or description.
2 State the uses of the listed components.
3 Determine the value of resistors and capacitors, given their colour coding or marking.
4 Determine upper and lower tolerance values from given data.
5 State why preferred values are useful.

Technology	Practical activities
1 Identification of resistors in common use (constructional detail is not required). Resistor value identification: colour code, BS1852, BS2488. Preferred values. Tolerances.	Identify resistors in simple electronic circuits. Measure resistor values.
2 Identification of capacitors in common use (constructional detail is not required). Capacitor value identification. Preferred values. Tolerances.	Identify capacitors in simple electronic circuits.
3 Identification of transformers and inductors in common use (constructional detail is not required). Power, audio and h.f. types.	Identify inductors and transformers in simple electronic circuits.
4 Identification of semiconductors: diodes, transistors, thyristors, diacs, triacs, integrated circuits. Use of manufacturers' data to obtain 'pin out' arrangement.	Identify semiconductor types and connections.

2 Electronic circuit diagrams

Objectives

1 State types of electronic diagram, giving reasons for their use.
2 Identify common electronic components in accordance with BS 3939 symbols.
3 State reasons for the use of component positional reference systems.
4 Use a component positional reference system.

Technology	Practical activities
1 Types of diagram: block, circuit, layout. Component positional reference systems.	Draw simple electronic diagrams.
2 Electronic diagram symbols for components in common use (BS 3939).	

3 Use of hand tools

Objectives

1 Identify the tools required to undertake specified jobs.
2 State maintenance requirements for tools and equipment.
3 Describe suitable methods for producing sound electrical connections without compounding damage.
4 Describe methods of component replacement.
5 State safe working procedures.

	Technology	**Practical activities**
1	The formation of good electrical connections by soldering and wire wrapping. Use of heat shunts and shields.	Soldering and wire wrapping.
2	Methods of component replacement.	Determination of faulty component in a simple resistive circuit. Replacement of faulty component.

4 Electronic units

Objectives

1 Identify the unit from a given diagram or description.
2 Describe the function of a given unit.
3 State how a malfunction of a unit would be recognised.
4 State applications of each unit.
5 State reasons for the use of regulated power supplies.
6 Compare display units.

	Technology	**Practical activities**
1	Amplifiers: small signal, power, operational.	Observation of simple audio amplifier input and output using a C.R.O.
2	Oscillators: sinusoidal, pulse and sawtooth.	Measure output frequency of simple oscillator circuit.
3	Filters: low pass, high pass.	

Technology	Practical activities
4 D.C. power supplies: regulated and unregulated.	Observe effect of loading and mains voltage fluctuation on each type.
5 Logic gates: AND, OR, NOT, NAND, NOR.	Test simple logic gate to check for correct operation.
6 Display units: light emitting diodes. Seven segment displays.	Use of test instrument incorporating these displays.

5 Testing and test equipment

Objectives

1 Select a suitable instrument for a given application.
2 State limitations of listed instruments.
3 Identify correct connections of listed instruments.
4 Describe the use of instruments to test the serviceability of components and units.
5 State reasons for the use of high impedance voltmetres on electronic circuits.
6 State precautions to be taken to protect electronic equipment when testing insulation resistance.
7 State safe working procedures.

Technology	Practical activities
1 Use of digital and analogue multimeters, signal generators, cathode ray oscilloscopes, logic probes and frequency meters.	Simple 'out of circuit' testing of resistors, capacitors, diodes, transistors, thyristors, diacs, triacs and integrated circuits.

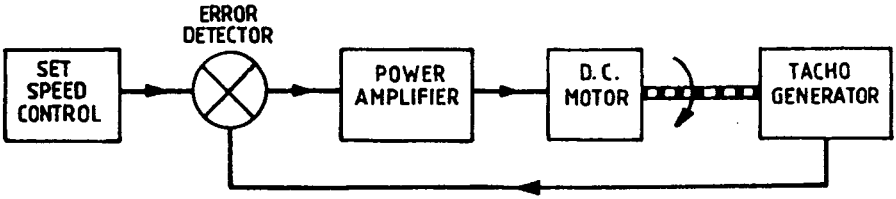
6 Electronic Systems

Objectives

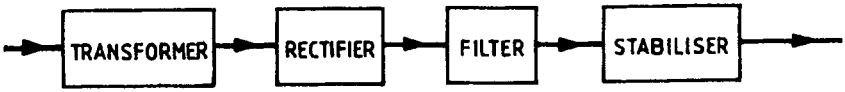
1 Identify block or circuit diagrams for the listed systems.
2 Name the units within a listed system and state the function of each.
3 Describe the operation of listed systems.

Standard Systems as shown.

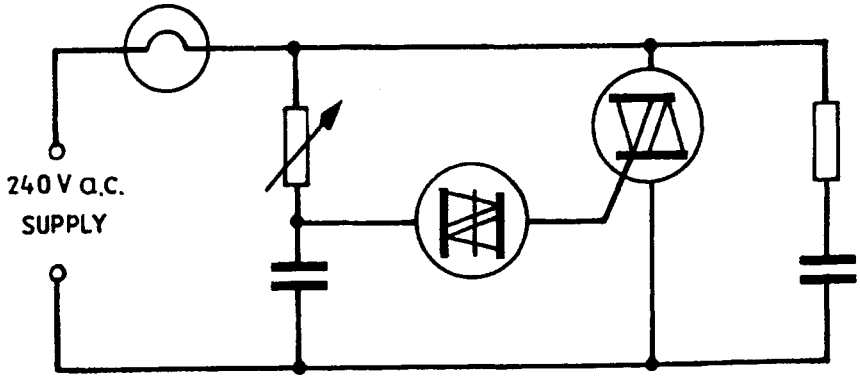
Motor Speed Control



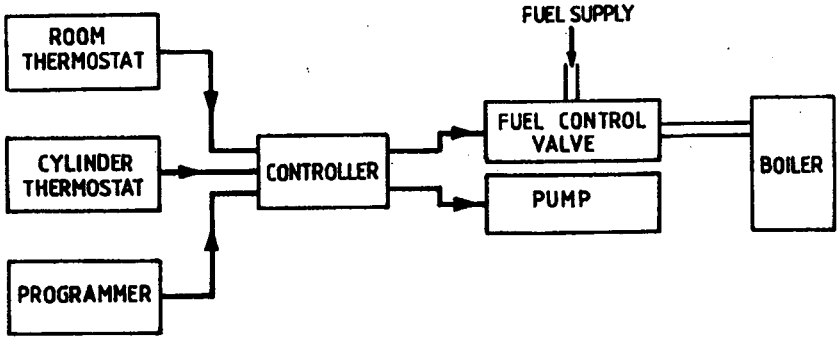
D.C. power supply



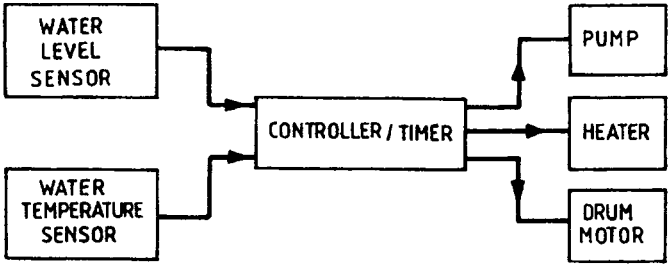
Lamp dimmer



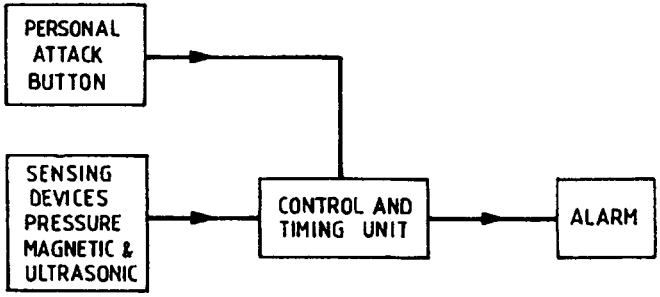
Space heating control



Washing machine control



Security system



Electrical Installation Work
Supplementary studies in electronics

Test specification for component 2360-031

There are 60 items in this multiple-choice test to be answered in 2 hours. They will be allocated to the sections of the component in approximately the following numbers.

Section		Number of Items
01	Component recognition	8
02	Electronic circuit diagrams	4
03	Use of hand tools	5
04	Electronic units	14
05	Testing and test equipment	11
06	Electronic systems	18
	Total	60

0236 Electrical Installation Competences

1 The certificates in Electrical Installation Competences are offered on the recommendation of the National Advisory Committee for Electrical, Electronic and Telecommunication Engineering. The Chairman of the National Advisory Committee, appointed by the Policy Committee for Education and Training, is

Mr D Bartley.

2 The members of the National Advisory Committee for Electrical, Electronic and Telecommunication Engineering are nominated by
Joint Industry Board for the Electrical Contracting Industry
Engineering Employers' Federation
British Radio and Electronic Equipment Manufacturers Association
Electrical and Electronic Manufacturers Training and Education Board
Electrical Contractors Association
Engineering Industry Training Board
Construction Industry Training Board
Electricity Supply Industry Training Committee
Amalgamated Engineering Union
Electrical, Electronic, Telecommunication and Plumbing Union
Department of Education and Science
Department of Education for Northern Ireland
The Training Agency
Ministry of Defence
Telecommunications Vocational Standards Council
Institute of Electrical and Electronic Incorporated Engineers
Association of Manufacturers of Domestic Electrical Appliances
Electronic Office Systems Maintenance Industry Lead Body
Security Alarms Industry Lead Body
Electronics Examinations Board.

Published by City & Guilds 1 Giltspur Street London EC1A 9DD
City & Guilds is a registered charity established to promote education and training

SP-00-0236